Landscape and Urban Planning 179 (2018) 17–37

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Review Article

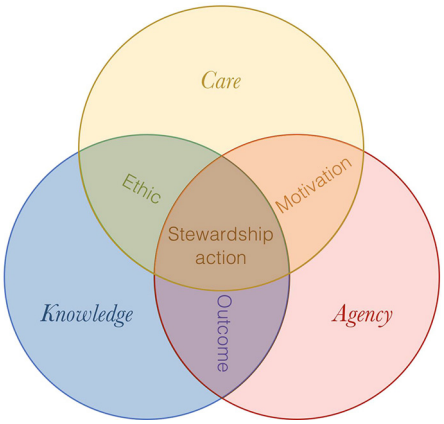
Stewardship as a boundary object for sustainability research: Linking care, knowledge and agency

Johan Peçanha Enqvist[a,*], Simon West[b], Vanessa A. Masterson[b], L. Jamila Haider[b], Uno Svedin[b], Maria Tengö[b]

[a] African Climate and Development Initiative (ACDI), University of Cape Town, Private Bag X3, 7701, South Africa
[b] Stockholm Resilience Centre (SRC), Stockholm University, SE-10691, Sweden

GRAPHICAL ABSTRACT

We identify four distinct uses or meanings of stewardship in the literature: Ethic, Motivation, Action and Outcome. Using a framework based on three overlapping dimensions of stewardship – care, knowledge and agency – we demonstrate how these meanings relate to each other and how this can facilitate communication and collaboration between and among scholars and practitioners.



ARTICLE INFO

Keywords:
Anthropocene
Environmental ethics
Human-nature relations
Literature review
Natural resource management

ABSTRACT

Current sustainability challenges – including biodiversity loss, pollution and land-use change – require new ways of understanding, acting in and caring for the landscapes we live in. The concept of stewardship is increasingly used in research, policy and practice to articulate and describe responses to these challenges. However, there are multiple meanings and framings of stewardship across this wide user base that reflect different disciplinary purposes, assumptions and expertise, as well as a long history of use in both academic and lay contexts. Stewardship may therefore be considered a 'boundary object'; that is, a conceptual tool that enables collaboration and dialogue between different actors whilst allowing for differences in use and perception. This paper seeks to map out the multiple meanings of stewardship in the literature and help researchers and practitioners to navigate the challenges and opportunities that come with using the term. We provide the first qualitative systematic review of stewardship, and identify four distinct meanings of the concept in the literature: Ethic, Motivation, Action and Outcome. We then develop a novel framework for thinking through and connecting these multiple meanings, centered around three dimensions: care, knowledge and agency. This framework is used to

* Corresponding author.
E-mail addresses: johan.enqvist@uct.ac.za (J. Peçanha Enqvist), simon.west@su.se (S. West), vanessa.masterson@su.se (V.A. Masterson), jamila.haider@su.se (L.J. Haider), uno.svedin@gmail.com (U. Svedin), maria.tengo@su.se (M. Tengö).

https://doi.org/10.1016/j.landurbplan.2018.07.005
Received 19 December 2017; Received in revised form 11 July 2018; Accepted 12 July 2018
Available online 25 July 2018

identify the care dimension and relational approaches as important areas for future stewardship research. In these efforts – and for scholars engaging with the stewardship concept more broadly – this paper can act as a helpful 'centering device', connecting practitioners, policy-makers and researchers from multiple disciplines in pursuit of sustainability.

1. Introduction

Contemporary landscapes face an array of sustainability challenges, including biodiversity loss, pollution and land-use change (Wu, 2013). Many of these challenges are rooted in a failure to realize and effectively acknowledge key characteristics of landscapes, including complexity, dynamic change, and the inextricability of social and natural phenomena (Ahern, 2011; Berkes, Colding, & Folke, 2003; Leach, Scoones, & Stirling, 2010; Lorimer, 2012). The global significance of these issues is captured in the Anthropocene concept, which refers to a proposed new geological epoch in which humans are influencing planetary-scale biophysical processes in unprecedented ways (Crutzen, 2002; Steffen, Crutzen, & McNeill, 2007). It is clear that we need to develop new ways of understanding, acting in and caring for the landscapes we live in Palsson et al. (2013).

Stewardship is increasingly used to articulate and describe responses to sustainability challenges (Connolly, Svendsen, Fisher, & Campbell, 2013; Enqvist, Tengö, & Bodin, 2014; Nassauer, 2011). The concept of stewardship has a long history of use in environmental thought and has often been used to refer to the wise or responsible use of natural resources (Welchman, 2012). More recently, stewardship has been used to indicate a broad shift away from techno-managerial, control-oriented approaches to landscape and environmental management, policy and planning, towards those that prioritize participatory, cross-scale, and trans-disciplinary, engagements rooted in shared values (e.g. Worrell & Appleby, 2000, Chapin, Sommerkorn, Robards, & Hillmer-Pegram, 2015). A variety of distinct framings of stewardship have emerged in recent years, each carrying particular disciplinary emphases and normative commitments. These include 'landscape stewardship' (Plieninger & Bieling, 2017), 'ecosystem stewardship' (Chapin, Kofinas, & Folke, 2009), 'earth stewardship' (Chapin et al., 2011), 'planetary stewardship' (Steffen et al., 2011) and 'biosphere stewardship' (Folke, Biggs, Norström, Reyers, & Rockström, 2016). The stewardship term has also been extensively adopted in policy and practice, ranging from, for instance, certification schemes such as the Forest Stewardship Council (FSC) (Eden, 2009) and Marine Stewardship Council (MSC) (Cummins, 2004), to civic and community environmental groups (Fischer, 2015).

With this wide and diverse use across research, policy and practice, the concept of stewardship has accrued multiple meanings – and particular uses have attracted a range of different critiques. These controversies reflect the complex, contested nature of pursuing sustainability, and also the different approaches to using concepts among natural and social scientists, policy-makers and citizens. For instance, social scientists have criticized the stewardship term for depoliticizing contemporary sustainability challenges and limiting the potential for radical social change (Swyngedouw & Ernstson, 2018). Meanwhile, natural scientists have accused the FSC and MSC of 'greenwashing' on account of their failure to secure promised environmental benefits (e.g. Christian & et al., 2013). While these controversies are rooted in different ideas of what stewardship ought to mean, researchers have only recently started to unpack and explore the assumptions, emphases and purposes underpinning different uses of the term (Bennett et al., 2018; Mathevet, Bousquet, & Raymond, 2018; Romolini, Brinkley, & Wolf, 2012).

The aim of this paper is to enhance understanding between scholars and others engaging with the stewardship concept, and help readers to navigate the opportunities and tensions that come with using the term. Our first contribution is a qualitative systematice literature review to examine the multiple meanings of stewardship. In the natural sciences, for example, one might seek to assess different approaches to stewardship by measuring their relative ability to secure particular sets of (environmental) outcomes, with the aim of discerning and then promoting the 'best performing' one. While this perspective might be useful for exploring the more ecological aspects of sustainability, it assumes that intentions for using the stewardship concept are uniform, and that desired results are unitary, explicit and easily quantifiable. However, with complex sustainability challenges there is likely no 'single best use' because intentions differ and desired results are often emergent, implicit and multi-faceted. We therefore take an approach more common in the social sciences, where we address stewardship as a 'boundary object': a concept, framework or tool that is "both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity" (Star & Griesemer, 1989, p. 393). The plasticity of boundary objects helps to facilitate communication between disciplines (interdisciplinarity) and science and policy (transdisciplinarity) towards a common goal, without requiring strict consensus on a final definition (Baggio, Brown, & Hellebrandt, 2015; Brand & Jax, 2007). While a 'boundary' is often taken to mean edge or barrier, Star (2010p. 602) clarifies that in the context of boundary objects, it should be thought of as a "shared space". Treating stewardship as a boundary object is valuable for researchers across the natural and social sciences and humanities, as it enables a greater appreciation of the range of knowledge and action necessary to address complex sustainability challenges.

Our second contribution is to provide a novel framework for connecting the multiple meanings of stewardship, centered around care, knowledge and agency. The framework is important theoretically, because it helps to maintain the 'common identity' and communicative ability of the stewardship concept across the broad range of disciplines engaged in landscape and sustainability science – facilitating engagement and discussion, establishing points of common ground, and identifying new research questions. The framework is important practically, because rather than forcing a single definition of stewardship upon policy-makers and practitioners, it provides them with the tools to understand what advantages and disadvangates their use of the term might have compared to others' interpretation of it. Our care-knowledge-agency framework may consequently serve as a useful 'centering device' within the stewardship literature, serving to bridge research, policy and practice.

The paper is structured as follows. We first outline our methodological approach – an exploratory reading group to identify how stewardship is used in the literature, followed by a qualitative systematic literature review to assess the presence of and connections between these uses in the stewardship scholarship more broadly. We then present the two contributions of this paper: the results of the review as an overview of the meanings of stewardship across a range of disciplines, and our proposed conceptual framework to help connect these meanings. The discussion examines the utility of engaging with multiple meanings for researchers and practitioners, and uses the care-knowledge-agency framework to identify two promising avenues for future research and practice: exploring the role of care in stewardship, and developing more relational approaches to stewardship.

2. Methodology

The first author initiated a reading group on stewardship in 2015 at Stockholm Resilience Centre, Stockholm University, motivated by the

Table 1
The initial readings identified four different meanings of stewardship. These meanings were used as a basis for a coding scheme in the formal literature review, including themes as indicated in the table (see Appendix C).

Meaning	Description	Themes
Ethic	Papers that discuss stewardship in terms of moral guidelines or philosophical principles that describe human obligations to take care of nature, including religious beliefs, scientific commitments, social contracts, and informal norms	*Type*, e.g. related to ecosystem management, corporate, or indigenous peoples
Motivation	Papers that approach stewardship in terms of personal or collective preferences, attitudes and traits that generate certain desirable behaviors, public support for and/or participation in sustainability-oriented policies and programs	*Scale*, e.g. individual, regional, global *Focus*, e.g. on environmental, social, or economic factors
Action	Papers that emphasize particular activities and interventions as expressions of stewardship including, for example, specific policies, management actions, governance approaches and forms of activism	*Scale*, e.g. individual, regional, global *Type of actor*, e.g. government, private sector, NGO *Type of action*, e.g. policies, management practices, education
Outcome	Papers that characterize stewardship in terms of the achievement of particular results including, for instance, increased populations of threatened species or improvements in human wellbeing	*Scale*, e.g. individual, regional, global *Focus*, e.g. on environmental, social, or economic factors

desire to clarify how stewardship is used and defined in relation to environmental and sustainability issues. The reading group initially selected papers based on members' interests, followed by a more purposeful sampling of papers intended to capture a diversity of uses and perspectives on stewardship (Appendix A). Through readings and discussions, the group inductively explored this subset of the stewardship literature and identified four main interpretations or meanings of the stewardship concept: stewardship as an Ethic, a Motivation, an Action, and an Outcome (Table 1). The meanings were developed independently by the reading group, however, our subsequent literature review revealed that Romolini et al. (2012) use similar categories to describe different notions of urban environmental stewardship. Moreover, Bennett et al. (2018) have since identified similar themes in their framework for local environmental stewardship.

In order to test the broader utility of our four meanings for understanding different uses of the stewardship concept, we developed them into a coding frame to be applied deductively in a qualitative systematic literature review. Qualitative systematic reviews are interpretive in nature, and seek to "broaden understanding of a particular phenomenon" by identifying 'themes' or 'constructs' within a body of literature (Grant & Booth, 2009). The 'qualitative' aspect of qualitative systematic reviews refers to the analytical procedures adopted – e.g. thematic analysis exploring meanings or constructs – rather than the epistemological orientation of the literature reviewed (we included both qualitative and quantitative studies in our review). Qualitative systematic reviews are different to the 'systematic reviews' common in medical and increasingly conservation science, which generally seek to assess the evidence for a specific intervention leading to a particular result (Pullin & Stewart, 2006). Our aim was not to assess the outcome or effectiveness of particular interpretations of stewardship (although this may of course be a valuable research avenue), but rather to explore the different meanings of stewardship – of which outcomes are only one. Hence, a qualitative systematic review was appropriate for our purposes.

Our first step was to use the search engine Scopus to identify peer-reviewed articles published from 1990 to 2016 that included the term 'stewardship' in the title or keywords. This initially produced 3034 document results. We then reviewed the titles and abstracts to exclude all articles without an environmental focus (see Appendix B for details), leaving a total of 1002 articles to be included in the analysis. We categorized these articles into academic fields based on Scopus' classification of the journals they were published in Table 2.

Based on the four meanings identified inductively through the reading group, we developed a basic coding structure (Table 1) including definitions, inclusion and exclusion criteria, keywords and examples (details in Appendix C). We then piloted the coding scheme on a subset of 30 abstracts in our dataset, on the basis of which we revised our definitions and themes to more effectively capture nuances in the literature. For instance, at this stage we developed sub-themes for each overarching meaning, that reflected distinctions encountered in the literature (consequently some sub-themes carry across between meanings, and others do not). This inductive identification and revision of themes represents thematic analysis – considered to sit at the heart of qualitative systematic reviews (Grant & Booth, 2009). The second author then applied the revised coding scheme to the entire dataset (Appendix B). We allowed for non-exclusive coding where one abstract could be coded under more than one main meaning – for instance, some abstracts focused on Action as well as Outcome – so that we could examine the interconnections and associations between meanings.

Overall, the inductive approach to identifying the review categories – tied closely to the literature as well as our particular aims in identifying meanings of stewardship – means that, in theory, other researchers following similar methodologies might illuminate different aspects of stewardship. Importantly however, our approach ensures that our identified meanings are empirically grounded in the stewardship literature, while the systematic, deductive and transparent aspects of the review make it repeatable. This, together with the presence of similar themes in the more specific work of Romolini et al. (2012) and Bennett et al. (2018), give us confidence that our results carry high general validity.

3. A review of stewardship – uses and tensions

In this section we present the results of the literature review and

Table 2
For our analysis, reviewed abstracts were assigned research fields by aggregating the subject areas Scopus has assigned to the journals where they were published.

Aggregated research field (no. of abstracts)	Scopus 'subject area' (no. of abstracts)
Environmental science (223)	Environmental science (223)
Other natural sciences (262)	Agricultural and biological sciences (231); earth and planetary sciences (29); chemistry (2)
Social sciences (342)	Social sciences (311); economics, econometrics and finance (30); decision sciences (1)
Arts and humanities (48)	Arts and humanities (48)
Applied sciences (115)	Engineering (36), business, management and accounting (33), medicine (25), energy (7), chemical engineering (6), materials science (4), veterinary (3), computer science (1)
Unknown/multidisciplinary (12)	Multidisciplinary (5), abstracts with no classification (7)

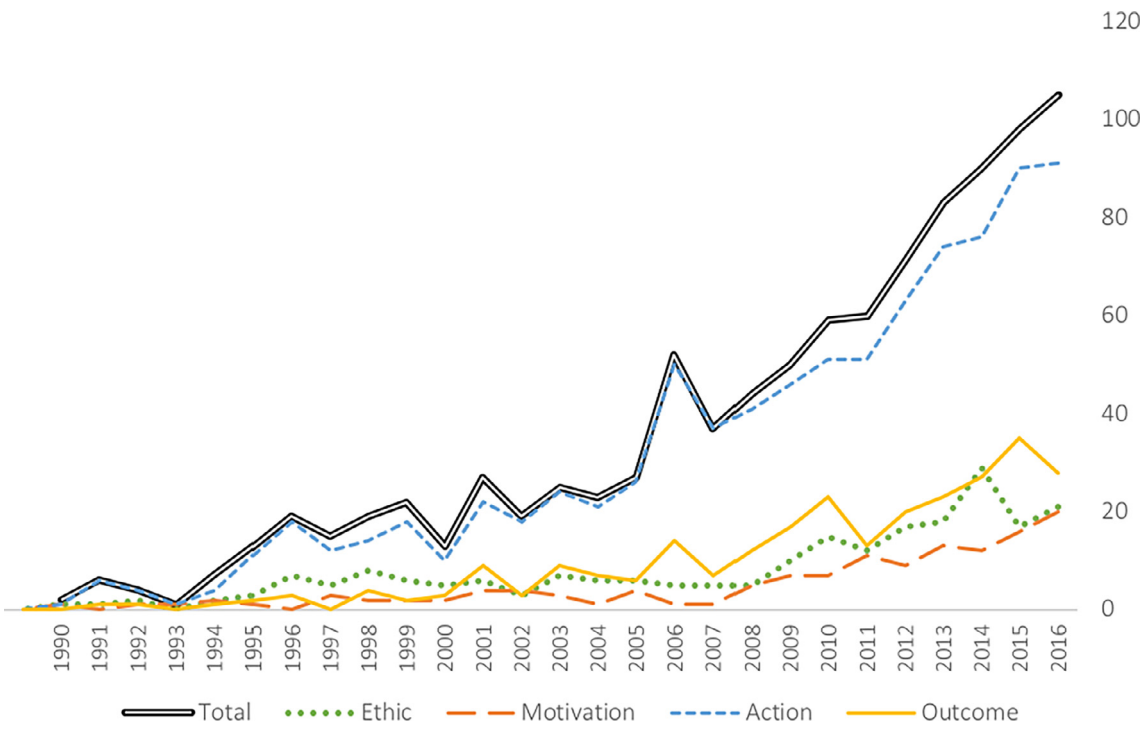


Fig. 1. Number of stewardship articles each year 1990–2016, and a breakdown of how many were coded into each of the four stewardship meanings. Some papers were coded as using more than one meaning, which means that the total number of articles any given year (double line) does not equal the sum of those for each meaning.

describe the range of uses of stewardship. As is evident in Fig. 1, stewardship is an increasingly common term in academic literature. It features prominently in the various branches of sustainability science (Barendse, Roux, Currie, Wilson, & Fabricius, 2016; Chapin et al., 2009; Folke et al., 2016; Raymond, Bieling, Fagerholm, Martin-Lopez, & Plieninger, 2015; Whyte, Brewer, & Johnson, 2015), and is also found in fields as diverse as management and business studies (Madison, Holt, Kellermanns, & Ranft, 2016), biblical studies (Gnanakan, 2006) and library studies (Maes & Thompson-Przylucki, 2012). Stewardship is further invoked in research on a range of environmental policy programs, including certification and agri-environmental schemes. While our formal review only includes peer-reviewed publications, the wide use of the concept outside academia is reflected in research on, for example, industry standards (Chin, Schuster, Tanzil, Beloff, & Cobb, 2015) and civic environmentalism (Krasny, Crestol, Tidball, & Stedman, 2014). The heterogeneity of the term's usage is further complicated by its historical lineage and associations with religion, colonialism and patriarchy (Welchman, 2012).

