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Review

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ABSTRACT

It has long been claimed that a better understanding of human or social dimensions of environmental issues will improve conservation. The social sciences are one important means through which researchers and practitioners can attain that better understanding. Yet, a lack of awareness of the scope and uncertainty about the purpose of the conservation social sciences impedes the conservation community's effective engagement with the human dimensions. This paper examines the scope and purpose of eighteen subfields of classic, interdisciplinary and applied conservation social sciences and articulates ten distinct contributions that the social sciences can make to understanding and improving conservation. In brief, the conservation social sciences can be valuable to conservation for descriptive, diagnostic, disruptive, reflexive, generative, innovative, or instrumental reasons. This review and supporting materials provides a succinct yet comprehensive reference for conservation scientists and practitioners. We contend that the social sciences can help facilitate conservation policies, actions and outcomes that are more legitimate, salient, robust and effective.

Contents

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1. Conservation and the social sciences

Conservation policy and practice can and should be guided by the best available information and adequate conceptual frameworks. Historically, the natural sciences have tended to be the sole or primary information source used to guide conservation action. Yet, many influential conservation scientists have long recognized the importance of both social and natural considerations for conservation. As the ecologist Aldo Leopold first argued in 1935, the fusion of those who study human, plant and animal communities "will perhaps constitute the outstanding advance of the present century" (Leopold, 1966). Much later, Michael Soulé's (1985) influential article in Bioscience placed social science under the synthetic discipline of conservation biology. Since then, a broader understanding of conservation science has emerged that more directly recognizes the role of a diverse set of natural, social, interdisciplinary and applied science traditions (Kareiva and Marvier, 2012). Moreover, it has become widely recognized that engaging with the human dimensions of conservation and environmental management is needed to produce robust and effective conservation policies, actions and outcomes (Bennett et al., 2016; de Snoo et al., 2013; Endter-Wada et al., 1998; Mascia et al., 2003; Sandbrook et al., 2013).

The social sciences are one means through which researchers and practitioners can come to understand the human dimensions of conservation and natural resource management. Indeed, the social sciences have been applied to understand diverse conservation and environmental management problems including, but not limited to, water governance (Armitage et al., 2012; Bakker, 2012; Curran, 2015), fisheries management (Heck et al., 2015; Symes and Hoefnagel, 2010; Wilson et al., 2013), agriculture landscape management (de Snoo et al., 2013), wildlife management (Clark et al., 2008; Gore et al., 2011; Teel and Manfredo, 2010), avian conservation (Kingston, 2016; Veríssimo et al., 2014), protected areas (Brockington and Wilkie, 2015; Ferraro and Pressey, 2015; Lockwood, 2010), forest management (Agrawal and Gupta, 2005; Allen et al., 2014; Ostrom and Nagendra, 2006; Stanturf et al., 2012) and marine conservation planning (Aswani and Hamilton, 2004; Ban et al., 2013; Cornu et al., 2014). The social sciences have also been used to research conservation and environmental management at all scales from local (Bennett et al., 2010) to regional (Pietri et al., 2015) and global (Fleischman et al., 2014). As the above examples show, social science research on conservation is increasingly commonplace as are commentaries on the need for more attention to the human dimensions of conservation. However, the integration of social science insights into conservation practice still remains limited and the field of conservation social science remains nascent.

In this paper, we use the term "conservation social science" (Bennett and Roth, 2015; Mascia et al., 2003; Newing et al., 2011) to refer to diverse traditions of using social science to understand and improve conservation policy, practice and outcomes. Yet, the terms "environmental social science" (Cox, 2015; Moran, 2010; Vaccaro et al., 2010; Wellman et al., 2014) and "human dimensions of natural resource management" (Clark et al., 2008; Decker et al., 2012; Gorenflo and Brandon, 2006) can be viewed as similar and overlapping traditions. More recently, research on "social-ecological systems" (Kittinger et al., 2012; Manfredo et al., 2014a, 2014b) has also sought to integrate social and ecological considerations into conservation science. These fields draw from diverse social science theories and approaches. We also recognize the important contribution of the environmental humanities, which provide and draw from an overlapping set of theories and methods to guide conservation (Holm et al., 2015; Sörlin, 2012).

Yet among many conservation scientists and practitioners, there remains a lack of awareness about the social sciences, including the different disciplines, objectives, methods and outputs, and uncertainty about the purpose of the conservation social sciences. We contend that this knowledge void and confusion interferes with the conservation community's ability to engage with the social sciences purposefully and constructively – i.e., in a manner that will guide conservation practice and improve conservation outcomes. Without greater knowledge of the breadth of fields and contributions, the promise of the social sciences to improve conservation will remain largely unfulfilled.

To encourage and facilitate greater engagement with the breadth of the conservation social sciences and to help meet calls to mainstream the social sciences in conservation practice (Bennett et al., 2016), this review paper provides a succinct and accessible reference guide to and overview of the conservation social sciences. The failure of conservation social science to be mainstream, we argue, stems in part from a lack of clearly articulated objectives and values associated with the social sciences. This article corrects this problem by identifying the distinct contributions that the social sciences can make to understanding and

improving conservation through a review of the classic, applied and interdisciplinary conservation social sciences. We conclude with a discussion of several key considerations for better engaging with the social sciences to improve conservation.

2. The social sciences

Both classic and applied social sciences are used to study a diverse set of social phenomena, social processes, or individual attributes (Fig. 1). The classic social science disciplines include sociology, anthropology, political science, geography, economics, history, and psychology. Applied social science disciplines include education, communication studies, development studies and law. Though not social sciences, the arts and humanities are often drawn upon to critically analyze, represent and shape social processes and phenomena, often applying a similar set of theories and methods to make empirical observations. The social science disciplines and the humanities focus on a variety of social phenomena (e.g., markets, governance, politics, culture, demographics, ideas, narratives, development, socio-economics, well-being, policy and law), social processes (e.g., social organization, decision-making, educating, marketing, local development, etc.) or individual attributes (e.g., values, beliefs, knowledge, motivations, preferences, perceptions, and behaviors). We note that there is some overlap between these categories and also that the example topics in Fig. 1 are illustrative rather than comprehensive.

When employing the social sciences, it is important to recognize that there are established bodies of social theory on all of the topics presented in Fig. 1 that cannot be ignored. Different disciplinary traditions have topical strengths – for example, anthropology is to culture what political science is to governance – and it behooves researchers to draw on these traditions when designing new research projects. For a variety of reasons, which we will not explore here, some areas of social theory have seen greater application to conservation problems, for example economics (Balmford et al., 2002; Costanza et al., 1997; Tallis et al., 2008), culture (Pilgrim and Pretty, 2010; Turner et al., 2003), behavior (Clayton and Myers, 2015; Schultz, 2011), power and justice (Brockington et al., 2008; Martin et al., 2013) and governance (Armitage et al., 2012; Borrini-Feyerabend and Hill, 2015; Lockwood, 2010). In a recent article, Hicks et al. (2016b) proposed a suite of social concepts that deserve more attention in sustainability science, including well-being, values, agency, and inequality. We concur, arguing that the conservation science community would do well to engage with an even broader set of social science theories and ideas than those conventionally explored, including concepts and ideas from non-Western and non-English language traditions.

Social science research can be conducted on issues at different scales from the individual to local to global (Fig. 2). At different scales, social scientists focus in on a variety of research topics or theories – i.e., the social phenomena, social processes, and individual attributes in Fig. 1 – and relevant units of analysis – i.e., the subjects or objects of study. For example, at the individual scale one might study perceptions, values, attitudes or behaviors of natural resource users (Bennett, 2016; Veríssimo et al., 2014). At the global scale, social scientists might study how narratives or ideas are changing and influencing international agreements - through the study of policy documents, global meetings or even mentions and representations of ideas on social media (Ladle et al., 2016). Social phenomena can also be studied at multiple scales simultaneously – e.g., social scientists might examine how changes in markets, policies or demographics at macro or national scales influence local decision-making or socio-economic outcomes (Adger et al., 2008).

