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Integrative Science to Achieve Long-Term Impact in Conservation: The Use of Participatory Mapping to Improve Trans-disciplinarity

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Biodiversity conservation is a major global issue (Sutherland et al., 2017). Conservation biology aims to identify and mitigate biodiversity loss through ecologically-centered planning (Salzer and Salafsky, 2006). Early conservation biology researchers recommended multi-disciplinary approaches to improve conservation (Soule, 1985), prompting inclusion of various disciplines to improve integrative approaches. A multitude of collaborations among social sciences and ecology resulted, combining theory and pragmatism in participatory approaches and action-research (Bennett et al., 2017).

Environmental degradation is inherently about the way people value and act in an environment. While understanding and integrating social values (defined here as the values of a particular community or the cultural values and norms of society at large) is acknowledged as important in conservation (Norton, 2005; Jacobs et al., 2016), concepts are often poorly defined, operationalized or tested (Dennis et al., 2005; Liu et al., 2007). Poor assessment of social values limits achievements for effective conservation outcomes (Brennan, 2004). Recent re-conceptualizations of the relationships between social and ecological values have resulted in efforts to formalize and institutionalize integrated approaches (Chan et al., 2016; Teel et al., 2018). There is a need to better integrate local and indigenous knowledge with scientific knowledge in the value frameworks and to include multiple value sets including biodiversity and ecosystem services and functions (Díaz et al., 2015).

The analysis of landscape values shows that people designate values through a range of frames (Plieninger et al., 2015; Luginbühl et al., 2016; Ernoul et al., 2018). The socio-political dimensions of management policy may be different from the ecological needs and management of species (Mathevet and Mauchamp, 2005). A science-engaged agenda that acknowledges social and cultural context of landscape management provides a scaffolding for effective planning (Turner et al., 2016). Conservation planning that integrates socio-cultural and ecological values identifies contingent social value-frameworks lighting pathways to potential solutions (Endter-Wada et al., 1998). Considering the way people value nature and their existing relationships with nature improves acceptance and implementation in conservation planning (Chan et al., 2016; Mathevet et al., 2018). Strategic sampling for participation that accounts for socio-geographic scale and value-frames

within the social catchment (Wardell-Johnson, 2005) of the conservation plan identifies the range of voices and values upon which effective conservation depends (Ernoul and Wardell-Johnson, 2013). Thus effective conservation planning depends on a clear understanding of why, how, and when to elicit social value information in order to integrate socio-cultural values in the spatial dimensions at the landscape scale (Vimal and Mathevet, 2011).

Participatory mapping of social values has been used in cultural geography (Ramirez-Gomez et al., 2016), conservation sciences (Ernoul et al., 2018), and landscape ecology (Brown, 2013) to incorporate human dimensions in landscape planning, modeling, and decision-support systems (Le Page et al., 2013). Participatory mapping provides a spatial platform to integrate knowledge about complex landscape situations (e.g., climate change, urban sprawl, tourism development, regional planning, landscape management etc.) (Alhamwi et al., 2017), thus identifying a range of values within a landscape and revealing context in representations. This platform integrating socio-ecological values is highly sensitive to norms and values of the people involved, potentially representing specific interests in the political and social descriptions of environmental issues and actions. The map is not a basic tool, but rather defines boundaries presenting different ideals, ideologies, and practices within a landscape (Wardell-Johnson, 2005). Mapping includes a diversity of technical artifacts, processes, interfaces, and interpretations. The map as a boundary-object is central in the role of elicitation, collection, representation, management, and coordination of distributed knowledge (Star and Griesemer, 1989). Maps serve as intermediate-objects in the material sense (in the sense of Vinck, 1999) mediating between different visions and knowledge contributing to normative representation of positions about the environment. Maps play a part in contextualizing knowledge in the representation of "truth" and "facts."

A key challenge is to integrate the plurality of value-frames using social science techniques in order to re-frame decision-making processes and institutional structures (Ernoul and Wardell-Johnson, 2015; Estévez et al., 2015). This article proposes 3 basic principles derived from Mathevet and Marty (2015) that can be used to create a deliberative and procedural consultative processes coupling democracy with scientific practice (Latour, 1999), that is necessary for effective participatory mapping.