Our results show that the most prominent meaning associated with stewardship throughout the study period is Action (Fig. 1), e.g. papers that emphasize particular activities and interventions such as policies, management actions, governance approaches and forms of activism. In total, Action is identified 891 times, more often than Ethic, Motivation and Outcome combined (Table 3). Abstracts coded under the second most common meaning, Outcome, are almost always coded under Action as well – as opposed to those under Ethic, which are less likely to be linked to other meanings. This reveals a significant cluster in the literature where stewardship is considered primarily in terms of interventions to achieve specific results.

The four meanings receive different levels of attention from different research fields (Fig. 2). For instance, 56% of the articles that view stewardship as an Ethic are published in social sciences or arts and humanities journals, while only 35% come from environmental or other natural science journals. The situation is reversed in the Outcome meaning, with 60% of articles coming from the environmental and natural sciences, and only 30% from the social sciences and arts and humanities.

In the following subsections, we present the findings of the literature review as a summary of how four different meanings attributed to stewardship – Ethic, Motivation, Action and Outcome. Importantly, this categorization should not be considered definitive, final or mutually exclusive. As we will show, the different uses of the term are often interrelated and any particular article may invoke multiple meanings at the same time. Here, we use these four rubrics to demonstrate the value in understanding the diversity of perspectives on stewardship – including sometimes dissimilar epistemological starting points, methods, and objects of study.

3.1. Ethic

The Ethic meaning captures papers that approach stewardship in terms of sets of moral guidelines, virtues or philosophical principles that inform or shape human relations with the environment. For instance, Seamer (1998) suggests that "stewardship involves responsibility for something and also responsibility to someone. This can mean responsibility to God, or for those without religious beliefs, responsibility to future generations" (p. 201). In a marine context, van Putten, Boschetti, Fulton, Smith, and Thebaud (2014) define environmental stewardship as "a set of normative values that private individuals may hold, and that entail perceived duties and obligations to carefully manage and use marine resources" (p. 1). Welchman (2012) describes stewardship as a "role that individuals adopt in certain contexts" (p.308) – similar to the role of a parent, friend or citizen, but one that under certain conditions it is morally obligatory to adopt. This role defines how one should relate to the environment based on moral principles of right and wrong.

We coded 223 abstracts for Ethic content. This interpretation of stewardship has a very strong link to arts and humanities journals; articles in this field are more likely to view stewardship as an Ethic than anything else (Fig. 2). The Ethic meaning has been consistently present in the stewardship literature since the mid-1990s (Fig. 1). Together,

Table 3
Number of abstracts coded under each meaning and themes (see Appendix C). Since one abstract can be coded more than once, the total can be > 100%.

Stewardship meaning	Code	Abstracts	Proportion
ETHIC		**223**	**100%**
Type	Ecosystem science & management	67	30%
	Civic/legal/economic	53	24%
	Religious	53	24%
	Agricultural	41	18%
	Corporate	27	12%
	Indigenous	16	7%
	Not clear/other	2	1%
MOTIVATION		**133**	**100%**
Scale	Individual	116	87%
	Local/regional	7	5%
	National/international	5	4%
	Global	0	0%
	Not clear/other	7	5%
Focus	Environmental	55	41%
	Social	62	47%
	Economic	27	20%
	Not clear/other	34	26%
ACTION		**891**	**100%**
Scale	Individual	13	1%
	Local/regional	355	40%
	National/international	269	30%
	Global	114	13%
	Not clear/other	151	17%
Actor	Public/government	243	27%
	Private sector	229	26%
	Primary resource users/ landholders	229	26%
	NGO	154	17%
	Citizens/communities	141	16%
	Scientists/educators	92	10%
	Collaborative networks	31	3%
	Not clear/other	124	14%
Type	Policies/programs/legislation	398	45%
	Production	230	26%
	Management	167	19%
	Scientific	114	13%
	Design	75	8%
	Governance	68	8%
	Educational	61	7%
	Activism	9	1%
	Not clear/other	39	4%
OUTCOME		**270**	**100%**
Scale	Individual	4	1%
	Local/regional	135	50%
	National/international	76	28%
	Global	26	10%
	Not clear/other	35	13%
Focus	Environmental	201	75%
	Social	103	38%
	Economic	61	23%
	Not clear/other	14	5%

these findings indicate that articles understanding stewardship as an Ethic represent a small but distinct and to some extent independent stream within the studied literature.

The most prominent theme in Ethic articles (30%, see Table 1) approaches stewardship as an ethic or principle informing ecosystem science and management (Hansen, 2014; Hobbs et al., 2010; Knuth & Siemer, 2004). This includes recent calls for ecosystem (Chapin et al., 2015), biosphere (Folke et al., 2016) and earth stewardship (Chapin, 2011). For instance, Felson, Bradford, and Terway (2013) claim "Earth Stewardship requires a repositioning of ecological science in society to promote social–ecological change" (p. 362). A second prominent theme (24% of Ethic abstracts) refers to stewardship as an ethic emerging from a particular religion or religious text, predominantly Christianity (Barrett & Grizzle, 1997; Horrell & Davis, 2014) but also including Hinduism (Dwivedi, 1997), Judaism (Tharan, 1997) and Buddhism (Suh, 2014). Reichenbach (2003), for example, suggests "the three commands of Genesis 1 and 2 provide the basis for a theistic stewardship ethic, where God as the Creator/Landowner establishes humans as stewards to administer his kingdom" (p. 93). Other prominent themes include 'Civic/Legal/Economic' (24%) where stewardship was discussed in terms of public principles, often captured in legal or economic concepts, including the notions of "intergenerational equity" (Dorsey, 2003) and a "statutory duty of care" (Earl, Curtis, & Allan, 2010); 'Agricultural' (18%), where papers linked stewardship to Aldo Leopold's idea of a "land ethic" (Quartuch & Beckley, 2013); and 'Corporate' (12%) where stewardship is framed as an approach to corporate leadership and business management (Spiller, Pio, Erakovic, & Henare, 2011). Finally, a small subset of papers (7%) discern a stewardship ethic in the worldviews and practices of particular Indigenous societies (Carroll, 2014; McMillan & Prosper, 2016).

3.2. Motivation

Papers coded for Motivation approach stewardship in terms of attitudes, traits, preferences and predispositions that make people inclined to engage in pro-environmental or sustainable behaviors, such as conservation or recycling. For example, Gupta, Grant, and Strauss (2012) refer to a need to "foster positive attitudes towards the environment and stewardship-related behaviors as these may serve as precursors to later choices that benefit the environment" (p. 1). While motivations for behavior may include ethical values (Colman, 1994; Hilts, 1993), papers coded for this theme often address motivations in terms of more instrumental and strategic interests (Deighan & Jenkins, 2015; Loftus & Kraft, 2003), emotions (Larson, Cooper, & Hauber, 2016) or social attachment (Lokocz, Ryan, & Sadler, 2011). Papers coded under Motivation appear themselves to be motivated by the potential ability to understand and predict human behavior, which might then be nurtured or 'nudged' in desirable directions (e.g. Mathijs, 2003; Ramsdell, Sorice, & Dwyer, 2016; Selinske, Coetzee, Purnell, Knight, & Lombard, 2015). For instance, in the context of private water well stewardship, Morris, Wilson, and Kelly (2016) suggest that educators "must develop an understanding of their audience so they are able to identify the most significant barriers to change and select motivational strategies that will directly reduce barriers" (p. 167).

Motivation is the least commonly used stewardship meaning in our study, only identified in 133 abstracts. Compared to the rest of the studied literature, these articles are more likely to come from social science journals (Fig. 2). Qualitative examination of these abstracts suggests that economics perspectives (Gilmour, Day, & Dwyer, 2012), as well as sociological (Creighton, Blatner, & Carroll, 2016) and behavioral scientific approaches such as psychology (Selinske et al., 2015), are prominent ways of approaching stewardship as a Motivation. Motivation articles tend to differ from Ethic articles in that they more often present the results of empirical studies, particularly using positivist approaches such as surveys and statistical analysis (Kreutzwiser et al., 2011), formal behavioral models (English, Bell, Wells, & Roberts, 1997) and experiments (Hensen, Keeling, de Ruyter, & Wetzels, 2016).

Two further insights are worth noting in Motivation abstracts (Table 3). Firstly, they overwhelmingly (87%) address stewardship as occurring at the individual rather than collective level (zero abstracts were coded at the global level). (It should be noted that we focus the scale parameter on where Motivation 'takes place,' in order to ensure consistency with the other stewardship meanings. Therefore, if a study

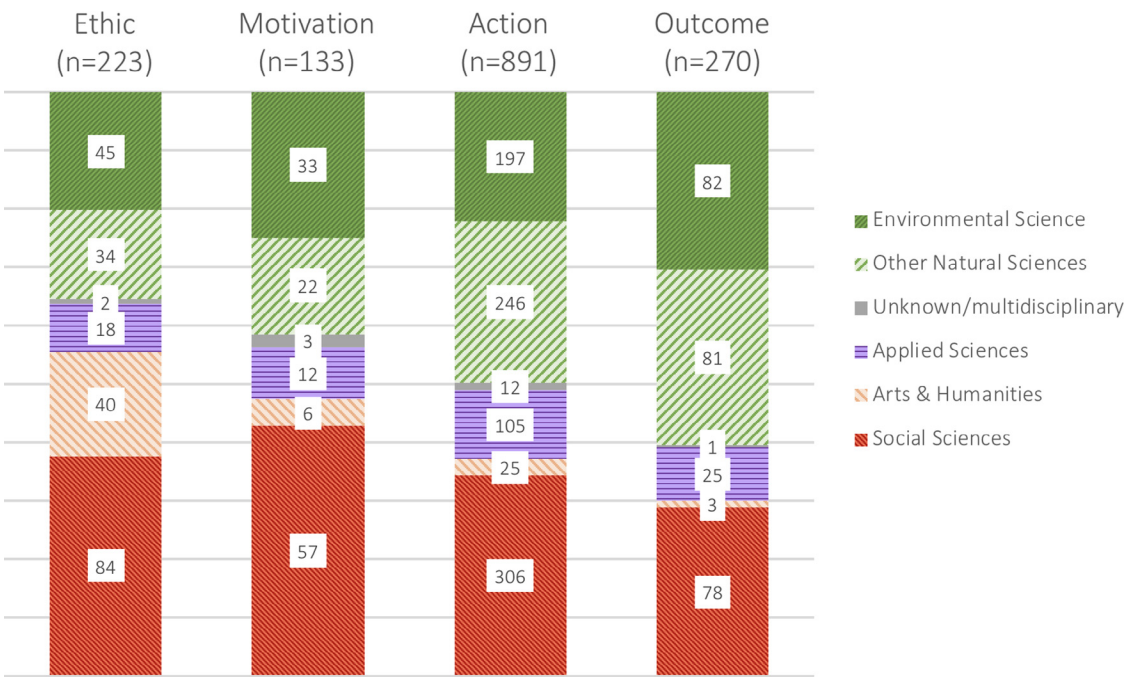


Fig. 2. Presence of different research fields in the articles invoking each of the four stewardship meanings. The size of each bar is normalized to facilitate comparison; the actual number of articles in each field using a specific meaning is indicated in each bar segment.

reported on a large sample of farmers it would be coded under 'Individual' if the motivation itself was considered to take place at the individual level.) While this is somewhat predictable, given the focus on attitudes, traits and preferences, it highlights an important difference between studies that approach stewardship as a Motivation, and those that treat it as a type of Action or Outcome – which more often implies a focus on a community or societal level. Secondly – and somewhat surprisingly given that we selected for environmentally focused articles in the study as a whole – abstracts coded at Motivation identify social motivations for stewardship more often than environmental ones, including improving relationships (Atari, Yiridoe, Smale, & Duinker, 2009) and developing a sense of belonging (Bramston, Pretty, & Zammit, 2011). This could be a bias caused by the dominance of social science perspectives in these publications, possibly making researchers more inclined to explore social factors for stewardship engagement. However, it may also challenge conventional understandings of why people engage in pro-environmental behavior (e.g. Asah & Blahna, 2012; Asah & Blahna, 2013).

3.3. Action

Papers coded under Action approach stewardship as a particular

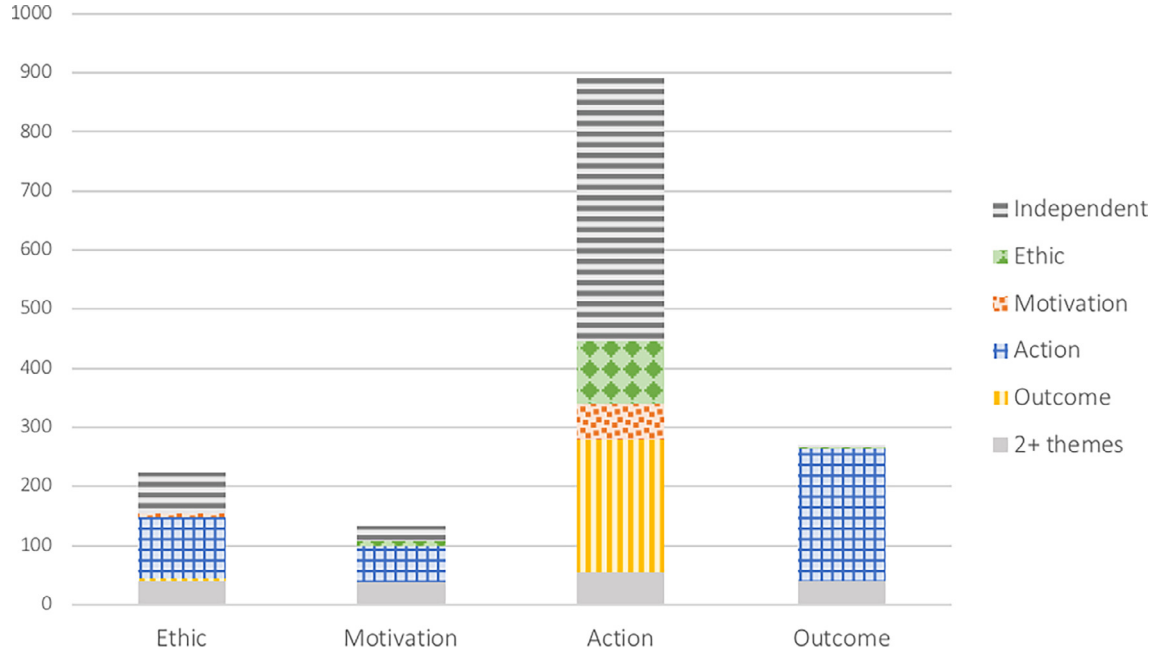


Fig. 3. Each bar shows the total number of abstracts associated with each of the four stewardship meanings. Some abstracts used one meaning alone, while many were coded also coded for a second one and a few combined multiple meanings.

kind of activity, practice, or initiative engaged in by particular actors, often – but not always – intended to achieve a perceived environmental benefit. For instance, Chapin et al. (2010) describe ecosystem stewardship as "an action-oriented framework intended to foster the social-ecological sustainability of a rapidly changing planet" (p. 241). What these actions consist of differs across papers. A large proportion of abstracts (45%) discuss stewardship in terms of specific policies, programs or legislation that require participants, citizens or those affected to undertake particular activities – including, for instance, the certification schemes of the Marine Stewardship Council (Bear & Eden, 2008) and Forest Stewardship Council (Bell & Hindmoor, 2012), agri-environmental stewardship programs (Amy et al., 2015), and international environmental agreements (Berkman, 2010). A substantial body of the literature (26%) discusses stewardship in terms of initiatives to make industrial and agricultural production more environmentally friendly (Almesfer & Ingham, 2014; Bradshaw, Cocklin, & Smit, 1998). Many papers (19%) referred to stewardship in the context of ecosystem management, conservation and restoration activities, conducted by formal authorities (Burger, 2000) or civic and volunteer groups (Curthoys, 2002). Finally, a smaller but significant section of the literature (13%) reports on scientific activities such as monitoring, experimentation and modeling as expressions of stewardship (Carr, 2004; Davis, 2005).