Social science researchers can have a number of objectives, including to understand, describe, theorize, deconstruct, predict, imagine or plan (see Moon and Blackman, 2014). First, social sciences can be used to understand and describe social phenomena, processes or individual attributes under study by asking why or how something is occurring. Second, similar to natural scientists, social scientists are also interested in developing theory or testing pre-existing theories. For example, social scientists might ask "What factors are associated with illegal activity?", "What governance arrangements lead to effective conservation?" or "When does money motivate people to participate in conservation?" – thus contributing to legal, governance or behavioral economics theory. Third, social scientists might seek to critically deconstruct a situation

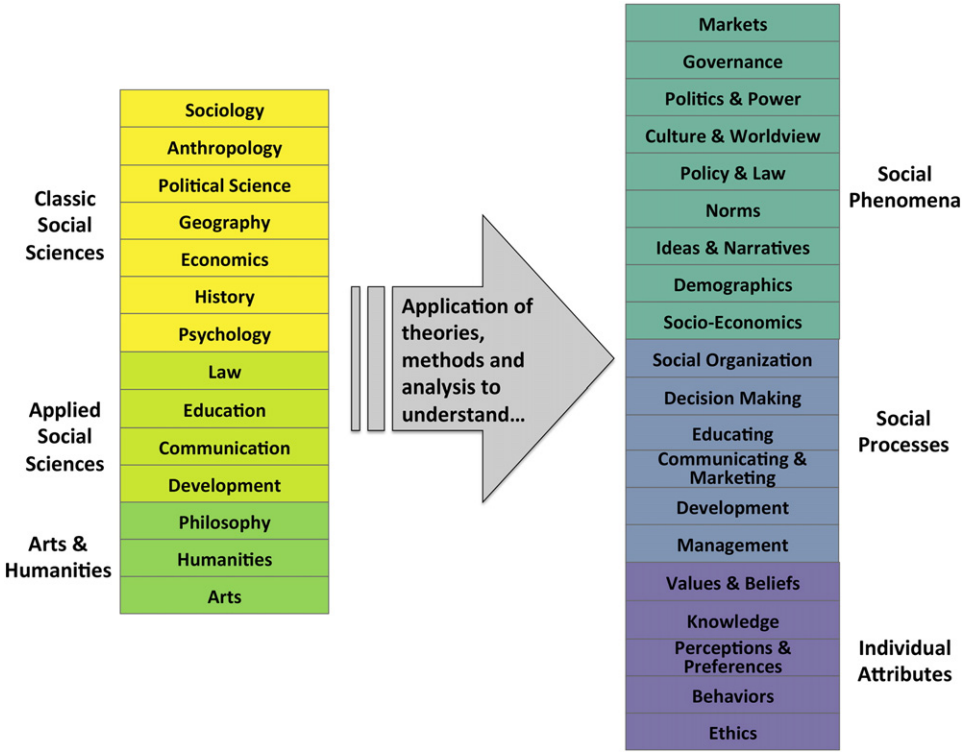

Fig. 1. The social sciences, humanities and related topics of study.

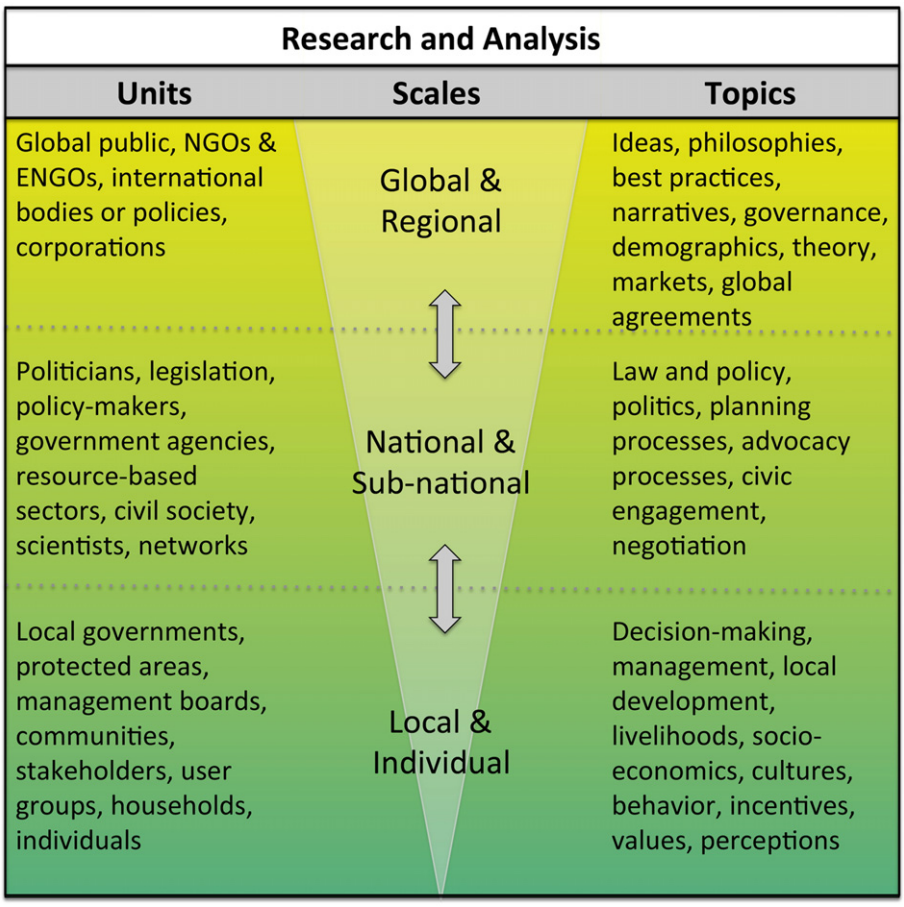

Fig. 2. Illustrative examples of units and topics of social science research and analysis at different scales. Research can be done at single or multiple scales.

or issue in order to construct more effective solutions (Toomey, 2016). For example, there has been a long history of critical social science research on racism, equity and environmental justice, in which the goal was critique and emancipation from unacceptable social and environmental conditions (Brechin et al., 2003; Gustavsson et al., 2014). Fourth, social scientists can anticipate future trends through modeling and forecasting social and/or economic conditions. Finally, social science might be employed to imagine desirable futures or to plan and identify courses of action to improve policies, programs or social outcomes. Of course, these different objectives of social science often overlap in practice.

Additional important social science research design considerations include: 1) whether and with whom to collaborate in the development of the research, 2) what methods to use, and 3) how to analyze the data. First, some social scientists might choose to develop their research questions, methods and protocols in collaboration with groups, organizations or communities to ensure their project meets the needs of those implicated and to facilitate action or policy change (Koster et al., 2012). Other social scientists may elect to develop research projects from a distance to maintain objectivity, when the focus is large-scale, or if the aim is to contribute to generalizable theory. Second, an array of methods is used to understand the social dimensions of conservation at different scales (see Table 1 and Appendix A for longer explanations of the different methods). We group social science methods under the following categories: qualitative, quantitative, participatory, planning and decision-making, evaluative, spatial, historical and meta-analytical methods. We emphasize that all methods provide important and distinct insights, while also recognizing that all methods have benefits and drawbacks. To overcome the limitations of any one method, the use of multiple or mixed methods is common in the social sciences as is applying both qualitative and quantitative analytical techniques to the same data (Bennett et al., 2014; Hicks and Cinner, 2014). Methodological triangulation – conducting research using a variety of methods, and focused on a diverse range of individuals and perspectives – can help to ensure the validity of results while also allowing differing

Table 1
The conservation social scientist's methods toolbox.

Categories of methods	Examples of social science methods
Qualitative	Interviews, focus groups, participant observation, discourse and textual analysis, document analysis, free lists and pile sorts, ethnographies, photo elicitation, institutional analysis, case studies, comparative analysis, image analysis
Quantitative	Surveys, economic valuation, cost-benefit analysis, modeling, lab and field experiments, physiological evaluation, scanner data gathering
Participatory	Group facilitation methods (nominal groups, delphi processes), community-based research (traditional calendars, group ranking), participatory action research, arts based methods (photovoice, participatory videography)
Planning and forward-thinking	Back-casting, visioning, scenario planning, structured-decision making, economic modeling
Evaluative	Monitoring & evaluation (e.g., randomized control trials, synthetic counterfactual, most significant change, process tracing, realistic evaluation), policy analysis, argument analysis, case analysis, statutory interpretation
Spatial	Geographic information systems (GIS), historical geographic information systems (HGIS), community-based mapping, 3-D mapping, transect walks
Historical	Archival research, landscape histories, oral histories, HGIS
Meta-analytical	Meta-analysis, systematic reviews, qualitative comparative analysis

Table 2
Overview of the conservation social sciences.