INTEGRATE SIMULTANEOUSLY FOUR DIMENSIONS OF NATURE-SOCIETY RELATIONSHIPS

The analysis of nature-society relationships requires simultaneously dealing with four different dimensions: a natural dimension (supported by ecology), a sociological dimension (including social, institutional, symbolic dimensions), an economic dimension (encompassing physical and financial capital), and a spatial dimension for environmental context. This 4-fold approach reveals the diverse ways in which people value nature in land access, as a natural resource, and in the distribution of benefits (Ostrom, 2009). The interactions and exercise of power in spatial relationships (Robbins, 2011) manifest in distributional equity both for people and nature. These dimensions provide the human-nature scaffolding for participatory mapping addressing critical social analysis objectives in multi-dimensional conservation planning.

RECOGNIZE THE SOCIO-ECOLOGICAL COMMUNITY

Socio-ecosystems become the unit of analysis when conceived as a hybrid collection of human and non-human interactions (Descola, 2011) forming social-ecological communities (Mathevet et al., 2016). Ideological values are negotiated resulting in changes to practice that modify representation, with a consequent change in environments and wildlife behavior. Participatory mapping can capture representation of values and changes in values through the analysis of human and non-human interdependencies and their differences (Mathevet et al., 2018).

RECOGNIZE THE POST-NORMALITY / TRANS-DISCIPLINARITY

Biodiversity conservation must consider complex interactions. In this complexity, uncertainty is linked to unpredictability of the impacts of multiple interactions between human and ecological processes, and the plurality of legitimacy of actions (Funtowicz and Ravetz, 1994). In a context where values and knowledge are often disputed, participatory processes provide opportunities for a range of problem definitions that offer solutions beyond unilateral approaches inherent to intra-disciplinary approaches. Integrative approaches that apply trans-disciplinary practices allow negotiation and dialogue at different scales promoting intellectual inter-dependence (Liu et al., 2015). In this context, participatory mapping provides the platform for collective decision-making processes in complex situations (Lynam et al., 2007; Ernoul et al., 2018) considering different power relationships, applying tools that are more applicable in an increasingly connected world.

This plurality identifies new frames for solutions and the exploration of new possibilities in intractable and wicked problems. Spatial platforms designed for mapping of social-cultural values and ecological change critique established institutions, procedures, and criteria framing existing knowledge building. The political and social dimensions that describe and explain different values in the environment (Wardell-Johnson et al., in press) are exposed through mapping practices creating powerful tools open to abuse in different situations (Chambers, 2006). Participatory mapping allows sensitivity to norms and values of the people contributing to the processes. Application of these three principles through the incorporation of a human-nature scaffolding to address social values in multi-dimensional conservation planning provides a platform for collective decision-making processes in complex conservation contexts.

Given the increasing use of mapping for environmental policy, planning, and management (Hauck et al., 2013), consideration of boundary objects in decision making improves credibility and legitimacy (Cash et al., 2003). Participatory mapping of socio-cultural values provides a means for different sectors in a social catchment to think collectively about environmental change. Spatial platforms that apply trans-disciplinary tools facilitate integrative and engaged science with improved long-term conservation impacts (Turner et al., 2016). Accounting for a range of knowledge, plural theories, and value-frames in the application of biodiversity planning and conservation through spatial analysis improves outcomes. Building a true-integrative science and participatory process for both research and landscape management bridges the gap between science, practice, and policy.

AUTHOR CONTRIBUTIONS

LE was responsible for identifying the subject and co-authors of the manuscript and contributed to the content, coordinated the contributions of the other co-authors and edited the manuscript. RM developed the theoretical framework and contributed to the design and implementation of the research and to the writing of the manuscript. AW-J contributed to the design and implementation of the research and to the writing and editing of the manuscript. AS contributed to the design and implementation of the research. LW contributed to the design and implementation of the research. OB contributed to the design and implementation of the research and to the writing of the manuscript.

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