Action is the most common meaning associated to stewardship, observed in 891 abstracts – more than Ethic, Motivation and Outcome combined (Fig. 1). In the study overall, 458 abstracts were coded for more than one meaning, and in all but 15 of these, one of the meanings is Action. In other words, in any given abstract the Ethic, Motivation and Outcome meanings are much more likely to co-occur with Action than with each other (Fig. 3). This indicates that Action is highly relevant for understanding how the other meanings of stewardship are used: typically, papers coded under Ethic attempt to articulate what actions are "right", those under Motivation explore what stimulates particular actions and how these might be encouraged, and those under Outcome examine the results that different actions generate.

Of particular interest in Action abstracts is the low proportion coded under 'Activism' (1%), which refers to activities intended to bring about social or environmental change through advocacy, protest or direct action. This suggests that the concept of stewardship is rarely used to describe or study confrontational actions that challenge existing power structures; more often, it refers to actions that work through and from those structures (but see e.g. Smith and Pulver (2009) and van Riper (2013) for notable exceptions). Also of interest is the very low number of abstracts coded at the 'Individual' level (1%). This may be because phenomena at this level tend to be addressed in articles treating stewardship as a Motivation. It could also reflect a notion that when it comes to action, stewardship is often understood to imply collective effort. Alternatively, individual actions might not have sufficient impact for researchers to consider these as effective stewardship, but rather regard these as 'pro-environmental behavior' (Larson, Stedman, Cooper, & Decker, 2015).

3.4. Outcome

The fourth stewardship meaning is the pursuit or achievement of a desirable set of results or consequences, often qualifying particular interventions. For instance, Nicolette, Burr, and Rockel (2013) suggest, "If an action creates net ecosystem service value above the baseline condition, it would be considered to embody environmental stewardship" (p. 2152). A significant majority of these abstracts (75%) report environmental outcomes of various policy interventions, such as the impacts of agri-environmental schemes on bumblebees (Lye, Park, Osborne, Holland, & Goulson, 2009), birds (Peach, Lovett, Wotton, & Jeffs, 2001) and butterflies and moths (Staley et al., 2016). However, there are also several abstracts that report on a range of social (38%) and economic (23%) results – including the achievement of "poverty reduction and community development" (Vega & Keenan, 2016) and improved financial income (Udagawa, Hodge, & Reader, 2014). The focus on outcomes and results is often associated with an emphasis on accurately describing and understanding the target of stewardship – be it species, resource or a social–ecological system – and calls for actions to be informed by scientific knowledge about their (potential) effects. For example, Davis (2005) suggests, "Knowledge of ecosystem structure and functioning is the cornerstone of stewardship" (p. 71).

Outcome is the second most common stewardship meaning identified in our review, with 270 abstracts. There is a high level of co-occurrence between Outcome and Action, and the two meanings also have similar profiles that emphasize local–regional and national-international scales (~70%) and very few abstracts that focus on the individual level (1%). The close links between Action and Outcome may reflect the emphasis within environmental and sustainability science on "problem-based" research, where identifying interventions to achieve specific results is often an explicit goal (e.g. Kates et al., 2001).

The similarities between Outcome and Action could be viewed as a reason to merge the meanings into one and the same. However, it should be noted that although abstracts coded for Outcome tend to also pay attention to Action, the reverse is not true – most articles that describe stewardship in terms of Actions do not mention Outcome. Further, articles using the Outcome meaning are distinct in that they are more likely to be published in environmental and other natural science journals, and least likely to be found in social sciences and arts and humanities publications (Fig. 2). Lastly, it is only recently that this stewardship meaning has emerged as the second most common: during the 1990s, an average year had only 14% of published articles coded under Outcome; for the years from 2010 onwards, this average has risen to 34% (Fig. 1). This is important because it indicates a shift from viewing stewardship as morally desirable acts (when Action and Ethic where the predominant meanings) towards viewing it in terms of what it can deliver (as Outcome replaces Ethic). Importantly, this shift in meanings also implies a growing influence from perspectives based in the environmental and natural sciences (Fig. 2).

4. A framework for engaging with multiple meanings of stewardship

Our review findings show that a wide range of disciplines are using the stewardship concept, in ways that have both commonalities and differences in interpretation. We have identified four broad categories of literature that each tend to emphasize a distinct meaning of stewardship: Ethic papers, which is the strongest contribution to stewardship scholarship from the arts and humanities; Motivation papers, which are more strongly based in the social sciences; Outcome papers, primarily published in the natural sciences; and Action papers, which constitute the largest body of literature and has its disciplinary roots more evenly spread compared to the other three categories (Fig. 2).

Our identification of four distinct meanings demonstrates that the stewardship concept displays the first two characteristics of a boundary object: i) interpretive flexibility, and ii) a range of uses from broad and unstructured to more tailored and precise (Star, 2010). That stewardship acts as a boundary object does not mean that it lies at the edge or periphery of research fields, but rather that it represents a "shared space" where different (inter-)disciplinary perspectives overlap and interact. For example, Asah and Blahna (2013) adopt a psychological approach to explore stewardship in terms of individual motivations to participate in urban conservation initiatives; Connolly et al. (2013) employ political science to explore stewardship in terms of organizational participation in network governance; and Baker, Freeman, Grice, and Siriwardena (2012) use an ecological approach to examine stewardship in terms of biodiversity outcomes from centralized agri-environmental schemes. Nevertheless, it is important to note that boundary objects do not automatically facilitate communication between different fields – in some cases, interpretive flexibility in the form

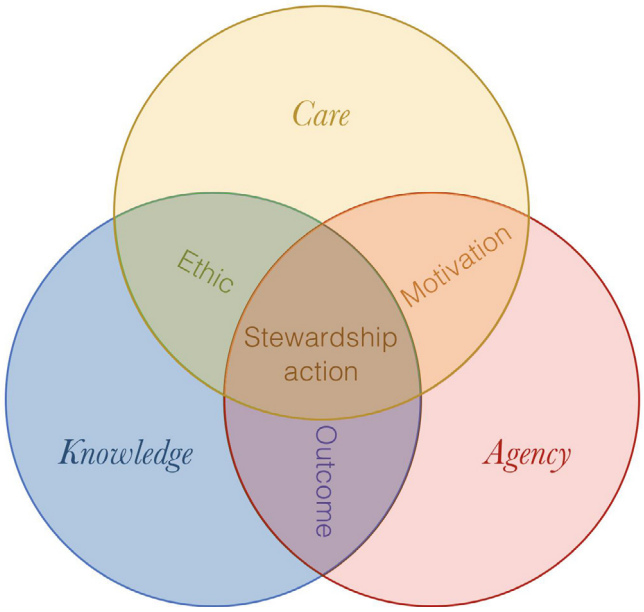


Fig. 4. *Care*, *knowledge* and *agency* help relate the different meanings of stewardship observed in reviewed literature, with the bulk of articles focusing on specific Actions and activities, and to various extents also on Ethic, Motivation, and Outcome – which lie in the interface between the different dimensions.

of poorly defined catchwords may "hide conflicts and power relations when different persons agree on the need for [them]" (Brand & Jax, 2007). For instance, those approaching stewardship in terms of civic participation and individual volunteerism might consider decentralized decision-making to be essential for stewardship, whereas those exploring stewardship in terms of governmental incentive schemes might advocate stricter regulation to ensure biodiversity outcomes.

In order to maintain stewardship as an effective boundary object and help to facilitate communication between the different existing meanings, we propose *care*, *knowledge* and *agency* as key dimensions of stewardship. In Fig. 4, we use these dimensions to structure and map out the 'landscape' of different stewardship uses and meanings. The idea of this structure is to recognize that the different meanings partially overlap, but are also distinct in how they relate to the underlying dimensions. This helps to address the third characteristic of boundary objects outlined by Star (2010) – active iteration between different conceptualizations of the boundary object. For instance, the broad category of 'agency' helps to facilitate comparison between the different kinds of action invoked in stewardship, the various motivations for it, and the different outcomes expected from it. Our framework recognizes plurality, but may also act as a centering device by facilitating bridging and integration between different formulations of stewardship (e.g. Baggio et al., 2015). Below, we first present these three dimensions and then explore how they help understand and navigate the four existing stewardship meanings identified in the literature.

4.1. Three dimensions of stewardship: care, knowledge and agency

The care-knowledge-agency framework (Fig. 4) draws on ideas introduced by Andersson, Enqvist, and Tengö (2017), who view urban landscape stewardship as emergent from three components: (a) care, creativity and values, (b) knowledge and know-how, and (c) agency, power and resources. This conceptualization also reflects the notion of 'heart, head and hands' invoked in relation to activities ranging from organizational leadership (Nicholls, 1994) to community building (Kelly & Sewell, 1998) to nursing (Galvin, 2010). Our use of care, knowledge and agency should not be seen as an attempt to define components of or prerequisites for stewardship (*sensu* Andersson et al., 2017), but as tools for navigating the existing uses of the term and identify useful pathways forward for future stewardship research and practice. Our definitions of each dimension below should be seen as tentative, and we encourage further discussion of which label and interpretation may be most useful to denote each dimension.

The *Care* dimension refers to the feelings of attachment and responsibility that underpin stewardship, including personal values, aesthetic ideals, identity and emotions as well as collective and societal notions of morality and ideology (Chawla, 2009; Nassauer, 2011). Care carries an explicitly normative aspect since it involves subjective preferences and value judgments. In sustainability science literature on stewardship, the notion of care has primarily been invoked indirectly compared to more explicit acknowledgement of knowledge and agency. Recent examples of more direct engagements include attention to values within ecosystem services science and policy (Iniesta-Arandia, García-Llorente, Aguilera, Montes, & Martín-López, 2014; Pascual et al., 2017), relational values within conservation (Chan et al., 2016; West et al., 2018), the role of care for a stewardship at a global scale (Heise, 2008a), and sense of place in ecosystem management and transformation research (Masterson et al., 2017; Walker & Moscardo, 2016).

The *Knowledge* dimension refers to the basic information and deeper understanding about the species, resource, technology, landscape or social–ecological system that is being stewarded, as well as a capacity to respond to and learn from its dynamics (Berkes et al., 2003). Such understanding can come from a variety of different knowledge systems, including conventional science and scientific methods (Chapin et al., 2009; Hansen, 2014), indigenous knowledge (Tengö, Hill, Malmer, Raymond, Kyttä, & Stedman, 2017; Whyte et al., 2015), hands-on practices and experiential knowledge (Cooke, West, & Boonstra, 2016; Olsson & Folke, 2001), social learning (Berkes, 2009) and collectively held memories about condition and change in a certain landscape (Andersson & Barthel, 2016; Barthel, Crumley, & Svedin, 2013).

Agency refers to the abilities and capacities of individuals, organizations and collaborative networks to engage in stewardship action and produce effects in the world (e.g. Brown & Westaway, 2011; Burkitt, 2016; Emirbayer & Mische, 1998; McLaughlin & Dietz, 2008). Agency also captures the power of the biophysical landscape and material technology to affect the character of stewardship action (Cooke & Lane, 2015). Agency can involve both shaping the conduct of others as well as influencing the social and ecological conditions that affect available opportunities in a landscape (Boonstra, 2016). Examples include collective action organized to manage common-pool resources (Ostrom, 1990), local residents engaging in green space governance (Krasny & Tidball, 2012), community leadership and grassroots innovation (Martiskainen, 2015), as well as institutional entrepreneurs that enable transformational change (Westley et al., 2013). Importantly, expressions of agency are often political and intricately related to power, as goals, strategies and imperatives to affect change (and capacities to realize them) vary between actors and networks (Boonstra, 2016).

4.2. A three-dimensional view of stewardship meanings

We use care, knowledge and agency as three 'attractors' to link the different meanings identified in our review (Fig. 4). We place Action at the center of the framework, as this is the most common interpretation of stewardship. We place Ethic, Motivation and Outcome in the fields extending from and overlapping with Action, because these interpretations of stewardship all co-occur with the Action meaning more than they do with each other (Fig. 3). Using the care, knowledge and agency dimensions then helps to relate and illuminate the connections between Ethic, Motivation, Outcome, and how they all intermingle in Stewardship Action. The meanings and dimensions should therefore not be seen as mutually exclusive, nor are they necessarily final or representing an 'accurate' view of stewardship; we intend the framework to have heuristic value by helping people thinking through and linking the different meanings and uses of the stewardship concept. To

demonstrate this, we now describe how our way of projecting the four stewardship meanings along these dimensions helps us explore similarities and differences between associated uses of the term.

Care helps to relate Ethic and Motivation, by capturing the general sense of normative directions for actions, whether treated in terms of rationalized moral principles (Ethic), or in terms of attitudes, preferences and traits (Motivation). This helps to relate two meanings that have its strongest roots in different research traditions: humanities and arts on the one hand, and positivist social science and economics on the other. As such, Ethic and Motivation are approached from different epistemological starting points, which helps us understand how these two aspects of care might interrelate in practice. For example, Aldo Leopold's (1949) influential "land ethic" reflects a profound sense of care for the natural world and a desire for its preservation – but does not explore as thoroughly how to influence motivations in order to express this care through actions. This is important because motivations – as expressions of what is desirable – are shaped by a range of factors in addition to ethical principles, such as monetary incentives and societal norms (Hahn & Nykvist, 2017).

Knowledge helps to relate Ethic and Outcome, by focusing on the underlying information and understanding about a landscape, resource or species population – which is required both for a reasoned deliberation on why stewardship is necessary, as well as assessment of tangible outputs in terms of improved environmental conditions and general sustainability. These two sides of knowledge can be linked to underlying differences between the focus in natural sciences on 'what' and 'how' questions, and humanities and social sciences which more often also ask 'why'. While the former tends to be driven by a specific desirable outcome, the latter more often refers to a more holistic view of landscapes where individuals, communities or humanity as a whole interact with and depend on the environment, ecosystems and species, in relationships that are desirable because they are ethically 'right'. This can be described as a tension between stewardship as limited in time (a specific project that ends once the intended outcome is achieved) and stewardship as a temporally unrestricted (longer term), open-ended and co-evolving relationship or process (Cornell et al., 2013).

Agency helps to relate Motivation and Outcome, by referring to the ability of actors (individuals, groups, states) to achieve desired changes through stewardship activities. Our review shows that these two notions of agency – what drives it and what is expected from it – are studied in different ways. Stewardship motivation is more often investigated as driven by social rather than environmental factors, and typically studied as an individual-level processes. Stewardship outcome, on the other hand, is almost never studied at an individual level and mostly assessed in terms of environmental rather than social or economic impact (Table 2). This is important to consider for studies that explore how stewardship can be incentivized (e.g. Payne, 2013; Raymond et al., 2015) because it requires clarity about whether the objective is to engage participants (intrinsic value), or optimize results (instrumental value). This is particularly relevant in the context of social–ecological systems research, where assumptions of desirability are not always made explicit (Hahn et al., 2017).

5. Discussion

Stewardship is a concept widely invoked by researchers, practitioners and policymakers seeking to better understand and more effectively pursue sustainability. In this paper we have identified four distinct meanings of stewardship in the academic literature: Ethic, Motivation, Action and Outcome (Fig. 1). The interpretive flexibility of concepts like stewardship is part of the social-ecological complexity that those seeking to bring about sustainability must learn to navigate. It is therefore vital to devise fruitful ways of acknowledging and engaging with the different ways in which stewardship is interpreted and used.