Discipline	Definition and focus	References
Classic Conservation Social Science Fields		
Environmental Anthropology (Anthropology)	Environmental anthropology studies how culture mediates the relationships between human societies and their physical, biotic, built, and cognitive environments. Sub-fields focus on understanding past human environmental impacts, primate conservation and human evolution, the relationship between language and the environment and the social dynamics of conservation.	Overviews: (Dove and Carpenter, 2008; Orr et al., 2015) Examples: (Hardin and Remis, 2006; Heckenberger et al., 2007; Maffi, 2005; West, 2006)
Environmental Economics (Economics)	Environmental economics focuses on the economic value of the environment, trade-offs between use and protection, and the role of markets and regulations in managing pollution and public goods. Environmental economics can help understand incentives and guide decisions given conditions of scarcity.	Overviews: (Fisher et al., 2014; Kolstad, 2011) Examples: (Balmford et al., 2002; Costanza et al., 1997; Loomis et al., 2000)
Human-Environment Geography (Geography)	Human-environment geography emphasizes the spatial dimensions of human-environment relationships across scales. Research can be in support of management through characterizing existing land use or helping to inform boundary demarcation or problematize management through spatially informed analysis of park-people conflicts and the implications of changing conservation strategies.	Overviews: (Moseley et al., 2013; Zimmerer, 2006) Examples: (Ayers et al., 2012; Neumann, 2001; Robbins et al., 2009)
Conservation and Environmental History (History)	Conservation history focuses on the origins and past processes associated with the conservation movement, including successes and failures and race, class and gender dimensions of conservation. Environmental history assesses environmental change over short and long-term timeframes, including baseline ecological conditions and wildlife populations.	Overviews: (Alagona et al., 2012; Cronon, 1993; Szabó and Hédl, 2011) Examples: (Madison, 2004; Schulte and Mladenoff, 2001; Szabó and Hédl, 2011)
Environmental and Conservation Governance (Political Science)	Environmental governance is the study of the relationship between people and the environment as mediated by the formal and informal rules, policies and social norms that influence behaviors, actions and outcomes in different social and ecological contexts. The focus can be on individual resources, local conservation initiatives or broad-scale environmental management.	Overviews: (Lemos and Agrawal, 2006; Ostrom, 2011; Van Laerhoven and Ostrom, 2007) Examples: (Coleman, 2009; Cox et al., 2010; Wilson et al., 2013)
Environmental Philosophy and Ethics (Philosophy)	Through formal reasoning, environmental ethics aims to understand how humans ought to view themselves in relationship to the natural world, and what the corresponding ethical implications of that conceptualization might be. Environmental philosophy and ethics is a prescriptive, not descriptive, endeavor.	Overviews: (Jamieson, 2008; Jardins, 2012; Nelson et al., 2015) Examples: (Callicott, 2014; Moore and Nelson, 2011; Vucetich et al., 2015)
Environmental and Conservation Psychology (Psychology)	Conservation psychology focuses on the study of human thought regarding the natural environment and conservation-related topics and its influence on behaviors. The focus is on the individual, often emphasizing values, attitudes, beliefs, norms, or emotions. Social psychology emphasizes the individual in the context of social groups.	Overviews: (Clayton and Myers, 2015; Manfredo, 2008; Saunders, 2003; Vaske and Manfredo, 2012) Examples: (Clayton et al., 2013; Schultz, 2011; Teel and Manfredo, 2010)
Environmental Sociology (Sociology)	Environmental sociology focuses on how local social contexts, social interactions and networks and macro-level social structures influence patterns of daily life as they relate to the environment and individual, collective, and institutional conservation behaviors. Environmental sociology also examines the influence of the material and socially-constructed environment on both resource-dependent and non-resource dependent facets of society.	Overviews: (Battel, 1996; Bell and Ashwood, 2015; Dunlap and Catton, 1979; Mills, 1959) Examples: (Brechin et al., 2002; Freudenburg, 1992; Radeloff et al., 2010; Stedman, 2012)
Applied Conservation Social Science Fields		
Conservation Marketing	Conservation marketing research focuses on understanding how to ethically apply marketing strategies, exploring the effectiveness of different concepts and techniques at influencing target audiences towards a desired action, such as the adoption of more environmentally sustainable behaviors.	Overviews: (McKenzie-Mohr et al., 2011; Verissimo et al., 2011; Wright et al., 2015) Examples: (DeWan et al., 2013; Martinez et al., 2013; Saypanya et al., 2013)
Conservation and Development	Conservation and development research focuses on the relationship between conservation and/or development processes and related environmental and socio-economic outcomes in different social and ecological contexts at scales ranging from local initiatives to the globe. It aims to understand the conditions that lead to ecological or social success or failure and the features of successful policies or projects.	Overviews: (Fisher et al., 2008; McShane and Wells, 2004; Roe et al., 2012) Examples: (Andam et al., 2010; Mascia et al., 2010; Sachs et al., 2009; West et al., 2006)
Environmental and Conservation Education	Environmental and conservation education aims to cultivate awareness, ecological sensitivity, civic engagement and pro-environmental behaviors through a foundation of knowledge, values and attitudes. Research in this area aims to improve program development through better understanding target audience characteristics and evaluating the effectiveness of conservation education and outreach campaigns	Overviews: (Heimlich, 2010; Hungerford and Volk, 1990; UNESCO UNEP, 1976) Examples: (Betiang, 2010; Kuhar et al., 2010; McDuff and Jacobson, 2000; Thomas et al., 2014)
Environmental and Conservation Law	Environmental law involves rules of behavior, interaction, use and stewardship of the environment. Law defines the scale at which conservation can occur, and the actors who have a formal role in management. Research informs environmental law through determining how to create socially appropriate and effective regulatory structures and standards for the preservation and/or use of the natural environment, and feasible mechanisms for the enforcement of those standards.	Overviews: (Boyd, 2011; Gillespie, 2012; Owley, 2015) Examples: (Curran, 2015; Van Hoorick, 2014; Walter et al., 2000; White, 2011)
Human Dimensions of Conservation	Human Dimensions (HD) is an evolving field that evolved largely out of the North American wildlife and resource management traditions. Historically, HD research involved application of social sciences (mainly sociology and social psychology) to address management information needs and to find practical solutions. The field is becoming progressively more interdisciplinary and more broadly applied to a diversity of environmental contexts and issues.	Overviews: (Decker et al., 2012; Heck et al., 2015; Kittinger et al., 2012) Examples: (Decker and Purdy, 1988; Hunt et al., 2013; Manfredo et al., 2003)
Policy Sciences	The field of policy sciences offers a meta-theoretical framework for analysis of and intervention in the conservation policy processes. This approach is applied to specific policy problems, focusing on that problem's context rather than seeking generalizable solutions.	Overviews: (Ascher et al., 2010; Clark, 2011) Examples: (Chamberlain et al., 2012; Clark et al., 2008; Rutherford et al., 2009)

(continued on next page)

Table 2 (*continued*)

Classic Conservation Social Science Fields		
Discipline	Definition and focus	References
Interdisciplinary Conservation Social Science Fields		
Environmental humanities	The environmental humanities emphasizes trans-disciplinarity, drawing from across the humanities disciplines to generate insights and to critique ideas concerning the human condition in order to (re)orient both thought and action. The field pays close attention to questions of what it means to be human (anthropos) on a rapidly changing planet (in the Anthropocene) and to what constitutes responsible conservation.	Overviews: (Holm et al., 2015; Palsson et al., 2013; Rose et al., 2012) Examples: (Holm et al., 2013; Sörlin, 2012)
Political Ecology	Political ecology investigates how processes of power (economic, social and political) shape human-environment relationships. In the field of conservation, this leads to investigations of conflict, displacement, state territorialization and unequal distribution of costs and benefits. The field is focused on critique as a means to improve conservation practice.	Overviews: (Adams and Hutton, 2007; Robbins, 2011) Examples: (Brockington et al., 2008; Neumann, 2004; West, 2006)
Science and Technology Studies	Science and technology studies (STS) focuses on the relationship between science, policy and practice, for example in conservation. STS examines how social, political, and cultural values shape scientific research and the co-evolutionary interactions between knowledge, expertise and socio-political change.	Overviews: (Clark et al., 2016a, 2016b; Forsyth, 2003; Jasanoff et al., 1998) Examples: (Beck et al., 2014; Leach and Scoones, 2013; Swedlow, 2012)
Ecological Economics	Ecological economics seeks to understand the value of nature to society (in monetary and other metrics) and assumes that the economy is embedded within ecosystems subject to biophysical limits. This field strives to understand and make progress towards environmental sustainability, efficient allocation, equitable distribution and human wellbeing in environmental policies and management decisions.	Overviews: (Common and Stagl, 2005; Daly and Farley, 2011; Wilson and Howarth, 2002) Examples: (Klain and Chan, 2012; Tallis et al., 2008)

perspectives on the same issue to emerge (Neuman, 2000). Third, the results of social science research can be analyzed in a deductive or inductive fashion. This means that some research draws on existing theory to guide research design and subsequently to make sense of data (deductive reasoning) while other research starts with results and works to construct theory from the data (inductive reasoning).