Understanding stewardship as a shared space or boundary object is useful for both research and practice. For researchers, treating the stewardship concept as a shared space can nurture 'epistemological agility' – the awareness of and ability to navigate different approaches to generating knowledge (and connecting that knowledge with action) among social and natural sciences and the humanities (*sensu* Haider et al., 2018). For instance, as we have shown, humanities scholars are more likely to approach stewardship in terms of consciously formulated principles, commitments or ideas, while ecologists and other natural scientists instead tend to focus on stewardship in terms of environmental outcomes. Becoming more aware of these differences enables researchers to identify 'blind spots' in their own approaches, collaborate with others more effectively, and better appreciate the richness of expanding beyond the limited, conditional nature of any single perspective. Indeed, inter- and transdisciplinary research are often presented as crucial in addressing contemporary sustainability challenges (e.g. Barreteau et al., 2016; Brondizio et al., 2016).

For policy-makers and practitioners, recognizing a range of interpretations of stewardship can help to broaden the appeal of any particular use of the concept, and help to navigate disagreements or conflicts around project implementation. For example, a stewardship program to plant urban trees might involve, among others, community members looking to make new friends, ecologists hoping to improve habitat functionality, and local politicians seeking to support the generation of skills and social capital. In such a context, awareness of and effective tools to think through different perspectives, motivations and interests can help improve the benefit of an intervention at all phases: in planning (with consultations to ensure different voices are heard), in implementation (targeting a range of needs and stakeholders) and in assessment and evaluation (using multiple metrics and understandings of 'successful' stewardship).

We introduce the care-knowledge-agency framework (Fig. 4) as a means of recognizing plurality, while also helping to guide future research and practice along productive pathways. Rather than imposing a single definition of stewardship, the care-knowledge-agency framework provides common "directions along which to look" (Blumer, 1954, p.7), enabling researchers, practitioners and policy-makers to think through their own uses of stewardship, identify areas of common ground, and generate new trajectories for research and practice. We demonstrate the utility of the framework by using it to highlight two such promising avenues: further exploring the care dimension, and developing relational approaches to stewardship.

The care dimension of the framework helps to connect two vital but underrepresented aspects of the stewardship literature: that on rationalized ethics intended to guide action, and on more tacit motivations for particular kinds of behavior. These two research areas reflect distinct perspectives on human action more common in, respectively, the arts and humanities, and economics and psychology. Connecting these perspectives under 'care,' understood broadly as 'looking after' something or someone, helps to generate ideas for empirical research – for instance, exploring how rationalized ideals of stewardship interact with financial incentives, senses of belonging, and perceptions of ecological change, to shape stewardship action in particular contexts and under potential future scenarios. Emphasizing care also carries implications for practice. Explicitly nurturing approaches to stewardship rooted in care may provide a route to bring about broad-scale behavioral change and 'reconnection to the biosphere' (Folke et al., 2011) without recourse to techno-managerial approaches (Ives et al., 2018).

By encouraging the mutual consideration of care, knowledge and agency, the framework as a whole points towards the importance of developing more holistic, non-hierarchical and non-linear understandings of stewardship. Relational approaches offer significant potential here, in conceiving of the world not in terms of static or categorical identities, but rather in terms of "dynamic, unfolding relations" (Emirbayer, 1997, p. 281). Relational approaches to social–ecological phenomena are advancing in a number of different areas, including relational values in conservation and ecosystem management to better

account for the reciprocal flows between nature and human well-being (Chan et al., 2016; Pascual et al., 2017), and in sense of place research to better assess the dynamic relations between mind, body, culture and environment (Raymond et al., 2017). Adopting relational approaches in stewardship practice might entail a greater emphasis on building meaningful and sustained connections between people and their environment, and an equal focus on the quality of processes as well as outcomes (e.g. Caillon, Cullman, Verschuuren, & Sterling, 2017).

6. Conclusions

This paper navigates a crucial tension in the field of sustainability science. On the one hand, devising effective responses to the challenges of the Anthropocene – driven by the influence by humans on planetary-scale biophysical processes, and characterized by complexity, uncertainty and rapid change – requires diverse perspectives, approaches and skillsets. On the other hand, bridging between these differences necessitates the development of shared language and concepts to facilitate partnerships and collaborations across scales, sectors and academic disciplines. This tension between diversity and common language extends beyond the topic of stewardship, as exemplified in sustainability science by calls for more transdisciplinary research processes and "wide discussions within the scientific community (…) regarding key questions, appropriate methodologies, and institutional needs" (Kates et al., 2001). In this paper we demonstrate how this tension can be navigated in a useful way, by mapping out the different meanings of stewardship – a central concept in sustainability – and providing a framework for how to relate these meanings and identify how they can enrich each other. Our care-knowledge-agency framework makes the tension productive by creating a useful space for inter- and transdisciplinary collaboration. As such, it acts as a centering device to help both stewardship researchers and practitioners understand and see value in the variety of uses of the term, and when needed, guide discussions about how stewardship may be studied or nurtured in particular contexts.

Effectively addressing sustainability challenges entails reconciling the connections between the practical use of and dependence on natural resources, related governance and managerial aspects, as well as the overriding conceptual and normative considerations framing these practices. Social–ecological systems perspectives emphasize that people are themselves part of the landscapes and ecosystems they try to govern. By implication, such perspectives challenge the technocratic norms that assume managers, policy-makers and scientists can guide action to sustainability in a detached and objective manner – instead suggesting that we are all personally invested stakeholders, implicitly or explicitly prioritizing particular values and subjective preferences. Our framework promotes an approach to stewardship that helps relate work primarily in the natural sciences on how to best achieve positive environmental outcomes, to research in the social sciences and humanities on the norms, beliefs, incentives and value systems that drive and direct pro-environmental action. This may be particularly relevant for exploring the potential in simultaneously pursuing the 'low-hanging fruit' of incremental change, and the transformative shifts that long-term sustainability is likely to require. We advocate particularly for further research on the care dimension of stewardship and its potential contribution to identifying and understanding how more sustainable human–nature relationships can emerge and persist over time.

Stewardship is, and is likely to remain an ambigous concept. Its practical utility is not universal, as pre-existing connotations may render it objectionable in some contexts. However, its wide and growing range of uses provides an opportunity to facilitate learning and collaboration while maintaining diverse approaches and perspectives. These objectives lie at the heart of inter- and transdisciplinary research for sustainability. We therefore hope that this paper will promote a more productive use of the stewardship concept, while also fostering the theoretical, methodological and practical development of sustainability and landscape science.

Acknowledgments

The authors would like to thank Erik Andersson, Million Belay, Emma Björkvik, Wiebren J. Boonstra, Julie Goodness, Caroline Schill, Lisen Schultz for participating and contributing in some of the reading group meetings. We also thank Raphaël Mathevet, Rosemary (Ro) Hill and F. Stuart (Terry) Chapin III for presenting their reflections on an earlier version of this paper during the session 'Exploring biosphere stewardship as care, knowledge, agency' at the Resilience 2017 conference (Stockholm, Sweden) – as well as the session's audience for contributing to a lively and valuable discussion. We also thank four reviewers for Landscape and Urban Planning for providing a broad set of comments that has strengthened this paper's interdisciplinary relevance.

We further thank Stockholm Resilience Centre's Biosphere Stewardship stream for funding. This stream as well as several of the authors are funded by a core grant from Mistra to the Stockholm Resilience Centre. MT also acknowledges a grant from the Swedish Research Council (VR 2015-03441).

This paper was developed with the first four authors (JPE, SW, VAM, LJH) as a core writing team.

Appendix A. Initial readings

Articles arranged chronologically in the order they were read in the reading group: Welchman (2012), Chapin et al. (2010), Chapin et al. (2011), Chapin et al. (2015), Folke, Colding, and Berkes (2003), Ogden et al. (2013), Hitzhusen and Tucker (2013), Worrell and Appleby (2000), Payne (2013), Raymond et al. (2015), Heise (2008a), Heise (2008b), Ghilarov (1995), Vernadsky (2012), Ingold (2000), Whyte et al. (2015), Bieling and Plieninger (2017), Plieninger and Bieling (2017).

Appendix B. Identifying records for literature review

The literature review conducted in this study used records identified through a search in the online database Scopus, on 20th March, 2017, accessed through Stockholm University. Relevant records were identified through five steps (Fig. B1).

Step 1: Records identified through Scopus search for 'stewardship'

We applied the following search protocol:

- "Stewardship" in [Article Title] OR "Stewardship" in [Keywords].
- Published 1990–2016.
- Document type: Article or Review.

Step 2: Records' subject areas screened for relevance

The search result was restricted to the following subject areas:

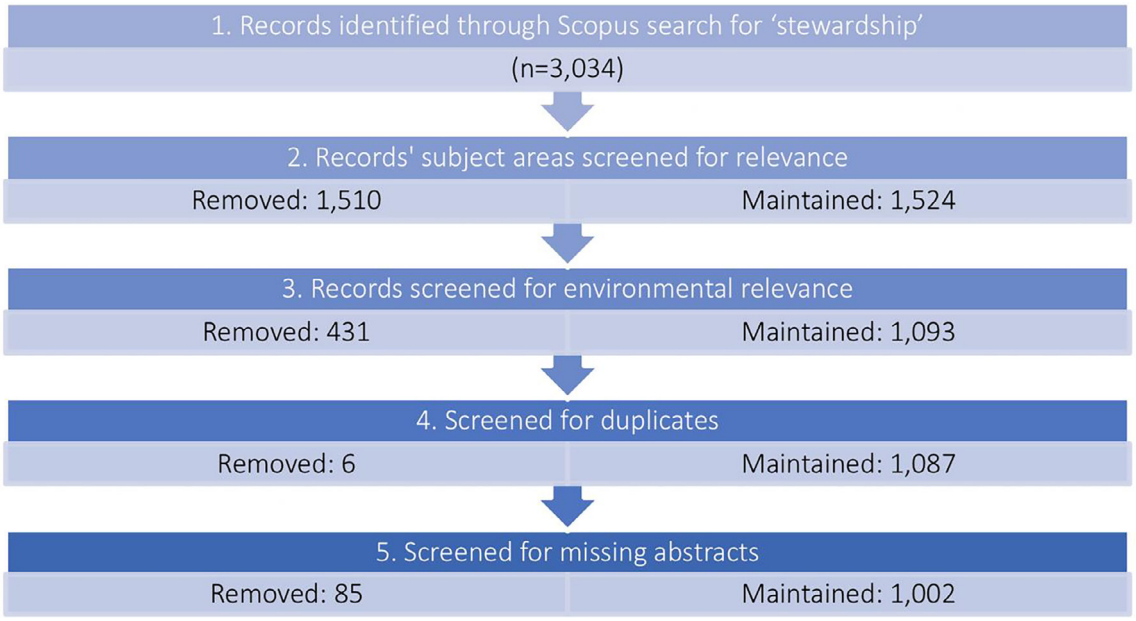


Fig. B1. A step-wise process to identify abstracts to be included in the literature review.

- Environmental science; social sciences; agricultural and biological sciences; business, management and accounting; economics, econometrics and finance; arts and humanities; earth and planetary sciences; materials science; decision sciences; multidisciplinary.

The following subject areas were excluded:

- Medicine; pharmacology, toxicology and pharmaceutics; engineering; immunology and microbiology; biochemistry, genetics and molecular biology; nursing; energy; chemical engineering; health professions; computer science; chemistry; psychology; veterinary; physics and astronomy; mathematics; neuroscience; dentistry; undefined.

This exclusion step uses a function that relies on Scopus' classification of the articles themselves. This classification is currently not directly accessible to users, neither when viewing a specific article entry, nor when exporting the aggregate list of search hits. As described in the main text, our study instead analyzes articles based on what Subject Area its journal is assigned (see Fig. 2 in the main text). A consequence of this is that there is a small number of articles in our study that, because of the journals where they are published, are classifieds in fields like Medicine – even though this subject was excluded in the initial search. To ensure environmental relevance of the specific article, we therefore also carried out Step 3.

Step 3: Records screened for 'environmental' relevance

We screened the remaining 1524 records based on a conventional understanding of 'environment' from the Online Oxford Dictionary: "the natural world, as a whole or in a particular geographical area, especially as affected by human activity" (https://en.oxforddictionaries.com/definition/environment). We deliberately adopted a rather conservative definition of 'environment' to limit our sample and maintain conceptual coherence.

In order to identify articles of environmental relevance, we specified this definition with keywords:

- Environment in general: environment, ecosystem, ecology, nature, sustainability, conservation, green, biodiversity
- Settings: landscape, land, planet, biosphere, marine, grassland, wilderness, ocean
- Resources: fishing, timber, water (including watersheds, groundwater, wells, lakes) game, tree, farm, livestock, crops, wildlife, animal, aquaculture, pests/pesticides, insects/insecticides, soil
- Issues/Problems: Climate Change (including ice melting and thinning), recycling (Note: not 'waste' in general), species loss/extinctions

We first searched for environmental relevance in the titles of the records. If the keywords were absent or environmental relevance unclear in the title, we then searched in the abstract. If the keywords were absent in the abstract and the article was clearly not of environmental relevance, we excluded the record. If the environmental relevance was still unclear, we retrieved the full-text PDF for the record and searched there. If still unclear, we interpreted the environmental relevance based on our perception of the underlying 'intent' of the article.

Step 4: Screened for duplicates

At this stage, the remaining 1093 records were imported from Scopus into a reference management software, Mendeley (version 1.17.9). Using the automatic inbuilt function in Mendeley, four sets of duplicates were identified and removed. Furthermore, two sets of duplicates were identified manually by visually scanning and comparing the records.

Step 5: Removal of records with no abstract.

The records were checked manually to ensure that all had abstract information. Any records without abstract information were removed. This left a total of 1002 records that were all included in the study.

Appendix C. Full coding structure for qualitative systematic review

The 1002 abstracts were coded in a qualitative systematic review, as defined by Grant and Booth (2009). Below, we present the coding structure including main themes (in bold) and sub-themes (underlined). Data segments (i.e. words or text) were coded directly at the sub-themes; they were allowed to be coded at multiple sub-themes within the same broad theme, and at multiple sub-themes across several broad themes. See Table 3 in the main text for reference.

C1. Ethics

The paper operationalizes/studies/advocates for stewardship as, or discusses stewardship in relation to, a type of moral guideline or philosophical principle that guides or informs human relationships with nature in particular social spheres.

- *Keywords:* care, responsibility, obligation, principle, values.
- *Inclusion/Exclusion:* Include if stewardship is formulated as a consciously articulated moral principle. Exclude if stewardship is framed as more of an unconscious preference, attitude or behavioral trait (code under Motivation).
- *Example:* "Stewardship involves responsibility for something and also responsibility to someone. This can mean responsibility to God, or for those without religious beliefs, responsibility to future generations" (Seamer, 1998).

Religious: Stewardship discussed as a principle, idea or belief expressed within organized religions such as Christianity, Islam, Judaism, Buddhism etc., and related religious texts.

- *Keywords*: faith, dominion, spiritual, God, creation, theology.
- *Example:* "Members of the Church of Jesus Christ of Latter-day Saints (LDS), like many other Christians, believe in the importance of human stewardship over the natural world" (Walker, 2014).

Ecosystem science and management: Stewardship discussed as a philosophical approach or ethical principle informing ecosystem science and management.

- *Keywords*: social-ecological, biosphere, resilience, structure, function, sustainable, conservation, earth stewardship.
- *Example:* "Addressing future uncertainty and risk has therefore become a central problem of ecosystem management. With risk management and resilience-based stewardship, two contrasting approaches have been proposed to address this issue. Whereas one is concentrated on anticipating and mitigating risks, the other is focused on fostering the ability to absorb perturbations and maintain desired properties" (Seidl, 2014).

Corporate: Stewardship discussed as an approach to or principle of corporate, business, organizational or private sector activity.

- *Keywords:* Corporate Social Responsibility (CSR), leadership, firm, managers, supply chain, indicators.
- *Example:* "In this worldview of business, humans are stewards endowed with a mandate to use the agency of their mana (spiritual power, authority, and sovereignty) to create mauri ora (conscious well-being) for humans and ecosystems – and this commitment extends to organizations" (Spiller et al., 2011).

Indigenous/customary: Stewardship discussed as a feature of, or in relation to, Indigenous or customary ethics, worldviews or cultures.

- *Keywords*: traditional, interconnected, values, reciprocity.
- *Example:* "Polynesian immigrants brought to New Zealand a distinctive world view which gave rise to both tribal traditions and living traditions of the Maori. The resultant environmental ethic emphasizes guardianship and stewardship" (Given, 1995).

Agricultural: Stewardship discussed as a philosophical approach or principle in agricultural, landscape or fisheries management, including animal husbandry.

- *Keywords:* Aldo Leopold, land ethic, landscape, farmer, organic, permaculture, soil health, agrarian, fishery.
- *Example:* "The moral as a basic concept of sustainable agriculture is to maintain continuous development in harmony with nature to meet requirements in the world for living creatures including human beings to live in and steward" (Szücs, Geers, & Sossidou, 2009).

Civic/legal/economic: Stewardship discussed in terms of individual, public and societal obligations to the environment, or principles guiding human interaction with the environment, including their manifestations in specific governance, legal (e.g. duty of care) and economic systems (e.g. limits to growth).

- *Keywords:* public good, duty of care, responsibility, utilitarian, intergenerational equity, statutory, rights.
- *Example:* "[in] environmental law, stewardship constitutes a general, universal duty to care for the planet" (Barrit, 2014); "Thus, economic efficiency and climate stewardship are not regarded as conflicting goals, but as synonyms for a single encompassing economic optimization exercise" (Hasselmann, 1999).

Not clear/other: Stewardship discussed in terms that do not fit clearly into any of the above sub-themes.

- Keywords: N/A
- *Example:* "the Pearl-poet goes on to establish the Green Knight as an alternative ideal for his aristocratic readers and a model of environmental

guardianship" (Martinez, 2016).

C2. Motivation

The paper operationalizes/studies/advocates for stewardship as, or discusses stewardship in relation to, a set of attitudes, preferences, or predispositions that make people inclined to behave or act in a particular manner.

- *Keywords:* attitudes, beliefs, preferences, decisions, interests, behaviors, psychological, traits, pro-environmental.
- *Inclusion/Exclusion:* See for Ethics (above). Include if stewardship is formulated as a set of values or ethics, if they are stated to explicitly motivate behavior (code also under ethics). If they are simply discussed in terms of values, then only code under ethics. Include if papers frame motivations as outcomes in themselves (*do not* also code in Outcomes – social).
- *Example:* "We found that volunteers' frequency of participation is most motivated by personal and social benefits rather than by environment-related reasons. Environmental motivations, otherwise marginally significant, were more salient predictors of participation to the extent that personal and social motivations were met" (Asah & Blahna, 2012).

C2.1. Scale

The scale at which the paper considers the motivation to occur. *NB:* do not code the sample size of the study (unless this correlates with the scale at which motivation is considered to occur), or the geographic scale of the paper in general, or scales at which the findings are suggested to be relevant, but the scale at which the phenomenon of motivation is considered to occur.

Individual: Motivations presented as occurring at the personal to household level.

- *Keywords:* citizens, people, volunteers, individuals, farmers, ranchers, landholders, family forests, family farms.
- *Examples:* "148 long-term volunteers from three environmental stewardship programs in Michigan" (Ryan, Kaplan, & Grese, 2001); "75 enrolled landowners" (Selinske et al., 2015); "individual farmers" (Valbuena et al., 2010).

Local/regional: Motivations are discussed as occurring at the collective level, up to (but not including) the level of a national society.

- *Keywords:* Communities, cities, firms, companies.
- *Examples:* "a community on the Hawkesbury-Nepean floodplain" (Norris & Burgin, 2009); "Important motives for firms to engage in POEM are addressing stakeholder interests and obtaining a competitive advantage" (de Bakker, Fisscher, & Brack, 2002).

National/international: Motivations are discussed as occurring collectively at the level of general populations, nation states or international groupings, up to the level of two continents.

- *Keywords:* societal, population, particular nations
- *Examples:* "societal preferences" (Carvalho-Ribiero et al., 2016); "a representative sample of the Norwegian population" (Kaltenborn, Gundersen, Stange, Hagen, & Skogen, 2016); "firms in Canada, the United States and Germany" (Cashore, Van Kooten, Vertinsky, Auld, & Affolderbach, 2005).

Global: Motivations are discussed as occurring at the global level, understood as the level of three continents and beyond.

- *Keywords:* world population, planetary, global community
- Example: N/A

Not clear/other: Motivations are discussed in terms that do not fit clearly into any of the above sub-themes.

- Keywords: N/A
- *Examples:* "human tolerance for large, terrestrial carnivores" (Bruskotter & Wilson, 2014); "using sense of place as motivation for long-term stewardship at multiple spatial scales" (Chapin & Knapp, 2015).

C2.2. Focus

The thematic focus or source of the motivation.

Environmental: Motivations are presented as informed by, or related to, environmental or ecological factors.

- *Keywords:* pro-environmental, environmental benefits/health, concern for nature, conservation-oriented
- *Examples:* "Residents considered that the environmental health of the local waterways was important, and they stated that they were willing to change their habits for environmental improvement" (Norris & Burgin, 2009); "Concern about rodenticides affecting wildlife was the most consistent predictor of potential to change or not change behavior" (Morzillo & Mertig, 2011).

Social: Motivations are presented as informed by, or related to, personal or social factors.

- *Keywords:* sense of place, attachment, personal values/benefits, well-being, belonging, recreation, community pressure, interests, responsibilities to others, moral dispositions, social norms
- *Examples:* "We found that volunteers' frequency of participation is most motivated by personal and social benefits rather than by environment-related reasons" (Asah & Blahna, 2012); "Relationships, public image, value alignment and feedback on management practices were most commonly cited as both motivations for and results of certification" (Crow & Danks, 2010).

Economic: Motivations are presented as informed by, or related to, economic, financial or monetary factors.

- *Keywords:* financial incentives, payment level, subsidies, private property rights, livelihood, competitive advantage, price premium, profit, income
- *Example:* "ESA farmers are largely motivated by financial gain" (Lobley & Potter, 1998); "economic theory suggests owners of private property rights have an incentive to act as resource stewards" (Gilmour et al., 2012).

Not clear/other: Motivations are presented as informed by, or related to, factors that do not clearly fit into any of the above sub-themes.

- Keywords: N/A
- *Examples:* "Factors that influence farmers' ability and willingness to participate in these mechanisms were identified" (Valbuena et al., 2010); "Extant literature posits that social entrepreneurs are predominantly guided in their sustainable solutions by ex-ante and ex-post resource positions" (Basu & Sharma, 2014).

C3. Action

The paper operationalizes/studies/advocates for stewardship, or discusses stewardship in relation to, a particular kind of activity engaged in by particular actors.

- *Keywords:* activities, act, projects, initiatives, efforts, practices, programs, policies, schemes
- *Inclusion/Exclusion:* Include if paper discusses actions as a means to achieve particular outcomes, but in this case also code under outcomes.
- *Examples:* "Agri-environment schemes (AES) are used extensively across Europe to address biodiversity declines in farmland. In England, Environmental Stewardship (ES) was introduced in 2005 to address the shortcomings of previous schemes" (Baker et al., 2012); "local groups have taken the initiative to provide hands-on environmental care and to pressure decision makers to act in environmentally responsible ways" (Lerner, 1994).

C3.1. Scale

The scale at which the paper considers the action to occur. *Note* – do not code the geographic scale of the paper in general, or scales at which the findings are suggested to be relevant, but the scale at which the action in question is considered to occur.

Individual: The paper refers to activities occurring at the personal or household level.

- *Keywords:* Specific people, individual farmers/landowners, a family, a manager
- *Examples:* "the activities of a social entrepreneur towards providing desired sustainable solutions" (Basu & Sharma, 2014); "The four women leaders consider their efforts as nothing special and business as usual" (van Riper, 2013).

Local/Regional: The paper refers to activities occurring at the sub-national level. This includes instances where papers compare multiple activities occurring within a single country (e.g. "75 brownfield sites in the USA"), unless the sites are owned or managed by a single national-level management agency/organization (e.g. "sites owned by the US Department of Defence") – in which case code at 'National/International.' This also includes activities occurring in multiple local/regional sites in different countries, unless the comparison is between entire sectors that occur across whole countries (e.g. "Russian salmon, Peruvian ceramics, Indonesian textiles, and Bolivian quinoa") – in which case code at 'National/International.' Note: some papers use 'regional' to mean sub-national, while others use 'regional' to mean international.

- *Keywords:* communities, neighborhoods, cities, districts, provinces, states, regions, ecosystems, habitat types, national parks, bioregions, watersheds, rivers, catchments, basins, fisheries, companies, firms
- *Examples:* "Mokil Atoll, an island in Pohnpei State, Federated States of Micronesia" (Oles, 2007); "the Siuslaw National Forest in the Pacific Northwest" (Peck & Christy, 2006); "five FSC certified Forest Management Units (FMUs) in Malaysia" (Rusli & Nabilah, 2009).

National/international: The paper refers to activities occurring at the national and international level, up to the level of two continents. This includes ecological zones, seas or geographic regions that cover an entire country or span multiple countries (e.g. "rural Canadian landscapes," "Mediterranean Oak Woodlands," "the Gulf of Mexico") – unless the paper clearly refers to only a portion of these areas, in which case code under 'Local/Regional.' This also includes the actions of national government agencies or departments, or to policies/programs that are described at the scale of entire countries (e.g. "Landcare groups across Australia").

- *Keywords:* countries, networks of countries, national, federal, national government, international, EU, oceans, arctic/Antarctic.
- *Examples:* "the governments in Europe and North America" (Macdonald & Vopni, 1994); "Three federal agencies, the U.S. Department of Agriculture, the Food and Drug Administration, and the Environmental Protection Agency" (Meilan, 2006); "the Finnish wood industry" (Holopainen, Toppinen, & Perttula, 2015).

Global: The paper refers to activities occurring from the level of three or more continents up to the entire planet. This includes broad references to 'developed' or 'developing' countries in general. This also includes specific global organizations and institutions, when the paper is clearly referring to the organization/institution as a whole.

- *Keywords:* planetary, world, earth, global, developed, developing, United Nations, FSC, MSC
- *Examples:* "Our global population" (Anderson, 2015); "the global forest community" (Apsley & Reed, 1996); "the Marine Stewardship Council (MSC)" (Christian et al., 2013), "global production networks (GPNs)" (Gibson & Warren, 2016).

Not clear/other: The paper refers to activities occurring at scales that do not clearly fit into the above themes. This includes broad industrial sectors to which a scale is not explicitly specified (e.g. "the metals sector," "the carpet industry") or actors that are spoken about in general, unspecific terms ("firms," "businesses"). This also includes papers that refer to broad/general principles or conceptual/practical approaches to types of action that are not linked explicitly to a particular scale. Note: for all of these distinctions, if a scale is mentioned (e.g. "a globally relevant principle," "a global principle") then the paper should be coded under the relevant sub-theme above.

- *Keywords:* multiple/different scales, firms, businesses, unspecified sectors
- *Examples:* "manufacturing plants" (Bean et al., 2016); "different levels of governance" (Carvalho-Ribiero et al., 2016), "133 business organizations" (Guimaraes & Liska, 1995), "the minerals and metals sector" (Fleury & Davies, 2012).

C3.2. Actor

The actors involved in the action/activity described in the paper.

Public/government: The paper refers to public sector or government actors, including 'policy' or 'policy-makers' (unless the paper is explicitly talking about corporate or business policies, in which case code under 'Private sector').

- *Keywords:* National/state/local governments, government agencies/departments, international inter-governmental organizations (e.g. United Nations, World Bank), international conventions/secretariats, policy, policy-makers
- *Examples:* "Ontario Ministry of Natural Resources" (Caldwell, Greening, Norman, & Williams, 1999); "the National Science Foundation Center for Integrated Pest Management" (Church, Stinner, Buhler, & Bradley, 2013); "Convention on Biological Diversity" (Garrelts & Flitner, 2011).

NGO: The paper refers to non-governmental organizations.

- *Keywords:* FSC, MSC, WWF, Greenpeace, non-governmental, civil society
- *Examples:* "Alberta Riparian Habitat Management Society (Cows and Fish)" (Ambrose, Fitch, & Bateman, 2006); "The main actors were environmental non-governmental organizations participating in prominent bioregional landscape partnerships" (Barendse et al., 2016); "The main actors were environmental non-governmental organizations participating in prominent bioregional landscape partnerships" (Bellchambers, Fisher, Harry, & Travaille, 2015).

Primary resource user/landholder: The paper refers to primary resource users, in the sense of farmers, fishers, graziers, etc.; also landholders, resource managers, well-owners and gardeners. Note: All agricultural and fisheries actors should be coded at this sub-theme, but often a paper may refer to an agricultural sector or business, or to farms as private business enterprises. In these cases, papers should also be coded at the 'Private Sector' sub-theme below.

- *Keywords:* farmers, farms, fishers, landholders, landowners, agriculture, graziers, ranchers, forest owners, forestry operators, horticulture, producers, resource managers, well-owners
- *Examples:* "forest managers and landowners" (Dias et al., 2015); "Small-scale tuna fisheries" (Duggan & Kochen, 2016); "Community Forest Organizations" (Furness, Harshaw, & Nelson, 2015).

Scientist/educator: The paper refers to scientific or educational actors or organizations.

- *Keywords:* scientists, teachers, researchers, instructors, experts
- *Examples:* "teams of physical, biological, and social scientists" (Chapin, 2011); "the National Science Foundation Center for Integrated Pest Management" (Church et al., 2013); "an interdisciplinary committee of 13 scientists" (Johnson et al., 1999).

Private sector: The paper refers to private enterprises or organizations, including firms, businesses and industrial sectors.

- *Keywords:* business, corporation, industry, firms, companies, markets, private, manufacturers
- *Examples:* "the Queensland sugar industry" (Davis, Lewis, Brodie, & Benson, 2014); "forty-six global food industry companies" (Deák & Hajdu, 2012); "The Canadian hydropower sector" (Fortin, 2002).

Citizen/community: The paper refers to citizens, communities and volunteers – in the context of individuals, groups or civic organizations. Include groups referred to by their religion if in their capacity as citizens/people – e.g. "religious believers," "American evangelicals" – but exclude if reference is to a church as an institution (e.g. "the Catholic church"). This latter example should be coded under 'Other/Not clear.'

- *Keywords:* communities, community-based, community groups, volunteers, citizens, civic groups, individuals
- *Examples:* "Core ideas focus on linking stewardship to the unique role that local communities and workers can play" (Gray, Enzer, & Kusel, 2001); "the challenge for citizens in local communities to take responsibility for their own futures" (Hilts, 1997); "Many cities have set ambitious planting goals, relying on volunteer community groups to meet them" (Jack-Scott, Piana, Troxel, Murphy-Dunning, & Ashton, 2013).

Collaborative network: The paper refers to voluntary or self-organized networks of individuals, organizations, and institutions (as distinct from hierarchical, authority-based or contractual relationships, e.g. supply chains).

- *Keywords:* networks, collaboration, self-organized, power-sharing, partnerships, coalitions
- *Examples:* "CBNRM entails collaborative efforts, typically involving local, state and federal agencies, private firms and landowners, non-governmental organizations such as environmental and economic development groups, and watershed councils" (Hibbard & Lurie, 2012); "this study demonstrates how organizations and individual volunteer practices evolved to manage watershed stewardship across multiple scales" (Chanse,

2011).

Not clear/other: The paper refers to actors that do not clearly fit into any of the sub-theme listed above.

- Keywords: N/A
- *Examples:* "Tourists" (Becken, 2014); "Ten national organizations" (Bookman, 2000), "The Romanian Orthodox Church" (Butiu & Pascaru, 2014), "All healthcare workers must accept responsibility for stewardship" (Edwards & Gould, 2012).

C3.3. Type

The type of action or activity referred to in the paper.

Management: The paper refers to the action or process of trying to control or direct ecosystems or environmental change, especially in the context of ecological restoration, conservation and environmental management.

- *Keywords:* protection, management, restoration, maintenance, conservation, preservation, biodiversity, remediation
- *Examples:* "community gardening, shellfish reintroductions, tree planting and care, and "friends of parks" initiatives to remove invasive and restore native species" (Krasny & Tidball, 2012); "An ecosystem-based approach was adopted as a process for making, implementing, and evaluating decisions affecting the management of natural resources" (Lillie & Ripley, 1998).

Production: The paper refers to the action or process of making, manufacturing and harvesting materials, food, supplies and products – including in both industrial and agricultural contexts. Note: If recycling is part of production processes (either agricultural or industrial), code at this sub-theme. If recycling is from households and the public and treated as part of municipal or public planning then code as 'Design.' If part of a specific policy or program, code under 'Policy/Program/Legislation' also.

- *Keywords:* harvesting, extraction, hunt, industrial, product stewardship, materials stewardship, waste, recycle, production emissions
- *Examples:* "comprehensive product stewardship campaign has been initiated to recover waste paint before it enters the waste stream" (Almesfer & Ingham, 2014); "access, leasing, and management programs of state wildlife agencies that assist hunted and nonhunted wildlife and recreation management on private lands" (Benson, 2001).

Policy/program/legislation: The paper refers to the construction or operation of specific policies, programs and legislation, including market certification schemes.

- *Keywords:* agri-environmental scheme, incentive schemes, environmental stewardship schemes, certification, Forest Stewardship Council (FSC), Marine Stewardship Council (MSC), regulation, law, policies
- *Examples:* "We focus on ISO (International Organization for Standardization) 14001, the most widely adopted voluntary environmental program in the world" (Berliner & Prakash, 2013); "this study examines how landowner assistance programs (which may include management plans, cost-share, technical assistance and advice, and education components) affect family forest owner behavior" (Andrejczyk et al., 2016).