3. What are the conservation social sciences?

We now turn our attention to the conservation social sciences. In particular, we ask: 1) "What are the conservation social sciences?" and 2) "What is the value and contribution of the social sciences to conservation?" The role that the social sciences can play in guiding and improving conservation is often misunderstood, which may limit both engagement and uptake of results (Campbell, 2005). We posit that a more clear understanding of the distinct objectives and values of the breadth of the conservation social sciences may increase their salience and legitimacy among conservation professionals, for conservation funders and in conservation practice (Bennett et al., 2016).

The *conservation social sciences* can be defined as a subset of the classic and applied social science disciplines that focus particularly on conservation or environmental management (Fig. 3). The classic conservation social sciences – which we define as those that have emerged from specific disciplines - include, for example, environmental anthropology, environmental psychology, environmental economics, environmental history, human-environment geography, environmental sociology and environmental governance. Many ideas from the social science disciplines feed into the applied conservation social sciences, including conservation communication studies, conservation education, conservation and development, science and technology studies, and conservation law. There are also numerous interdisciplinary fields – political ecology, human ecology, ethno-ecology, social-ecological systems, human dimensions of conservation, ecological economics, etc. - that draw on and bridge concepts from different social and/or natural science disciplines. Finally, we recognize that the interdisciplinary environmental humanities – which often involve collaborations among traditional humanities fields, the social sciences, the biophysical sciences, and engineering – can be applied to conservation problems.

Below, we provide brief overviews of 18 sub-fields of the conservation social sciences, that are fairly well-established or experiencing rapid growth (see overview in Table 2). We preface this section by recognizing: a) while our goal in this review is to be as comprehensive as possible, we cannot cover the entirety of conservation social sciences in this manuscript; b) the distinctions between the categories classic, interdisciplinary and applied are blurred (Fig. 3), but these categories remain a useful heuristic for understanding how the different sub-fields emerged primarily from single disciplines, multiple disciplines or pragmatic managerial needs; and c) often multiple social science fields are drawn from or combined in the design of individual research projects.

3.1. Classic conservation social sciences

3.1.1. Environmental anthropology

Environmental anthropology investigates how culture mediates the relationships between human societies and their physical, biotic, built, and cognitive environments (Dove and Carpenter, 2008). The specialty arose when anthropologists were confronted with widespread environmental changes occurring in their study sites (Orr et al., 2015). Environmental anthropology encompasses the full disciplinary breadth of anthropology: archeology, biological, linguistic, and cultural anthropology. In archeology, the main focus of environmental anthropology has been uncovering the historical evidence of human impacts on the environment to provide context for current impacts (Heckenberger et al., 2007). Biological anthropologists have worked to advance primate conservation as well as to show the evolution of the human species in relationship to environmental change (Hardin and Remis, 2006). Linguistic environmental anthropologists explore how languages reflect their speakers' biotic and physical environment (Maffi, 2005). Among other topics, cultural anthropologists have revealed the complex social dynamics that can make conservation initiatives thrive or fail (West, 2006). Ethnography (including participant observation, interviews, and other qualitative methods) is a major method of the specialty. Historically, anthropology's scale of analysis focused on small-scale communities and the smallholder households that made up these communities. But, starting in the 1990s, environmental anthropologists increasingly made connections between local-scale dynamics and broader political and economic forces (Orr et al., 2015).

3.1.2. Environmental economics

Environmental and natural resource economics can help understand incentives and decisions given conditions of scarcity (Fisher et al., 2014; Kolstad, 2011). Environmental economists address conservation issues by applying neoclassical economic concepts of maximizing individual satisfaction or well-being (i.e., utility) and rational choice theory (i.e., individuals have consistent preferences that drive social behavior) to the management of natural resources and pollution. This field uses cost benefit analysis to assess trade-offs between the present use and potential depletion of natural resources for production on the one

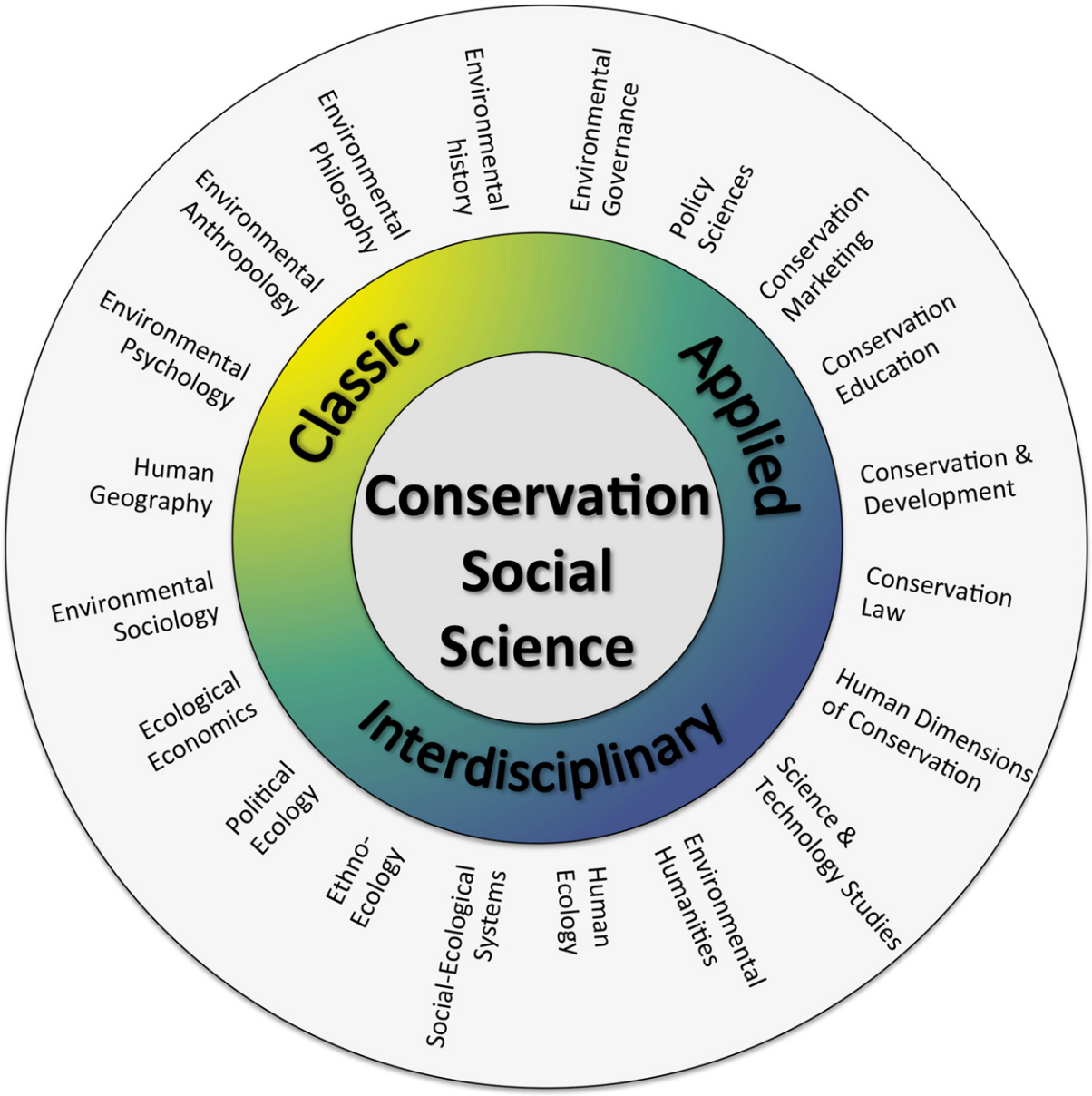

Fig. 3. The conservation social sciences – classic, interdisciplinary and applied traditions.

hand, and the maintenance and future use of these resources on the other. Environmental economics has provided support for protected areas and other forms of conservation, most famously by valuing ecosystem services, often, but not always, in monetary terms (Balmford et al., 2002; Costanza et al., 1997). Environmental economics research can also strengthen arguments for other forms of environmental management, such as ecological restoration (Loomis et al., 2000). See also the section later in the article that differentiates environmental economics from the interdisciplinary field of ecological economics.

3.1.3. Human-environment geography

Geography is a broad discipline encompassing the humanities, social sciences and physical sciences. Human-environment geography, as the sub-discipline most interested in conservation issues makes contributions across these approaches including (but not limited to) mapping and modeling land use patterns and conservation management, interrogating the social and political implications of protected area border demarcation and analyzing the changing tools of conservation funding and practice (Ayers et al., 2012; Moseley et al., 2013; Zimmerer, 2006). Due to its breadth, geographers have much in common with many of the other disciplines and sub-disciplines reviewed in this manuscript, however, the geographic perspective is unique in its focus on the spatial organization of human-environment relationships across scales. Drawing on a mix of qualitative (interviews, focus groups, participatory methods) and quantitative (GIS, remote sensing, surveys) human environment geographers have explored the spatial dynamics of illicit resource use (Robbins et al., 2009), investigated the social and ecological outcomes of conservation mechanisms with different spatial qualities (Zimmerer, 2006, 2000) and drawn attention to conservation as a spatial process (Neumann, 2001; Roth, 2008).

3.1.4. Conservation and environmental history

Environmental history offers enormous potential to inform the contemporary conservation movement. The field has produced a large body of literature on the origins and histories of conservation (Madison, 2004), noting successes but also managerial failures and social injustices embedded within the movement (Jacoby, 2014; Loo, 2011). Historical archival research can provide critical data on baseline wildlife

populations or environmental conditions (Alagona et al., 2012; Rayburn and Major, 2008; Schulte and Mladenoff, 2001; Szabó and Hédl, 2011). Environmental historians have also developed powerful digital analytical tools, especially historical geographic information systems (HGIS) to reconstruct historical landscapes, a potentially invaluable tool for restoration initiatives (Bonnell and Fortin, 2014). Structural barriers to collaboration between environmental historians and ecologists are many, including contrasting thematic foundations (natural systems versus human agency) and methodological approaches (the hypothetico-deductive model versus interpretative approaches to sources) (Pooley, 2013). But if conservation is in part an attempt to preserve and/or recover what nature has been, environmental historians are well positioned to assess historical ecological conditions, and provide some window on the social and economic context that fostered ecological change over time.

3.1.5. Political science and conservation governance

Political scientists have made major contributions to the theory and practice of conservation by drawing upon multiple methods, including case studies, models, experiments and statistical analysis (Poteete et al., 2010; Young et al., 2006), to better understand the institutional dimensions of conservation. Political scientists adopt a problem orientation to consider how institutions (namely conservation policies, formal and informal rules, and social norms) structure the incentives, opportunities and constraints that actors face as they interact with the environment and each other (Lemos and Agrawal, 2006; Ostrom, 2011; Van Laerhoven and Ostrom, 2007). Collectively research on conservation governance has highlighted the importance of local participation, monitoring, and linkages between resource users, governments, and other stakeholders as critical conditions for success across diverse contexts (Armitage et al., 2012; Cox et al., 2010; Ostrom, 1990); contributing notably to the growth of community-based conservation and co-management around the world. Although environmental governance research has tended to emphasize problems associated with monitoring the behavior of free-riders (Coleman, 2009; Rustagi et al., 2010) and improving the fit between rules and contexts (Epstein et al., 2015) at small spatial scales; more recent research has turned to consider questions about large-scale environmental problems and regional and transboundary conservation governance (Fleischman et al., 2014; Gruby and Basurto, 2014).

3.1.6. Environmental and conservation psychology

Psychology, and more specifically social psychology that takes into account one's social surroundings, has played an important role in applied conservation social science research (Clayton et al., 2013; Clayton and Myers, 2015; Gifford, 2014; Manfredo, 2008; Saunders, 2003; Vaske and Manfredo, 2012). Its focus is on the *individual*, and applications have typically centered on the following key questions: What are people's thoughts and behaviors regarding the natural environment and conservation?; Why do people think and behave the way that they do in that context?; and How can management actions be designed to engender support, change behaviors and increase effectiveness? Prior research has often emphasized individual values, attitudes, beliefs, norms, and behaviors and employed a diversity of methods ranging from quantitative surveys to more qualitative techniques such as interviews and focus groups. Contributions to conservation have included anticipating people's responses to conservation issues and interventions, determining more socially acceptable management actions, informing communication and other attitude-behavior change strategies, and understanding the basis for and address social conflict among different population segments and user groups. Promising new directions in this area call for greater attention to non-cognitive (e.g., emotions) and broader cultural and societal-level (e.g., urbanization, institutions) influences on human behavior (Manfredo et al., 2014a, 2014b).

3.1.7. Environmental sociology

Sociology is concerned with what people do as members of a group or when interacting with one another, systematic prediction of societal behaviors and responses, and the logical and persistent patterns of regularity in social life (Mills, 1959). It engages with social contexts, emphasizing how people's lives are influenced by society/social structure and how they in turn reshape their society. Sociology studies social facts (e.g., societal values, cultural norms, and social structures) rather than individual-level explanations of behavior. For example, a sociological analysis might engage the broader social drivers of conservation in the face of land use pressure (Brechin et al., 2002), or the social drivers of rapid land use changes themselves (Hicks et al., 2016a, 2016b; Radeloff et al., 2010) as stemming from changes in pricing, regulatory structure (Freudenburg, 1992), or inequality. These broader social factors enable or constrain the expectations, experience and behaviors of people within communities. Environmental/natural resource sociology in particular posits a causal role for the environment in shaping behavior (Battel, 1996), views social and ecological systems as components of an integrated community (Bell and Ashwood, 2015) and emphasizes that humans are part of the natural world (Dunlap and Catton, 1979). Until recently, sociological concepts and research have been used relatively little in specific conservation management initiatives. This is perhaps because much of sociology engages with the macro level forces (e.g., inequality, globalization) that contribute to key problems in conservation, and since such forces are not easily "managed", sociology is sometimes seen as better at raising problems than solving them (Stedman, 2012). Yet, application of basic sociological concepts - such as power, class, social capital and social networks - to local and regional conservation initiatives (Alexander and Armitage, 2015; Christie et al., 2009; Hoelting et al., 2014) can yield important insights that will help managers grapple with the complexity of conservation in rapidly changing and fragmented landscapes.

3.1.8. Environmental philosophy and ethics

For decades environmental philosophers have been focused on two entwined questions: 1. What parts of the world ought to be attributed intrinsic value (that is, value beyond mere use or instrumental value)?, and What arguments for moral inclusion ought to be most persuasive? In other words, what deserves direct moral standing, and why? (Chan, 2011; Jamieson, 2008; Jardins, 2012). These efforts have revealed intellectually interesting value taxonomies that should be of interest to more empirically minded social scientists (Vucetich et al., 2015). Employing conceptual and philosophical analysis, environmental philosophers have also focused significant efforts on a variety of topics of interest to the larger environmental community: from the concept of wilderness to the concept of sustainability (Callicott and Nelson, 1998; Vucetich and Nelson, 2010), from the ethical dimensions of climate change (Moore and Nelson, 2011) to the ethics of human population control (Jardins, 2012; Nelson et al., 2015), from the ethics of hunting and fishing (List, 2013) to what constitutes ethical conservation policy (Moore and Russell, 2009). Though philosophy and theoretical ethics is largely a conceptual endeavor, environmental philosophers have been successful at integrating and applying their work into conservation more generally (Callicott, 2014; Moore and Nelson, 2011).

3.2. Applied conservation social sciences

3.2.1. Conservation and development studies

Research on conservation and development is concerned with the relationship between conservation initiatives and environmental outcomes on the one hand and development processes and socio-economic outcomes on the other. Having emerged largely since the 1980s, during a time when local development needs have been increasingly recognized in conservation policy and when environmental concerns have been simultaneously mainstreamed in development practice (Fisher et al., 2008; Walpole and Wilder, 2008), this nascent field is based on

normative commitments to social equity and sustainable development. It is a highly interdisciplinary field that draws on the theories and methods of development studies, geography, anthropology, sociology, economics, political science, as well as the natural sciences to answer pragmatic policy oriented questions in different social and ecological contexts and at local to global scales. Conservation and development researchers explore whether human development (e.g., poverty or wealth) enables or undermines environmental outcomes (Cinner et al., 2009; Fisher and Christopher, 2007), whether conservation initiatives produce harmful or support beneficial development outcomes (Andam et al., 2010; Mascia et al., 2010; Roe et al., 2012), under what conditions win-win environmental and socio-economic outcomes are possible or where trade-offs are required (Chan et al., 2007; McShane et al., 2011; Sachs et al., 2009), and how to design and implement successful conservation and development (e.g., poverty reduction, sustainable livelihoods, payments for ecosystem services, tourism) programmes (Bennett et al., 2012; Blom et al., 2010; McShane and Wells, 2004; Spenceley, 2008).