Governance: The paper refers to the processes, structures and patterns of governing (rather than specific policies, programs and legislation), including in particular the ways that decisions are arrived at, stakeholders engaged, and paths of action decided.

- *Keywords:* negotiation, collaboration, network, vision, dialogue, multi-scalar, rules for action, links, participation, bridging organizations, decision-making, coordination
- *Examples:* "collaboration and patterns in the flow of information, ideas, and funding among stakeholders in an industrial urban ecosystem" (Belaire, Dribin, Johnston, Lynch, & Minor, 2011); "Private rule-setting organizations increasingly design, implement, and monitor rules and standards that prescribe behavior in the global governance for sustainability" (Kalfagianni & Pattberg, 2014).

Activism: The paper refers to activities intended to bring about social, ecological or political change, including through advocacy or protest.

- *Keywords:* campaigns, justice, advocacy, organizing, protest, activism, pressure, alliance building, environmentalism
- *Examples:* "local groups have taken the initiative to provide hands-on environmental care and to pressure decision makers to act in environmentally responsible ways" (Lerner, 1994); "bring the message of Green Judaism to the wider community through a variety of activities, publications, and activism" (Tharan, 1997).

Educational: The paper refers to activities intended to provide information, stimulate learning and raise awareness of particular issues, including teaching and provision of hands-on experiences.

- *Keywords:* environmental education, environmental literacy, awareness, information exchange, training, classroom
- *Examples:* "we address opportunities to enhance hunter stewardship through appeals to social norms and strengthened hunter education training that fosters moral norms and ecological understanding" (Holsman, 2000); "podcast tours increase perceived social presence and mindfulness that lead to enhanced tourist experiences and environmental stewardship" (Kang & Gretzel, 2012); "new market-based tools, including consumer awareness campaigns" (Jacquet et al., 2010).

Scientific: The paper refers to the generation, organization and dissemination of scientific data, ideas, and information.

- *Keywords:* experimentation, monitoring, civic science, data stewardship, data
- *Examples:* "Microwave radar's unique ability to penetrate clouds and weather make these types of data invaluable to the CIS's support to efficient

environmental stewardship" (Arkett et al., 2015); "volunteers are engaged in environmental monitoring, discovery, and experimentation. They are conducting community science" (2004).

Design: The paper refers to the development and implementation of plans, including in urban/rural planning, architecture, landscaping and technological applications. Include papers that refer to recycling if from the general public and treated as part of municipal or public planning. If referring to a specific policy or program, then code under 'Policies/Programs/Legislation' as well. Exclude if talking about recycling of industrial products by the private sector (in which case, should be coded in 'Production.'

- *Keywords:* engineer, planning, technologies, landscape, architecture, building design, sustainability indexes/indicators, life-cycle assessment, geoengineering
- *Examples:* "Planning processes such as "smart growth" and "urban infill" help to better manage development and slow down sprawl" (Dorsey, 2003); "large-scale technological interventions to combat climate change" (Galaz et al., 2012).

Not clear/other: The paper refers to actions/activities that do not clearly fit into any of the above themes.

- Keywords: N/A.
- *Examples:* "By implementing a "tax wise" gifting strategy, the landowner can lower his current tax bill, while at the same time enhancing his family's future net worth" (Browder & Staggs, 2004); "the environmental practices a firm's management undertakes" (Cui, Jo, & Velasquez, 2015).

C4. Outcome

The paper operationalizes/studies/advocates for stewardship as the achievement of a specific, desirable set of results or consequences.

- *Keywords:* benefits, results, protective, health, mitigation, achievements, impacts, objectives, goals
- *Inclusion/Exclusion:* Exclude if the paper talks about motivation as an outcome – in this case code at Motivation.
- *Examples:* "Climate change policy has the potential to integrate sustainability concerns into all levels of economic decision making, thereby producing ancillary societal benefits such as improvements in existing air quality and public health" (Choi, 2005); "the economic benefits for the forestry business sector could exceed US150 million" (Zhao, Xie, Wang, & Deng, 2011); "if an action creates net ecosystem service value above the baseline condition, it would be considered to embody environmental stewardship" (Nicolette et al., 2013).

C4.1. Scale

The scale at which the paper considers the outcome to occur. *Note* – do not code the geographic scale of the paper in general, or scales at which the findings are suggested to be relevant, but the scale at which the outcome in question is considered to occur.

Individual: The paper refers to outcomes occurring at the personal or household level.

- *Keywords:* Specific people, individual farmers/landowners, a family, a manager
- *Examples:* "the landowner can lower his current tax bill, while at the same time enhancing his family's future net worth" (Browder & Staggs, 2004); "city residents are finding innovative ways of stewarding nature that integrate environmental, community, and individual outcomes" (Krasny & Tidball, 2012).

Local/regional: The paper refers to outcomes occurring at the sub-national level (for further details, see 'Local-Regional' sub-theme in the 'Action' theme).

- *Keywords:* communities, neighborhoods, cities, districts, provinces, states, regions, ecosystems, species, habitat types, national parks, bioregions, watersheds, rivers, catchments, basins, fisheries, companies, firms
- *Examples:* "seven states including California, Colerado, Hawaii, Maryland, Mississippi, Pennsylvania, and Texas" (Barbeiro, Barolsky, Culp, & Ritter, 2008); "in temperate eucalypt woodlands, southeastern Australia" (Barton, Sato, Kay, Florance, & Lindenmayer, 2016).

National/international:The paper refers to activities occurring at the national and international level, up to the level of two continents (for further details, see 'National/International' sub-theme in the 'Action' theme).

- *Keywords:* countries, networks of countries, national, federal, national government, international, EU, oceans, arctic/Antarctic.
- *Examples:* "the American landscape" (Dorsey, 2003); "hemiboreal Europe" (Lohmus & Kraut, 2010); "120 firms in 30 countries" (Singh, Ma & Yang, 2016).

Global: The paper refers to activities occurring from the level of three or more continents up to the entire planet (for further details, see 'Global' sub-theme in the 'Action' theme).

- *Keywords:* planetary, world, earth, global, developed, developing, United Nations, FSC, MSC
- *Examples:* "the world's fisheries" (Agnew, Gutiérrez, Stern-Pirlot, & Hoggarth, 2014); "the need to ensure the sustainability of fish stocks around the world" (Cummins, 2004); "the health of planet Earth" (Goltsman, Kelly, McKay, Algara, & Larry, 2009).

Not clear/other: The paper refers to activities occurring at scales that do not clearly fit into the above themes (for further details, see 'Not clear/other' sub-theme in the 'Action' theme).

- *Keywords:* multiple/different scales, firms, businesses, unspecified sectors
- *Examples:* “restoration of a larger area of hedgerow habitat (Amy et al., 2015)”; “The goal is to protect the public and the environment” (Morris, 1996).

C4.2. Focus

The thematic focus or location of the outcome.

Environmental: The paper presents outcomes as environmental, ecological or biophysical in character.

- *Keywords:* water, species, environmental, ecological, fish stocks, fisheries, ecosystem services, nitrogen/carbon cycles, climate change, structure and function, mammals, invertebrates, conservation
- *Examples:* “benefit both woodland- and matrix-inhabiting bird species” (Attwood et al., 2009); “provide the structural vegetation necessary for nesting harvest mice” (2003); “conserving Earth's biodiversity” (Berkman, 2010).

Social: The paper presents outcomes as social in character.

- *Keywords:* wellbeing, learning, health, food security, safety, peace, poverty alleviation, attitudes, accountability, livelihood
- *Examples:* “alleviation of poverty; security of livelihoods and better governance systems” (Bridgewater, Regnier & Garcia 2015); “the process benefited forest management by including tourism operators in forest management planning, promoting dialogue between the two industries, and balancing power relationships” (Browne, Rutherford, & Gunton, 2006).

Economic: The paper presents outcomes as economic in character.

- *Keywords:* profit, livelihood, cost, value, cost-effective, efficiency, poverty reduction
- *Examples:* “increases productivity and profitability and improves fertilizer use efficiency” (Bryla, 2011); “Findings reveal the sub-regional income and employment effects of such schemes to be significant” (Courtney, Mills, Gaskell, & Chaplin, 2013).

Not clear/other: The outcomes presented by the paper do not clearly fit into any of the sub-themes above.

- Keywords: N/A.
- *Examples:* “outcomes” (Romolini et al., 2012); “realize the full potential of the forest resource” (2003).

Appendix D. Supplementary material

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.landurbplan.2018.07.005.

References

Agnew, D. J., Gutiérrez, N. L., Stern-Pirlot, A., & Hoggarth, D. D. (2014). The MSC experience: Deveoping an operational certification standard and a marked incentive to improve fishery sustainability. *ICES Journal of Marine Science, 71*(2), 216–225.

Ahern, J. (2011). From *fail-safe* to *safe-to-fail*: Sustainability and resilience in the new urban world. *Landscape and Urban Planning, 100*, 341–343.

Almesfer, N., & Ingham, J. (2014). Effect of waste latex paint on concrete. *Cement & Concrete Composites, 46*, 19–25.

Ambrose, N. E., Fitch, L., & Bateman, N. G. (2006). Evaluating characteristics of community riparian awareness program interactions. *Water Science and Technology, 53*(19), 193–199.

Amy, S. R., Heard, M. S., Hartley, S. E., George, C. T., Pywell, R. F., & Staley, J. T. (2015). Hedgerow rejuvenation management affects invertebrate communities through changes to habitat structure. *Basic and Applied Ecology, 16*, 443–451.

Anderson, W. C. (2015). The challenges facing comprehensive energy policy. *Strategic Planning for Energy and the Environment, 34*(3), 72–80.

Andersson, E., & Barthel, S. (2016). Memory carriers and stewardship of metropolitan landscapes. *Ecological Indicators, 70*, 606–614.

Andersson, E., Enqvist, J., & Tengö, M. (2017). Stewardship in urban landscapes. In C. Bieling, & T. Plieninger (Eds.). *The science and practice of landscape stewardship* (pp. 222–238). Cambridge, UK: Cambridge University Press.

Andrejczyk, K., Butler, B. J., Dickingson, B. J., Hewes, J. H., Markowski-Lindsay, M., Kittredge, D. B., et al. (2016). Family forest owners perceptions of landowner assistance programs in the USA: A qualitative exploration of program impacts on behaviour. *Small-scale Forestry, 15*(1), 17–28.

Apsley, T. M., & Reed, F. L. C. (1996). World timber resoures outlook: Current perceptions with implications for policy and practice. *Commonwealth Forestry Review, 144*, 155–159.

Arkett, M., Braithwaite, L., Pestieau, P., Carrieres, T., Pogson, L., Fabi, C., et al. (2015). Preparation by the Canadian Ice Service for the operational use of the RADARSAT constellation mission on their ice and oil spill programs. *Canadian Journal of Remote Sensing, 41*(5), 380–389.

Asah, S. T., & Blahna, D. J. (2012). Motivational functionalism and urban conservation stewardship: Implications for volunteer involvement. *Conservation Letters, 5*, 470–477.

Asah, S. T., & Blahna, D. J. (2013). Practical implications of understanding the influence of motivations on commitment to voluntary urban conservation stewardship. *Conservation Biology, 27*, 866–875.

Atari, D. O. A., Yiridoe, E. K., Smale, S., & Duinker, P. N. (2009). What motivates farmers to participate in the Nova Scotia environmental farm plan program? Evidence and environmental policy implications. *Journal of Environmental Management, 90*, 1269–1279.

Baggio, J. A., Brown, K., & Hellebrandt, D. (2015). Boundary object or bridging concept? A citation network analysis of resilience. *Ecology & Society, 20*.

Baker, D. J., Freeman, S. N., Grice, P. V., & Siriwardena, G. M. (2012). Landscape-scale responses of birds to agri-environment management: A test of the english environmental stewardship scheme. *Journal of Applied Ecology, 49*(4), 871–882.

Barbeiro, G., Barolsky, R., Culp, M., & Ritter, R. (2008). PEL: A path to streamlining and stewardship. *Public Roads, 71*(5), 2.

Barendse, J., Roux, D., Currie, B., Wilson, N., & Fabricius, C. (2016). A broader view of stewardship to achieve conservation and sustainability goals in South Africa. *South African Journal of Science, 112*, 1–15.

Barreteau, O., Giband, D., Schoon, M., Cerceau, J., DeClerck, F., Ghiotti, S., ... Therville, C. (2016). Bringing together social-ecological system and territoire concepts to explore nature-society dynamics. *Ecology and Society, 21*, 14.

Barrett, C. B., & Grizzle, R. E. (1997). A holistic approach to sustainability based on pluralism stewardship. *Environmental Ethics*.

Barrit, E. (2014). Conceptualising stewardship in environmental law. *Journal of Environmental Law, 26*(1), 1–23.

Barthel, S., Crumley, C., & Svedin, U. (2013). Bio-cultural refugia—Safeguarding diversity of practices for food security and biodiversity. *Global Environmental Change, 23*, 1142–1152.

Barton, P. S., Sato, C. F., Kay, G. M., Florance, D., & Lindenmayer, D. B. (2016). Effects of environmental variation and livestock grazing on ant community structure in temperate eucalypt woodlands. *Insect Conservation and Diversity, 9*(2), 124–134.

Basu, S., & Sharma, A. (2014). Exploring stewardship as an antecedent behavioural trait of social entrepreneurs. *Journal of Entrepreneurship, 23*(1), 19–33.

Bean, T. G., Bergstrom, E., Thomas-Oates, J., Wolff, A., Bartl, P., Eaton, B., et al. (2016). Ecaluation of a novel approach for reducing emissions of pharmaceuticals to the environment. *Environmental Management, 58*(4), 707–720.

Bear, C., & Eden, S. (2008). Making space for fish: The regional, network and fluid spaces of fisheries certification. *Social & Cultural Geography, 9*, 487–504.

Becken, S. (2014). Water equity - Contrasting tourism water use with that of the local community. *Water Resources and Industry, 7–8*, 9–22.

Belaire, J. A., Dribin, A. K., Johnston, D. P., Lynch, D. J., & Minor, E. S. (2011). Mapping stewardship networks in urban ecosystems. *Conservation Letters, 4*(6), 464–473.

Bell, S., & Hindmoor, A. (2012). Governance without government? The case of the forest stewardship council. *Public Administration, 90*, 144–159.
Bellchambers, L. M., Fisher, E. A., Harry, A. V., & Travaille, K. L. (2015). Identifying and mitigating potential risks for Marine Stewardship Council assessment and verification. *Fisheries Research, 183*, 7–17.
Bennett, N. J., Whitty, T. S., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., & Allison, E. H. (2018). Environmental stewardship: A conceptual review and analytical framework. *Environmental Management, 61*, 597–614.
Benson, D. E. (2001). Survey of state programs for habitat, hunting, and nongame management on private lands in the United States. *Wildlife Society Bulletin, 29*(1), 354–358.
Berkes, F. (2009). Evolution of co-management: role of knowledge generation, bridging organizations and social learning. *Journal of Environmental Management, 90*, 1692–1702.
Berkes, F., Colding, J., & Folke, C. (2003). *Navigating social–ecological systems: Building resilience for complexity and change.* Cambridge, UK: Cambridge University Press.
Berkman, P. A. (2010). Biodiversity stewardship in international spaces. *Systematics and Biodiversity, 8*, 311–320.
Berliner, D., & Prakash, A. (2013). Signaling environmental stewardship in the shadow of weak governance: The global diffusion of ISO 14001. *Law and Society Review, 47*(2), 345–373.
Bieling, C., & Plieninger, T. (2017). *Leveraging landscape stewardship: Principles and ways forward.* C. Bieling, & T. Plieninger *The science and practice of landscape stewardship*Cambridge, UK: Cambridge University Press368–369.
Blumer, H. (1954). What is wrong with social theory? *American Sociological Review, 18*, 3–10.
Bookman, C. A. (2000). Town meeting on America's coastal future: Using the Internet to promote coastal stewardship. *Ocean Coastal Management, 43*, 937–951.
Boonstra, W. J. (2016). Conceptualizing power to study social-ecological interactions. *Ecology and Society, 21*.
Bradshaw, B., Cocklin, C., & Smit, B. (1998). Subsity removal and farm-level stewardship in Northland. *New Zealand Geographer, 54*, 12–20.
Bramston, P., Pretty, G., & Zammit, C. (2011). Assessing environmental stewardship motivation. *Environment and Behavior, 43*, 776–788.
Brand, F. S., & Jax, K. (2007). Focusing the meaning(s) of resilience: Resilience as a descriptive concept and a boundary object. *Ecology and Society, 12*.
Bridgewater, P., Régnier, M., & Garcia, R. C. (2015). Implementing SDG 15: Can large-scale public programs help deliver biodiversity conservation, restoratin and management, while assisting human development? *Natural Resources Forum, 39*, 214–223.
Brondizio, E. S., Brien, K. O., Bai, X., Biermann, F., Steffen, W., Berkhout, F., ... Chen, C.-T. A. (2016). Re-conceptualizing the anthropocene: A call for collaboration. *Global Environmental Change, 39*, 318–327.
Browder, H. E., & Staggs, C. (2004). Tax-wise stewardship – Leveraged gifting: Part I. *Forest Landowner, 63*(1), 39–40.
Brown, K., & Westaway, E. (2011). Agency, capacity, and resilience to environmental change: Lessons from human and disasters. *Annual Review of Environment and Resources, 36*, 321–342.
Browne, S. A., Rutherford, M. B., & Gunton, T. (2006). Incorporating shared decision making in forest management planning: An evaluation of Ontario's resource stewardship agreement process. *Environments, 34*(3), 39–56.
Bruskotter, J. T., & Wilson, R. S. (2014). Determining where the wild things will be: Using psychological theory to find tolerance for large carnivores. *Conservation Letters, 7*(3), 158–165.
Bryla, D. R. (2011). Application of the "4R" nutrient stewardship concept to horticultural crops: Getting nutrients in the "right" place. *HortTechnology, 21*(6), 674–682.
Burger, J. (2000). Integrating environmental restoration and ecological restoration: Long-term stewardship at the department of energy. *Environmental Management, 26*, 469–478.
Burkitt, I. (2016). Relational agency: Relational sociology, agency and interaction. *European Journal of Social Theory, 19*(3), 322–339.
Butiu, C. A., & Pascaru, M. (2014). Religious leadership and environmental concerns. A mining project case study. *Journal for the Study of Religions and Ideologies, 13*(39), 164–180.
Caillon, S., Cullman, G., Verschuuren, B., & Sterling, E. (2017). Moving beyond the human–nature dichotomy through biocultural approaches: Including ecological well-being in resilience indicators. *Ecology and Society, 22*(4).
Caldwell, W. J., Greening, S. B. H., Norman, L., & Williams, O. (1999). A community development approach to environmental management. *Environments, 27*(2), 5–78.
Carr, A. J. L. (2004). Why do we all need community science? *Society & Natural Resources, 17*, 841–849.
Carroll, C. (2014). Geoforum native enclosures : Tribal national parks and the progressive politics of environmental stewardship in Indian Country. *Geoforum, 53*, 31–40.
Carvalho-Ribiero, S., Pinto, Correia T., Paracchini, M. L., Schüpbach, B., Ode, Sang A., Vanderheyden, V., et al. (2016). Assessing the ability of rural agrarian areas to provide cultural ecosystem services (CES): A multi scale social indicator framework (MSIF. *Land Use Policy, 53*, 8–19.
Cashore, B., Van Kooten, G. C., Vertinsky, I., Auld, G., & Affolderbach, J. (2005). Private or self-regulation? A comparative study of forest certification choices in Canada, the United States and Germany. *Forest Policy and Economics, 7*(1), 53–69.
Chan, K. M. A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., ... Turner, N. (2016). Opinion: Why protect nature? Rethinking values and the environment. *Proceedings of the National Academy of Sciences, 113*, 1462–1465.
Chanse, V. (2011). Context and complecities: A case study in evolving participatory watershed stewardship. *Landscape Journal, 30*(1), 121–132.
Chapin, F. S., Carpenter, S. R., Kofinas, G. P., Folke, C., Abel, N., Clark, W. C., ... Swanson, F. J. (2010). Ecosystem stewardship: Sustainability strategies for a rapidly changing planet. *Trends in Ecology & Evolution, 25*, 241–249.
Chapin, F. S., & Knapp, C. N. (2015). Sense of place: A process for identifying and negotiating potentially contested visions of sustainability. *Environmental Science and Policy, 53*, 38–46.
Chapin, F. S., Kofinas, G. P., & Folke, C. (2009). *Principles of ecosystem stewardship: Resilience-based natural resource management in a changing world.* Amsterdam: Springer.
Chapin, F. S., Power, M. E., Pickett, S. T. A., Freitag, A., Reynolds, J. A., Jackson, R. B., ... Bartuska, A. (2011). Earth stewardship: Science for action to sustain the human-earth system. *Ecosphere, 2* Article 89.
Chapin, F. S., Sommerkorn, M., Robards, M. D., & Hillmer-Pegram, K. (2015). Ecosystem stewardship: A resilience framework for arctic conservation. *Global Environmental Change, 34*, 207–217.
Chawla, L. (2009). Growing up green: Becoming an agent of care for the natural world. *The Journal of Developmental Processes, 4*(1), 6–23.
Chin, K., Schuster, D., Tanzil, D., Beloff, B., & Cobb, C. (2015). Sustainability trends in the chemical industry. *Chemical Engineering Progress, 111*, 36–40.
Choi, I. (2005). Global climate change and the use of economic approaches: The ideal design features of domestic greenhouse gas emissions trading with an analysis of the European Union's CO_2 emissions trading directive and the climate stewardship act. *Natural Resources Journal, 45*(4), 865–952.
Christian, C., et al. (2013). A review of formal objections to marine stewardship council fisheries certifications. *Biological Conservation, 161*, 10–17.
Church, C. S., Stinner, R. E., Buhler, W. G., & Bradley, L. K. (2013). Evolution of a pesticide safety website – Cooperative extension agents help define target audience needs. *Acta Horticulture, 999*, 221–226.
Colman, D. (1994). Ethics and externalities: Agricultural stewardship and other behavior: Presidential address. *Journal of Agricultural Economics, 45*, 299–311.
Connolly, J. J., Svendsen, E. S., Fisher, D. R., & Campbell, L. K. (2013). Organizing urban ecosystem services through environmental stewardship governance in New York City. *Landscape and Urban Planning, 109*(1), 76–84.
Cooke, B., & Lane, R. (2015). How do amenity migrants learn to be environmental stewards of rural landscapes? *Landscape and Urban Planning, 134*, 43–52.
Cooke, B., West, S., & Boonstra, W. J. (2016). Dwelling in the biosphere: Exploring an embodied human–environment connection in resilience thinking. *Sustainability Science, 11*, 1–13.
Cornell, S., Berkhout, F., Tuinstra, W., Tàbara, J. D., Jäger, J., Chabay, I., ... van Kerkhoff, L. (2013). Opening up knowledge systems for better responses to global environmental change. *Environmental Science & Policy, 28*, 60–70.
Courtney, P., Mills, J., Gaskell, P., & Chaplin, S. (2013). Investigating the incidential benefits of Environmental Stewardship scehemes in England. *Land Use Policy, 31*, 26–37.
Creighton, J., Blatner, K. A., & Carroll, M. S. (2016). For the love of the land: Generational land transfer and the future of family forests in western. *Small-scale Forestry, 15*, 1–15.
Crow, S., & Danks, C. (2010). Why certify? Motivations, outcomes and the importance of facilitating organizations in certification of community-based forestry initiatives. *Small-scale Forestry, 9*(2), 195–211.
Crutzen, P. J. (2002). Geology of mankind. *Nature, 415*, 2002.
Cui, J., Jo, H., & Velasquez, M. G. (2015). The influence of Christian religiosity on managerial decisions concerning the environment. *Journal of Business Ethics, 132*(1), 203–231.
Cummins, A. (2004). The marine stewardship council: A multi-stakeholder approach to sustainable fishing. *Corporate Social Responsibility and Environmental Management, 11*(2), 85–94.
Curthoys, L. P. (2002). Mary's point western hemispheric shorebird reserve: A case study in community leadership and successful protected area management. *Environments, 30*, 43–62.
Davis, G. E. (2005). National park stewardship and "vital signs" monitoring: A case study from Channel Islands National Park, California. *Aquatic Conservation: Marine and Freshwater Ecosystems, 15*, 71–89.
Davis, A. M., Lewis, S. E., Brodie, J. E., & Benson, A. (2014). The potential benefits of herbicide regulation: A cautionary note for the Great Barrier Reef catchment area. *Science of the Total Environment, 490*, 81–92.
de Bakker, F. G. A., Fisscher, O. A. M., & Brack, A. J. P. (2002). Organizing product-oriented environmental management from a firm's perspective. *Journal of Cleaner Production, 10*(5), 455–464.
Deák, Z. S., & Hajdu, I. (2012). The role of socially responsible investing and the media in the environmental stewardship of food industry companies. *Acta Alimentaria, 41*, 24–38.
Deighan, L. K., & Jenkins, L. D. (2015). Fishing for recognition: Understanding the use of NGO guidelines in fi shery improvement projects. *Marine Policy, 51*, 476–485.
Dorsey, J. W. (2003). Brownfields and greenfields: The intersection of sustainable stewardship. *Environmental Practice, 5*, 69–76.
Duggan, D. E., & Kochen, M. (2016). Small in scale but big in potential: Opportunities and challenges for fisheries certification of Indonesian small-scale tuna fisheries. *Marine Policy, 67*, 30–39.
Dwivedi, O. P. (1997). Vedic heritage for environmental stewardship. *Worldviews: Environment, Culture, Religion, 1*, 25–36.
Earl, G., Curtis, A., & Allan, C. (2010). Towards a duty of care for biodiversity. *Environmental Management, 45*, 682–696.
Eden, S. (2009). The work of environmental governance networks: Traceability, credibility and certification by the forest stewardship council. *Geoforum, 40*(3), 383–394.
Edwards, B., & Gould, I. M. (2012). Antimicrobial stewardship: Lessons from human healthcare. *OIE Revue Scientifique et Technique, 31*(1), 135–144.
Emirbayer, M. (1997). Manifesto for a relational sociology. *American Journal of Sociology, 103*(2), 281–317.

Emirbayer, M., & Mische, A. (1998). What is agency? *American Journal of Sociology, 103*(4), 962–1023.
English, B. C., Bell, C. D., Wells, G. R., & Roberts, R. K. (1997). Stewardship incentives in forestry: Participation factors in Tennessee. *Sourthern Journal of Applied Forestry, 21*, 5–10.
Enqvist, J., Tengö, M., & Bodin, Ö. (2014). Citizen networks in the garden city: Protecting urban ecosystems in rapid urbanization. *Landscape and Urban Planning, 130*, 24–35.
Felson, A. J., Bradford, M. A., & Terway, T. M. (2013). Promoting earth stewardship through urban design experiments. *Frontiers in Ecology and the Environment, 11*, 362–367.
Fischer, A. P. (2015). A boundary-spanning organization for transdisciplinary science on land stewardship: The stewardship network. *Ecology and Society, 20*(4).
Fleury, A.-M., & Davies, B. (2012). Sustainable supply chains – Minerals and sustainable development, going beyond the mine. *Resources Policy, 37*(2), 175–178.
Folke, C., Biggs, R., Norström, A. V., Reyers, B., & Rockström, J. (2016). Social-ecological resilience and biosphere-based sustainability science. *Ecology & Society, 21*.
Folke, C., Colding, J., & Berkes, F. (2003). Synthesis: building resilience and adaptive capacity in social-ecological systems. In F. Berkes, J. Colding, & C. Folke (Eds.). *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change* (pp. 352–387). Cambridge, UK: Cambridge University Press.
Folke, C., Jansson, Å., Rockström, J., Olsson, P., Carpenter, S. R., Chapin, F. S., ... Elmqvist, T. (2011). Reconnecting to the biosphere. *Ambio, 40*(7), 719.
Fortin, P. (2002). Hydropower, environmental stewardship and climate change. *International Journal on Hydropower and Dams, 9*(3), 39–42.
Furness, E., Harshaw, H., & Nelson, H. (2015). Community forestry in British Columbia: Policy progression and public participation. *Forest Policy and Economics, 58*, 85–91.
Galaz, V., Biermann, F., Crona, B., Loorbach, D., Folke, C., Olsson, P., ... Reischl, G. (2012). "Planetary boundaries" - exploring the challenges for global environmental governance. *Current Opinion in Environmental Sustainability, 4*, 80–87.
Galvin, K. T. (2010). Revisiting caring science: Some integrative ideas for the "head, hand and heart" of critical care nursing practice. *Nursing in Critical Care*.
Garrelts, H., & Flitner, M. (2011). Governance issues in the Ecosystem Approach: What lessons from the Forest Stewardship Council? *European Journal of Forest Research, 130*(3), 395–405.
Ghilarov, A. M. (1995). Vernadsky's biosphere concept: A historical perspective. *Quarterly Review of Biology, 70*, 193–203.
Gibson, C., & Warren, A. (2016). Resource-sensitive global production networks: Reconfigured geographies of timber and acoustic guitar manufacturing. *Economic Geography, 92*(4), 430–454.
Gilmour, P. W., Day, R. W., & Dwyer, P. D. (2012). Using private rights to manage natural resources: Is stewardship linked to ownership? *Ecology & Society, 17*.
Given, D. R. (1995). Forging a biodiversity ethic in a multicultural context. *Biodiversity and Conservation, 4*(8), 877–891.
Gnanakan, K. (2006). Creation, christians and environmental stewardship. *Evangelical Review of Theology, 30*.
Goltsman, S., Kelly, L., McKay, S., Algara, P., & Larry, W. (2009). Raising "free range kids": Creating neighborhood parks that promote environmental stewardship. *Journal of Green Building, 4*(2), 90–106.
Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal,* 91–108.
Gray, G. J., Enzer, M. J., & Kusel, J. (2001). Understanding community-based forest ecosystem management: An editorial synthesis. *Journal of Sustainable Forestry, 12*, 1–23.
Guimaraes, T., & Liska, K. (1995). Exploring the business benefits of environmental stewardship. *Business Strategy and the Environment, 4*(1), 9–22.
Gupta, A. S., Grant, S., & Strauss, A. L. (2012). 4-H and forestry afterschool clubs: A collaboration to foster stewardship attitudes and behaviors in youth. *Journal of Extension, 50*.
Hahn, T., & Nykvist, B. (2017). Are adaptations self-organized, autonomous, and harmonious? Assessing the social–ecological resilience literature. *Ecology & Society, 22*.
Haider, L. J., Hentati-Sundberg, J., Giusti, M., Goodness, J., Hamann, M., Masterson, V. A., ... Sinare, H. (2018). The undisciplinary journey: Early-career perspectives in sustainability science. *Sustainability Science*.
Hansen, W. D. (2014). Generalizable principles for ecosystem stewardship-based management of social-ecological systems: Lessons learned from Alaska. *Ecology & Society, 19*.
Hasselmann K., Intertemporal accounting of climate change harmonizing economic efficiency and climate stewardship, Climatic Change 41, 1999, 333.350.
Heise, U. K. (2008a). From the blue planet to google earth - environmentalism, ecocriticism, and the imagination of the global. In U. K. Heise (Ed.). *Sense of place and sense of planet: The environmental imagination of the global* (pp. 17–67). Oxford, UK: Oxford University Press.
Heise, U. K. (2008b). Sense of place and sense of planet. In U. K. Heise (Ed.). *Sense of place and sense of planet: The environmental imagination of the global* (pp. 3–13). Oxford, UK: Oxford University Press.
Hensen, N., Keeling, D. I., de Ruyter, K., & Wetzels, M. (2016). Me, myself, and future generations: The role of affinity and effectiveness in the creation of consumer environmental stewardship (CENS). *Psychology & Marketing, 33*, 389–406.
Hibbard, M., & Lurie, S. (2012). Creating socio-economic measures for community-based natural resource management: A case from watershed stewardship organisations. *Journal of Environmental Planning and Management, 55*(4), 525–544.
Hilts, S. (1997). Landscapes and stewardship in the Ontario countryside. *Environments, 24*(3), 11–16.
Hilts, S. G. (1993). Natural heritage stewardship program. In M. A. Beavis (Ed.). *Environmental stewardship: History, theory and practice workshop proceedings (march 11–12, 1994)* (pp. 109–117). Winnipeg, Canada: The Institute of Urban Studies, The University of Winnipeg.
Hitzhusen, G. E., & Tucker, M. E. (2013). The potential of religion for Earth Stewardship. *Frontiers in Ecology and the Environment, 11*, 368–376.
Hobbs, R. J., Cole, D. N., Yung, L., Zavaleta, E. S., Aplet, G. H., Chapin, F. S., ... Woodley, S. (2010). Guiding concepts for park and wilderness stewardship in an era of global environmental change. *Frontiers in Ecology and the Environment, 8*, 483–490.
Holopainen, J., Toppinen, A., & Perttula, S. (2015). Impact of European union timber regulation on forest certification strategies in the Finnish wood industry value chain. *Forests, 6*(8), 2879–2896.
Holsman, R. H. (2000). Goodwill hunting? Exploring the role of hunters as ecosystem stewards. *Wildlife Society Bulletin, 28*(4), 808–816.
Horrell, D. G., & Davis, A. (2014). Engaging the bible in GCSE and a level religious studies: Environmental stewardship as a test case. *British Journal of Religious Studies, 36*, 72–87.
Ingold, T. (2000). Globes and spheres: The typology of environmentalism. *The perception of the environment: Essays on livelihood, dwelling and skill* (pp. 207–218). London, UK: Routledge.
Iniesta-Arandia, I., García-Llorente, M., Aguilera, P. A., Montes, C., & Martín-López, B. (2014). Socio-cultural valuation of ecosystem services: Uncovering the links between values, drivers of change, and human well-being. *Ecological Economics, 108*, 36–48.
Ives, C. D., Abson, D. J., von Wehrden, H., Dorninger, C., Klaniecki, K., & Fischer, J. (2018). Reconnecting with nature for sustainability. *Sustainability Science,* 1–9.
Jack-Scott, E., Piana, M., Troxel, B., Murphy-Dunning, C., & Ashton, M. S. (2013). Stewardship success: How community group dynamics affect urban street tree survival and growth. *Arboriculture and Urban Forestry, 39*(4), 189–196.
Jacquet, J., Hocevar, J., Lai, S., Majluf, P., Pelletier, N., Pitcher, T., et al. (2010). Conserving wild fish in a sea of market-based efforts. *Oryx, 44*(1), 45–56.
Johnson, K. N., Agee, J., Beschta, R., Dale, V., Hardesty, L., Long, J., et al. (1999). Sustaining people's lands: Recommendations for stewardship of the natural forests and grasslands into the next century. *Rangelands, 21*(4), 25–28.
Kalfagianni, A., & Pattberg, P. (2014). Exploring the output legitimacy of transnational fisheries governance. *Globalizations, 11*(3), 385–400.
Kaltenborn, B. P., Gundersen, V., Stange, E., Hagen, D., & Skogen, K. (2016). Public perceptions of biodiversity in Norway: From recognition to stewardship? *Norsk Geografisk Tidsskrift, 70*(1), 54–61.
Kang, M., & Gretzel, U. (2012). Effects of podcast tours on tourist experiences in a national park. *Tourism Management, 33*(2), 440–455.
Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., ... Svedin, U. (2001). Sustainability science. *Science, 292*, 641–642.
Kelly, A. D., & Sewell, S. (1998). *With head, heart and hand: Dimensions of community building.* Brisbane: Boolarong.
Knuth, B. A., & Siemer, W. F. (2004). Fostering aquatic stewardship: A key for fisheries sustainability. *American Fisheries Society, Symposium, 43*, 243–255.
Krasny, M. E., Crestol, S. R., Tidball, K. G., & Stedman, R. C. (2014). New York City's oyster gardeners: Memories and meanings as motivations for volunteer environmental stewardship. *Landscape and Urban Planning, 132*, 16–25.
Krasny, M. E., & Tidball, K. G. (2012). Civic ecology: A pathway for Earth Stewardship in cities. *Frontiers in Ecology and the Environment, 10*, 267–273.
Kreutzwiser, R., De Loë, R., Imgrund, K., Jane, M., Simpson, H., & Plummer, R. (2011). Understanding stewardship behaviour: Factors facilitating and constraining private water well stewardship. *Journal of Environmental Management, 92*, 1104–1114.
Larson, L. R., Cooper, C. B., & Hauber, M. E. (2016). Human dimensions of wildlife emotions as drivers of wildlife stewardship behavior: Examining citizen science nest monitors ' responses to invasive house sparrows emotions as drivers of wildlife stewardship behavior: Examining citizen science nest monito. *Human Dimensions of Wildlife, 21*, 18–33.
Larson, L. R., Stedman, R. C., Cooper, C. B., & Decker, D. J. (2015). Understanding the multi-dimensional structure of pro-environmental behavior. *Journal of Environmental Psychology, 43*, 112–124.
Leach, M., Scoones, I., & Stirling, A. (2010). *Dynamic sustainabilities: Technology, environment, social justice.* London, UK: Earthscan.
Leopold, A. (1949). *A sand county almanac.* New York, USA: Oxford University Press.
Lerner, S. (1994). Local stewardship: Training ground for an environmental vanguard. *Alternatives, 20*(2), 14–19.
Lillie, T. H., & Ripley, J. D. (1998). A strategy for implementing ecosystem management in the United States Air Force. *Natural Areas Journal, 18*(1), 73–80.
Lobley, M., & Potter, C. (1998). Environmental stewardship in UK agriculture: A comparison of the environmentally sensitive area programme and the countryside stewardship scheme in South East England. *Geoforum, 29*(4), 413–432.
Loftus, T. T., & Kraft, S. E. (2003). Enrolling conservation buffers in the CRP. *Land Use Policy, 20*, 73–84.
Lohmus, A., & Kraut, A. (2010). Stand structure of hemiboreal old-growth forests: Characteristic features, variation among site types, and a comparison with FSC-certified mature stands in Estonia. *Forest Ecology and Management, 260*(1), 155–165.
Lokocz, E., Ryan, R. L., & Sadler, A. J. (2011). Landscape and urban planning motivations for land protection and stewardship: Exploring place attachment and rural landscape character in Massachusetts. *Landscape and Urban Planning, 99*, 65–76.
Lorimer, J. (2012). Multinatural geographies for the anthropocene. *Progress in Human Geography, 36*, 593–612.
Lye, G., Park, K., Osborne, J., Holland, J., & Goulson, D. (2009). Assessing the value of rural stewardship schemes for providing foraging resources and nesting habitat for bumblebee queens (Hymenoptera: Apidae). *Biological Conservation, 142*, 2023–2032.
Macdonald, D., & Vopni, P. (1994). Policy barriers to 50% diversion of municipal solid waste. *Waste Management and Research, 12*(3), 257–270.
Madison, K., Holt, D. T., Kellermanns, F. W., & Ranft, A. L. (2016). Viewing family firm behavior and governance through the lens of agency and stewardship theories. *Family*