3.2.2. Environmental and conservation law

Conservation law, as an enterprise and a field of study, is concerned with the legal frameworks and regulatory structures for the preservation and use of the natural environment (Owley, 2015). Laws can protect an ecological feature such as a watershed and allow its use according to specified criteria, or can prohibit an activity and make it an offence to do that activity unless a person obtains a license or other permission (Sax, 2000). It also focuses on governance and administrative structures for conservation (Van Hoorick, 2014), as well as the effectiveness of enforcement, licensing and permits to "use" the environment for a specific activity such as oil and gas extraction, and the role of rights holders (private property rights, Aboriginal/Indian rights) in conservation (Borrows, 2010; Sax, 2011) A hallmark of law is defining the scale at which conservation can occur, and the actors who have a formal role in decision-making for environmental management (Curran, 2015). The study of conservation law often critically analyzes why the law has failed to protect or manage ecological health (Boyd, 2011), particularly law's inability to enable adaptation (Craig and Ruhl, 2014) and effective enforcement (White, 2011). Using textual and case analysis, conservation law uncovers the political ecology of conservation and makes recommendations for law reform to improve the use of science, public participation, Indigenous knowledge and other factors in decision-making about the environment (Gillespie, 2012).

3.2.3. Environmental and conservation education

Conservation education strives to develop awareness and concern among the world's population for the environment while facilitating development of knowledge, skills, attitudes, motivations and commitment to seek solutions for environmental problems through individual and collective action (UNESCO UNEP, 1976). Given its application globally, the context and setting for issues addressed by conservation education is broad, and program formats range from free-choice learning (Dierking and Falk, 1994; Falk, 2005), to more structured initiatives that take place within institutions (Salata and Ostergren, 2010). Social science research can inform all stages of conservation education program development and implementation in order to optimize success in the form of positive outcomes for the environment, for local groups or communities and for society. At the outset of a conservation education initiative, social science frameworks can contribute to a better understanding of target audience cognitions (e.g., values, attitudes and norms (Teel and Manfredo, 2010; Thomas et al., 2014)), existing knowledge, and barriers and perceived ability to take action to solve environmental issues (Hungerford and Volk, 1990). Social science can also form the foundation for rigorous evaluation of outcomes and impacts to ensure program objectives were met (Heimlich, 2010; Thomas, 2016) by focusing on, for example, changes in pro-environmental human behavior, increased civic engagement, or changes in thinking towards conservation issues, in addition to ecological indicators of program success (Betiang, 2010; Kuhar et al., 2010; McDuff and Jacobson, 2000).

3.2.4. Conservation marketing

Conservation marketing adapts marketing strategies, concepts and techniques to influence the target audience towards the adoption of more sustainable behaviors that benefits the individual as well as society (Wright et al., 2015). The field of research emphasizes the center stage role of the target audience, making sure that the values, perceptions and social norms of this group underpin any marketing campaign (Verissimo et al., 2011). Conservation marketers thus focus on building a benefits exchange where the target audience perceives benefits to exceed the costs associated with adopting the new behavior (McKenzie-Mohr et al., 2011). Conservation marketing researchers use both qualitative and quantitative research methods, with an emphasis on interviews, surveys, focus groups, field experiments and observation of actual behavior (DeWan et al., 2013; Martinez et al., 2013; Saypanya et al., 2013). These methods are used not only to characterize and understand the target audience and any barriers to behavior adoption but also to pre-test multiple alternative marketing strategies, define the benefit exchange to be proposed and evaluate the impact of the marketing effort (DeWan et al., 2013; Martinez et al., 2013; Saypanya et al., 2013). Given that it has historically been a practitioner-lead field, conservation marketers can also play an important role across the behavioral and conservation sciences by bridging the gap between knowledge produced in academia and its practical application in the field.

3.2.5. Human dimensions of natural resource management

Because environmental issues are usually defined in biophysical terms, "human dimensions" has become a useful bridging term across disciplines and with non-specialist audiences (Jacobson and Duff, 1998). However, "human dimensions of natural resource management" (HDNRM) research also remains the recognized label for an interdisciplinary approach to conservation social science that aims to inform and improve the management of specific natural resources (Decker et al., 2012). HDNRM is most prominent in wildlife conservation where it now has its own journal (*Human Dimensions of Wildlife*, Taylor & Francis), began by applying and adapting quantitative sociological approaches (Decker et al., 2012), and developed specific conceptual frameworks and ways to measure them, e.g. "wildlife stakeholder acceptance capacity" (Decker and Purdy, 1988) and the "potential for conflict index" (Manfredo et al., 2003). However, HDNRM research is also becoming an established approach for investigating conservation of marine ecosystems (Charles and Wilson, 2009; Kittinger et al., 2011), fisheries (Heck et al., 2016; Hunt et al., 2013), forests (Flint et al., 2008; Naughton-Treves and Weber, 2001; Skole et al., 1994), and- most generally- global environmental change (Janssen and Ostrom, 2006).

3.2.6. Policy sciences

Originating in legal jurisprudence literature, the policy sciences approach has found a ready audience among conservationists seeking to understand and ameliorate conservation controversies (Clark et al., 2016a, 2016b; Edwards and Gibeau, 2013; Gibeau, 2012) As a subfield of policy scholarship the conservation-focused policy sciences are distinctive for three specific features: 1. methodological flexibility, 2. an orientation towards carefully defining the problem at hand, and 3. attention to the social and ecological context that shapes situations (Clark, 2011). The field provides a meta-theoretical framework for analysis of and intervention in policy processes which can be used by researchers and practitioners alike (Ascher et al., 2010; Clark, 2011). That framework breaks down policy processes into discrete components, allowing precise diagnosis of what's going wrong and enabling interventions to be designed by integrating relevant information about all dimensions of the problem at hand. Comprehensive applications have focused on

large carnivore conservation in the North American west (Chamberlain et al., 2012; Clark and Rutherford, 2014; Clark et al., 2005; Rutherford et al., 2009) and endangered species recovery (Clark, 2005).

3.3. Interdisciplinary conservation social sciences

3.3.1. Political ecology

Political Ecology is an interdisciplinary approach characterized by a focus on how processes of power shape human-environment relationships across scales. While diverse in method and subject area, proponents of political ecology are united in their general dissatisfaction with business as usual approaches to conservation and a desire to see more socially equitable forms of environmental governance (Robbins, 2011). Scholars in this field are particularly concerned about conservation policy that excludes people (Adams and Hutton, 2007; Neumann, 2004) and have made contributions to understanding the differential impacts of conservation projects (Holmes and Cavanagh, 2016; Stevens, 2014) examined the rationales underlying particular conservation strategies (Corson et al., 2014), analyzed instances of displacement and violence in the name of conservation (Brockington and Igoe, 2006; Lunstrum, 2014) and critically interrogated new forms of conservation governance and their relationship to global capitalism (Brockington et al., 2008; Büscher and Arsel, 2012). Political ecology research makes frequent use of case studies to illustrate regional or global trends, and employs a variety of mostly qualitative (e.g.: ethnography, interviews, participatory methods, discourse analysis) but also quantitative methods (e.g.: livelihood surveys).

3.3.2. Science and technology studies

Science and technology studies (STS) focuses on the role of scientific knowledge and expertise in social and policy change. Operating at any scale in which scientific research is conducted – from the gene to the global climate system – STS illustrates how scientific knowledge reflects a particular time, place, and set of values, and considers how relationships between science, policy and society mutually reinforce each other (known as "co-production") (Jasanoff et al., 1998). STS research both critiques and hopes to improve these relationships and it provides insights into the ways in which scientific knowledge is used (or not) to support social and policy change (Clark et al., 2016a, 2016b; Forsyth, 2003; Webster, 2016). STS research is trans-disciplinary, utilizing qualitative and quantitative methods, rich descriptive analysis and comparative case studies. STS examines diverse topics, including how scientific concepts like "old growth" are constructed (Swedlow, 2012), how modes of research privilege certain governance arrangements (Leach and Scoones, 2013), or comparing the capacity for different structures of global governance to integrate scientific and other types of knowledge (Beck et al., 2014). STS provides insight into the value of different knowledge and the means through which to integrate non-academic knowledge into conservation science and practice (Wyborn, 2015a). These insights can inform the design of research, conservation programs, decision-making processes, and policy to be more inclusive of diverse perspectives. Through constructive critique and theoretically informed guidance, STS can play a vital role in connecting conservation science with conservation outcomes.

3.3.3. Environmental humanities

The environmental humanities is a trans-disciplinary field of research and practice that emphasizes methodological and conceptual innovation among humanities scholars concerned with environmental problems and that encourages collaborations among the human, social, engineering, and natural sciences (Bergthaller et al., 2014; Holm et al., 2015, 2013; Palsson et al., 2013; Rose et al., 2012; Sörlin, 2012). Within conservation, a key contribution has been the field's emphasis on producing insights about the human-in-its-environment that can better orient thought and action, especially in situations of increased uncertainty, ambiguity, rapid change, and ethical ambivalence where standard methods of knowing and acting become less desirable or effective (Bergthaller et al., 2014). To this end, environmental humanities scholars have shown that the concepts conservation uses to understand and shape the world have cultural histories, political consequences and ecological impacts that need to be understood by responsible environmental researchers and practitioners (Cronon, 1996; Pilgrim and Pretty, 2010) Therefore, the field tends to focus on the refinement and creation of concepts and insights that better reflect what it means to be human (*anthropos*) as causal agent and in responding to local, regional, and global ecological change (the Anthropocene).

3.3.4. Ecological economics

In contrast to environmental economics, ecological economics considers the economy as a subsystem of ecosystems and so subject to biophysical limits, including the imperfect substitutability of human-made capital for natural capital. Human-made capital—physical infrastructure and knowledge— is differentiated from natural capital, defined as the stock of environmental assets that provides a flow of ecosystem goods and services (e.g., a forest that filters water, provides timber and habitat for other species) (van den Bergh, 2001). Environmental economics assumes that human-made capital is substitutable for natural capital (e.g., a water filtration plant can be substituted for a forested watershed in providing water quality) while ecological economics highlights imperfections in this substitutability (e.g., a water filtration plant will not provide the biodiversity and other benefits that a forested watershed provides). Using more diverse approaches to understanding the interdependence of economies and ecosystems (Common and Stagl, 2005; Daly and Farley, 2011; Wilson and Howarth, 2002), ecological economics refutes the neoclassical assumption of perpetual economic growth in a finite biosphere. Ecological economics also questions the commensurability of environmental values by identifying types of values that cannot be appropriately expressed in monetary terms (e.g., the spiritual value of a sacred grove is incommensurate with economic value of the grove converted to timber). Unlike environmental economics, ecologi-

Box 1
The value and contributions of the conservation social sciences.

What are the values and contributions of the social sciences to conservation?

The conservation social sciences can be valuable to conservation for descriptive, diagnostic, disruptive, reflexive, generative, innovative, or instrumental reasons.

1. Documenting and increasing understanding of the diversity of ways in which conservation occurs in different contexts (descriptive value)
2. Facilitating learning about and knowledge of conservation challenges, practices and processes as well as successes or failures (descriptive or diagnostic value)
3. Aiding in proactive consideration of and reactive rethinking about why and how conservation does or should occur (diagnostic, disruptive or reflexive value)
4. Interrogating the underlying assumptions, concepts and models of conservation (disruptive or reflexive value)
5. Allowing for imagination, innovation and creation of novel or desirable concepts, practices or models for conservation (generative or innovative value)
6. Improving conservation management practices and governance processes, including understanding how to better engage different stakeholders (instrumental value: to better processes)
7. Enabling planning and design of conservation initiatives that match different social, economic, cultural and governance contexts and that are socially acceptable (generative, innovative or instrumental value: to better conservation design and models)
8. Helping to justify and normalize conservation actions (instrumental value: to conservation action)
9. Increasing the likelihood of more ecologically effective conservation planning and management in different social, economic and political contexts (instrumental value: to ecological outcomes)
10. Facilitating more socially equitable and just conservation processes and outcomes (instrumental value: to social outcomes)

cal economics places distributive justice (defined as a socially just distribution of goods, including ecosystem services) as a fundamental normative principle not reducible to the sum of individual utilities. Finally, ecological economics highlights limits to the substitutability between human-made and natural capital by defining the concept of "critical natural capital" as an irreversible threshold below which an ecosystem ceases to function (Faber, 2008). Ecological valuations can fill strategic gaps in conventional economic analyses by highlighting non-monetary dimensions of value (Klain and Chan, 2012). Ecological economics can help identify policies, management systems, incentive structures and development options that are more sustainable biophysically, more responsive to ecological complexity, and more conducive to long-term human well-being (Power, 2001).

4. The contributions of the social sciences to conservation

What is the value and contribution of the social sciences to conservation? The answer to this question may not have been articulated clearly and succinctly enough for broad engagement with the conservation social sciences. This may be one reason that the role of social science is often misunderstood and that social scientists are often pegged as implementers and educators (Bennett et al., 2016; Viseu, 2015). The predominant understanding of the value and contribution of the conservation social sciences is that they are instrumental to achieving effective conservation. This may be true; however, there are additional rationales for the use of social sciences in conservation. For example, Sandbrook et al. (2013) suggest that social science research can be either *for* conservation or *on* conservation. Yet, we need to move beyond this dichotomy towards a more nuanced understanding of the values and contributions of the conservation social sciences. Drawing on this review and our collective understanding of the various conservation social sciences, we articulate ten propositions regarding the value and contributions of the social sciences to conservation (Box 1).

Broadly, the conservation social sciences can be valuable for descriptive, diagnostic, disruptive, reflexive, generative, innovative, or instrumental reasons. Below, we provide examples of research projects that might contribute to conservation in each of these ways. First, the social sciences can be used to document and *describe* the diversity of conservation practices, including historic and current examples (Berkes, 1999; Cinner and Aswani, 2007; Colding and Folke, 2001; Jacquet et al., 2011), as well as conservation planning, decision-making and governance processes (Borrini-Feyerabend and Hill, 2015; Flannery et al., 2015; Osmond et al., 2010). Second, social science can help to *diagnose* why conservation is succeeding or failing (Bennett and Dearden, 2014; Cinner et al., 2016; Cullman, 2015), what scales are appropriate for different conservation processes and projects (Levine, 2007; Wyborn and Bixler, 2013) and how different processes (e.g., collaboration or integration of science) might fail as a result of the interactions between groups (Gray, 2010; Walley, 2002; Wyborn, 2015b).

Third, the insights provided by social science can be *disruptive* – for example, the critical social sciences can be challenging when they reveal inequities, power imbalances or systemic issues at the scale of specific conservation initiatives or in global conservation organizations (Adams and Hutton, 2007; Brockington et al., 2008; Dowie, 2009). Fourth, we note here the *reflexive* value of both the social sciences and the environmental humanities – including history and philosophy - which allow us to explore the history and underlying assumptions of conservation (Adams, 2004; Cronon, 1996; Jacoby, 2014) and what constitutes ethical or responsible conservation actions (Moore and Russell, 2009; Moore and Nelson, 2011). The social sciences can also enable us to examine the way that different cultures or groups might think about nature or conservation and the implications for practice (Augustine and Dearden, 2014; Berkes and Turner, 2006; Christie, 2011).

Fifth, the lessons learned from examining the contexts, processes, models and ways of thinking about conservation can be *generative*, producing *innovative* ways of thinking about or planning conservation. Anthropological studies and the humanities can guide us to think about new and more appropriate models for conservation – for example, that include culture (Gavin et al., 2015; Pilgrim and Pretty, 2010) or ways of thinking about the future (Murphy et al., 2016). Similarly, the arts can help us to think in new ways about old sustainability problems (Scheffer et al., 2015). Innovations, both in science (e.g., novel methods) and the planning of conservation, are enabled by constantly learning about what makes conservation work (Ban et al., 2013; Moon et al., 2014).