Business Review, 29, 65–93.
Maes, M. K., & Thompson-Przylucki, T. L. (2012). Collaborative stewardship: Building a shared, central collection of print legal materials. *Collection Management, 37*, 294–306.
Martiskainen, M. (2015). The role of community leadership in the development of grassroots innovations. *Environmental Innovation and Societal Transitions, 22*, 78–89.
Masterson, V. A., Stedman, R. C., Enqvist, J., Tengö, M., Giusti, M., Wahl, D., & Svedin, U. (2017). The contribution of sense of place to social-ecological systems research: A review and research agenda. *Ecology and Society, 22*, 49.
Mathevet, R., Bousquet, F., & Raymond, C. M. (2018). The concept of stewardship in sustainability science and conservation biology. *Biological Conservation, 217*, 363–370.
Mathijs, E. (2003). Social capital and farmers' willingness to adopt countryside stewardship schemes. *Outlook on Agriculture, 32*, 13–16.
McLaughlin, P., & Dietz, T. (2008). Structure, agency and environment: Toward an integrated perspective on vulnerability. *Global Environmental Change, 18*, 99–111.
McMillan, L. J., & Prosper, K. (2016). Remobilizing netukulimk: indigenous cultural and spiritual connections with resource stewardship and fisheries management in Atlantic Canada. *Reviews in Fish Biology and Fisheries, 26*, 629–647.
Meilan, R. (2006). Challenges to commercial use of transgenic plants. *Journal of Crop Improvement, 18*(1), 433–450.
Morris, L., Wilson, S., & Kelly, W. (2016). Methods of conducting effective outreach to private well owners - A literature review and model approach. *Journal of Water and Health, 14*, 167–182.
Morzillo, A. T., & Mertig, A. G. (2011). Linking human behaviour to environmental effects using a case study of urban rodent control. *International Journal of Environmental Studies, 68*(1), 107–123.
Nassauer, J. I. (2011). Care and stewardship: From home to planet. *Landscape and Urban Planning, 100*, 321–323.
Nicholls, J. (1994). The "heart, head and hands" of transforming leadership. *Leadership & Organization Development Journal*.
Nicolette, J., Burr, S., & Rockel, M. (2013). A practical approach for demonstrating environmental sustainability and stewardship through a net ecosystem service analysis. *Sustainability, 5*, 2152–2177.
Norris, A., & Burgin, S. (2009). Rhetoric and reality surrounding water quality issues in a peri-urban western Sydney community. *International Journal of Environmental Studies, 66*(6), 773–783.
Ogden, L., Heynen, N., Oslender, U., West, P., Kassam, K.-A., & Robbins, P. (2013). Global assemblages, resilience, and Earth Stewardship in the Anthropocene. *Frontiers in Ecology and the Environment, 11*, 341–347.
Oles, B. (2007). Access and alienation: The promise and threat of stewardship on Mokil Atoll. *Human Organization, 66*(1), 78–89.
Olsson, P., & Folke, C. (2001). Local ecological knowledge and institutional dynamics for ecosystem management: A study of Lake Racken watershed, Sweden. *Ecosystems, 4*, 85–104.
Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action.* Cambridge, MA, USA: Cambridge University Press.
Palsson, G., Szerszynski, B., Sörlin, S., Marks, J., Avril, B., Crumley, C., ... Weehuizen, R. (2013). Reconceptualizing the "Anthropos" in the anthropocene: Integrating the social sciences and humanities in global environmental change research. *Environmental Science & Policy, 28*, 3–13.
Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., ... Yagi, N. (2017). Valuing nature's contributions to people: The IPBES approach. *Current Opinion in Environmental Sustainability, 26*, 7–16.
Payne, B. (2013). Local economic stewards: The historiography of the Fishermen's role in resource conservation. *Environmental History, 18*, 29–43.
Peach, W. J., Lovett, L. J., Wotton, S. R., & Jeffs, C. (2001). Countryside stewardship delivers cirl buntings (Emberiza cirlus) in Devon, UK. *Biological Conservation, 101*, 361–373.
Peck, J. E., & Christy, J. A. (2006). Putting the stewardship concept into practice: Commercial moss harvest in Northwestern Oregon, USA. *Forest Ecology and Management, 225*(1–3), 225–233.
Plieninger T., & Bieling C. (2017). The emergence of landscape stewardship in practice, policy and research. xiii-xiv. In: C. Bieling and T. Plieninger (Eds.), *The science and practice of landscape stewardship*. Cambridge, UK; Cambridge University Press.
Pullin, A. S., & Stewart, G. B. (2006). Guidelines for systematic review in conservation and environmental management. *Conservation Biology, 20*(6), 1647–1656.
Quartuch, M. R., & Beckley, T. M. (2013). Landowners perceptions of their moral and ethical stewardship responsibilities in New Brunswick, Canada, and Maine, USA. *Small-Scale Forestry, 12*, 437–460.
Ramsdell, C. P., Sorice, M. G., & Dwyer, A. M. (2016). Using financial incentives to motivate conservation of an at-risk species on private lands. *Environmental Conservation, 43*, 34–44.
Raymond, C. M., Bieling, C., Fagerholm, N., Martin-Lopez, B., & Plieninger, T. (2015). The farmer as a landscape steward: Comparing local understandings of landscape stewardship, landscape values, and land management actions. *Ambio*.
Raymond, C. M., Kyttä, M., & Stedman, R. (2017). Sense of place, fast and slow: The potential contributions of affordance theory to sense of place. *Frontiers in Psychology, 8*, 1674.
Reichenbach, B. R. (2003). Boulders, native prairie and a theistic stewardship ethic. *Worldviews, 7*, 93–112.
Romolini, M., Brinkley, W., & Wolf, K. L. (2012). What is urban environmental stewardship? constructing a practitioner-derived framework.
Rusli, M., & Nabilah, H. S. (2009). Impacts of forest stewardship council (FSC) certification on natural and plantation forests. *Malaysian Forester, 72*(2), 185–193.
Ryan, R. L., Kaplan, R., & Grese, R. E. (2001). Predicting volunteer commitment in environmental stewardship programmes. *Journal of Environmental Planning and Management, 44*(5), 629–648.
Seamer, J. H. (1998). Human stewardship and animal welfare. *Applied Animal Science, 59*, 201–205.
Seidl, R. (2014). The shape of ecosystem management to come: Anticipating risks and fostering resilience. *BioScience, 64*(12), 1159–1169.
Selinske, M. J., Coetzee, J., Purnell, K., Knight, A. T., & Lombard, A. T. (2015). Understanding the motivations, satisfaction, and retention of landowners in private land conservation programs. *Conservation Letters, 8*, 282–289.
Singh, N., Ma, J., & Yang, J. (2016). Optimizing environmental expenditures for maximizing economic performance. *Management Decision, 54*(10), 2544–2561.
Smith, A. M., & Pulver, S. (2009). Ethics-based environmentalism in practice: Religious-environmental organizations in the. *Worldviews, 13*, 145–179.
Spiller, C., Pio, E., Erakovic, L., & Henare, M. (2011). Wise up: Creating organizational wisdom through an ethic of kaitiakitanga. *Journal of Business Ethics, 104*, 223–235.
Staley, J. T., Botham, M. S., Chapman, R. E., Amy, S. R., Heard, M. S., Hulmes, L., ... Pywell, R. F. (2016). Little and late: How reduced hedgerow cutting can benefit Lepidoptera. *Agriculture, Ecosystems and Environment, 224*, 22–28.
Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science, Technology & Human Values, 35*, 601–617.
Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, "translations", and boundary objects: amateurs and professionals in Berkeley's museum of vertebrate zoology, 1907–39. *Social Studies of Science, 19*, 387–420.
Steffen, W., Crutzen, J., & McNeill, J. R. (2007). The anthropocene: Are humans now overwhelming the great forces of Nature? *Ambio, 36*, 614–621.
Steffen, W., Persson, Å., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., ... Svedin, U. (2011). The anthropocene: From global change to planetary stewardship. *Ambio, 40*, 739–761.
Suh, J. (2014). Towards sustainable agricultural stewardship: Evolution and future directions of the permaculture concept. *Environmental Values, 23*, 75–98.
Swyngedouw, E., & Ernstson, E. (2018). *Interrupting the anthropo-obScene: Immuno-biopolitics and depoliticizing ontologies in the anthropocene.* Theory, Culture and Society1–28.
Szücs, E., Geers, R., & Sossidou, E. N. (2009). Stewardship, stockmanship and sustainability in animal agriculture. *Asian-Australasian Journal of Animal Sciences, 22*(9), 1334–1340.
Tengö, M., Hill, R., Malmer, P., Raymond, C., et al. (2017). CBD and beyond – lessons learned for sustainability. *Current Opinions in Environmental Sustainability,* 17–25.
Tharan, Z. J. (1997). The Jewish American environmental movement: Stewardship, renewal and the greening of diaspora politics. *Pennsylvania Geographer, 35*, 69–97.
Udagawa, C., Hodge, I., & Reader, M. (2014). *Farm level costs of agri-environment measures: The impact of entry level stewardship on cereal farm incomes, 65*, 212–233.
van Putten, I., Boschetti, F., Fulton, E. A., Smith, A. D. M., & Thebaud, O. (2014). Individual transferable quota contribution to environmental stewardship: A theory in need of validation. *Ecology & Society, 19*.
van Riper, L. (2013). Women as collaborative leaders on rangelands in the western United States. *Rangelands, 35*, 47–57.
Vega, D. C., & Keenan, R. J. (2016). Land use policy agents or stewards in community forestry enterprises? Lessons from the mayan biosphere reserve, Guatemala. *Land Use Policy, 52*, 255–265.
Vernadsky, V. I. (2012). The Biosphere (with commentary by Pey-Yi Chu) In L. Robin, S. Sörlin, & P. Warde (Eds.). *The Future of Nature: Documents of Global Change*. New Haven, USA: Yale University Press.
Walker, K., & Moscardo, G. (2016). Moving beyond sense of place to care of place: the role of Indigenous values and interpretation in promoting transformative change in tourists' place images and personal values. *Journal of Sustainable Tourism, 24*, 1243–1261.
Welchman, J. (2012). A defence of environmental stewardship. *Environmental Values, 21*, 297–316.
West, S., Haider, L. J., Masterson, V. A., Peçanha Enqvist, J., Svedin, U., & Tengö, M. (2018). Stewardship, care and relational values. *Current Opinion in Environmental Sustainability* In preparation.
Westley, F. R., Tjornbo, O., Schultz, L., Olsson, P., Folke, C., Crona, B., & Bodin, Ö. (2013). A theory of transformative agency in linked social-ecological systems. *Ecology and Society, 18*.
Whyte, K. P., Brewer, J. P., & Johnson, J. T. (2015). Weaving indigenous science, protocols and sustainability science. *Sustainability Science,* 25–32.
Worrell, R., & Appleby, M. C. (2000). Stewardship of natural resources: Definition, ethical and practical aspects. *Journal of Agricultural and Environmental Ethics, 12*, 263–277.
Wu, J. (2013). Landscape sustainability science: Ecosystem services and human well-being in changing landscapes. *Landscape Ecology, 28*, 999–1023.
Zhao, J., Xie, D., Wang, D., & Deng, H. (2011). Current status and problems in certification of sustainable forest management in China. *Environmental Management, 48*(6), 1086–1094.