Finally, and largely as a result of the other values and contributions, the social sciences can be *instrumental* to conservation in 5 ways - they can 1) improve management practices and governance processes, 2) enable better conservation designs and models, 3) justify conservation actions, 4) help to achieve ecological outcomes and 5) facilitate more socially equitable processes and outcomes. The ongoing monitoring and evaluation of social and governance considerations is key to improving the effectiveness of management practices and quality and legitimacy of governance processes (Borrini-Feyerabend et al., 2013; Hockings et al., 2006; Lockwood, 2010; Pomeroy et al., 2004), for example, through determining the social or governance determinants of success or failure (Cinner et al., 2016; Cox et al., 2010). Better incorporation of social, economic, economic, cultural and governance considerations can facilitate conservation planning (Ban et al., 2013; Cornu et al., 2014; Gray et al., 2010) and can produce initiatives that are better matched to local contexts (Nursey-Bray, 2011), that are more socially acceptable (Bennett, 2016) or that have more democratic decision-making or enhanced governance (Lockwood et al., 2010; Reed, 2008). Ecological economics, through documenting the economic and societal values of nature, can help to justify and even normalize the need to take conservation or restorative action (Balmford et al., 2002; Loomis et al., 2000). By helping to identify management actions that are more or less efficient or effective, social science might help to facilitate better ecological outcomes (Clayton and Myers, 2015; Roman et al., 2007; Saypanya et al., 2013). Anthropologists, geographers, economists and development scholars have studied the social impacts of protected areas and the means to overcome negative consequences (Mascia et al., 2010; McShane and Wells, 2004; Oldekop et al., 2015; West et al., 2006), which could be applied to improve social outcomes. Integrating social and ecological data can help identify trade-offs and optimal solutions for both humans and nature (Chan et al., 2007; Sala et al., 2002).

We acknowledge here that there is also a broader and less directly applicable value of studying humans in the context of conservation. Beyond providing critical insights into how to improve conservation practice, policies or outcomes, the conservation social sciences can also contribute to advancing knowledge on concerns that are foundational to the social sciences – e.g., to our understanding of human nature, social organization and human-environment relations via analysis of political, social and economic processes.

The list of values and contributions of the conservation social sciences in Box 1 might be framed as objectives - providing a useful reference for those articulating the purpose of and designing conservation social science research projects. Clearly stating the rationale for employing conservation social sciences would also serve as a guide to monitor whether the objectives have been achieved at the end of a project. We encourage this. Yet we recognize that, while these types of values and objectives are often stated in publications, there is still a need to strengthen the "proof of concept" for the conservation social sciences. By this we mean that there is a need to document real-world case studies and examples of where and how each of the conservation social science fields has actually helped to achieve the types of idealized contributions that we have identified here. In particular, we highlight the need to demonstrate case studies where critical social science analysis has been used to construct novel conservation solutions or improve practices. Documentation of failed attempts to integrate social science into conservation would also be instructive, particularly when accompanied by an exploration of why these attempts were unsuccessful.

Furthermore, we need to identify how the results of the conservation social sciences have been and can be communicated and incorporated into conservation decision-making in order to make real world change and impact.

5. Conclusion: engaging the social sciences to improve conservation

The conservation social sciences are not an optional complement but rather a vital component, along with the natural sciences, for effective conservation decision-making during planning, implementation and management. Integrating the social and natural sciences will ensure that these processes are indeed guided by the best available information. In this paper, our objective has been to clarify the role and solidify the rationale for engaging with the social sciences in conservation. We aim to increase knowledge and inspire uptake of the social sciences in order to increase their impact on conservation policy and practice. However, we recognize that designing and implementing conservation social science projects and communications strategies that will enable real improvements in conservation practices or outcomes is not a straightforward task. In closure, we make three broad points below.

First, there is a need for greater knowledge of and acknowledgement of the breadth of the conservation social sciences among the conservation science and practitioner communities – including the various disciplines, theories and topics of study, scales and units of analysis, and research design considerations (i.e., level of collaboration, research methods, analytical approach, means of communicating results) reviewed in this paper. In particular, we highlight the need to engage with a greater array of social science fields and theories than those that typically receive attention in conservation. We also re-emphasize the need to recognize the benefits offered by diverse methods and approaches to analysis. For example, not all human dimensions considerations are amenable to quantitative methods, Big Data analyses or integration into predictive models. Qualitative approaches to research can provide distinct insights and increase our understanding of how to improve conservation. Practically, this means that it can be worthwhile or necessary to draw on multiple social science fields and methods simultaneously in research projects focused on the human dimensions of conservation.

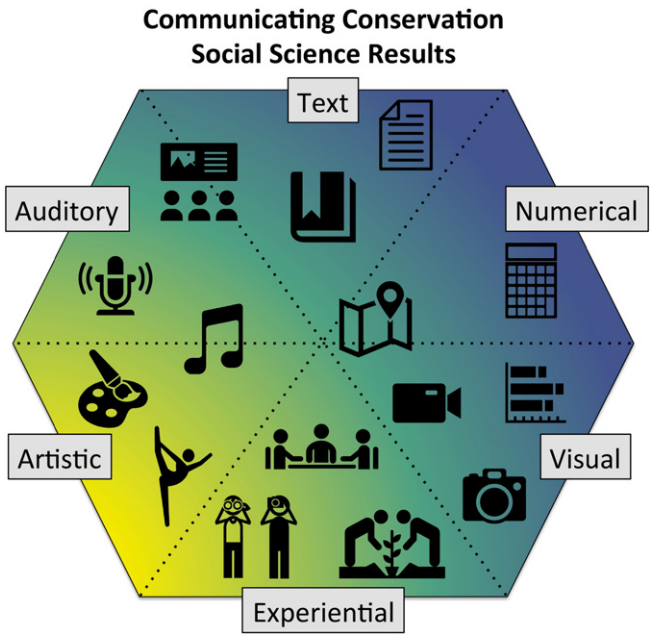

Fig. 4. Communicating conservation social science results, implications and policy recommendations to increase understanding and potential impact. Social science training tends to prepare scientists to share results in modes depicted on the blue background. Modes on the green and yellow backgrounds may engage a larger audience but tend to require collaboration with others who have expertise in these types of communication.

Second, for social science to have real and tangible impacts on conservation practice, those engaging with or employing conservation social science need to pay greater attention to lessons from the extensive literature on a) interdisciplinary research, b) knowledge co-production, c) the science-policy interface, and d) science communication. For example, writing on effective interdisciplinary research and knowledge co-production emphasizes the need to take a problem-based approach, to incorporate social scientists into projects and teams at all stages, to develop shared knowledge of the different areas of expertise and to co-develop research objectives, methods and outputs (Bennett et al., 2016; Campbell, 2005; Turner et al., 2016; Viseu, 2015). To improve the link between social science and conservation policy, researchers need to clearly identify management or policy implications of research (Game et al., 2015) and consider how to ensure the salience, credibility and legitimacy of results (Cash et al., 2003; Cook et al., 2013). Science communicators might urge social scientists to communicate the results of their research more strategically and in diverse formats and to disseminate their results through a wider array of media in order to have a greater impact (Baron, 2010).

We would encourage conservation social scientists to explore the array of possible formats in which they might present their research and to consider communicating via a wider variety of outputs to reach intended audiences (Fig. 4). Formats for presenting social science results might include: textual (e.g., case study descriptions, narrative accounts, lists of best practices), numerical (e.g., tallies, valuations, graphs, statistics), visual (e.g., charts, maps, models), auditory (e.g., presentations, interviews, music), artistic (e.g., videos, photographs, drawings or paintings, dance) and even experiential (e.g., experiential learning, citizen science, guided or facilitated journeys). Outputs can include the typical academic venues, such as journal articles, reports and conference presentations, but the impact of social science research on conservation might be augmented when additional venues are used. These might include writing manuals or policy briefs, connecting with media (e.g., print, radio, TV), doing public presentations (e.g., in communities, to the general public, to youth), presenting results in alternative formats (e.g., documentaries, art shows, blog posts), or engaging in advocacy work.

Finally, we highlight a need for broader knowledge among conservation funders and practitioners of the diversity of ways that the social sciences can contribute to improving both the ways that conservation occurs and the outcomes of conservation. In this paper, we articulate ten contributions of the conservation social sciences that align with descriptive, diagnostic, disruptive, reflexive, generative, innovative, or instrumental values (Box 1). Ignoring the diverse insights and contributions of the social sciences will undermine the acceptability and effectiveness of conservation. At worst, it may even lead to conflict and active opposition to conservation initiatives at all scales from local communities to global conservation meetings. In contrast, truly heeding and integrating the various insights and lessons offered by the social sciences about the human dimensions of environmental issues will lead to an improved conservation. On a rapidly changing and increasingly crowded planet, the legitimacy, saliency, robustness and effectiveness of conservation decisions and actions will increasingly depend on rapid social learning and institutional adaptation based on multiple types of knowledge.

Supplementary data to this article, including a review of social science methods (Appendix A) and of the sub-fields of conservation social science (Appendix B), can be found online at http://dx.doi.org/10.1016/j.biocon.2016.10.006.

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