

REVIEW AND SYNTHESIS

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Cultural ecosystem services and decision-making: How researchers describe the applications of their work

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Abstract

1. Cultural ecosystem services (CES) are some of the most difficult ecosystem services (ES) to characterize and connect to specific ecosystem processes. Given their connections to human emotion, deep meaning, fulfilment and motivation, they are also crucial for human well-being.
2. Scholars have published hundreds of peer-reviewed articles addressing CES in myriad ways. In this systematic review, we analyse 232 peer-reviewed articles on CES and examine how these studies discuss the interaction between CES research and decision-making.
3. We describe the primary ways that scholars have addressed the relationship between CES and decision-making, and we characterize each study with respect to how thoroughly its authors attend to the possible applications of their results. We find that 27% of papers discuss connections to decision-making in general terms, 28% discuss specific connections to decision-making, and the remainder mention decision-making links briefly or not at all.
4. We also discuss patterns based on the particular CES studied (e.g. recreation, identity); methods used; change through time; and geographical location of authors and of study sites.
5. We end with reflections on the current state of the interface between CES (and related concepts for approaching the non-material values associated with ecosystems) and decision-making, and we discuss future steps to increase connections between CES and decision-making.

KEYWORDS

human dimensions, non-material, policy, relational values, social dimensions of ecosystem services, social values, valuation, values

1 | INTRODUCTION

Cultural ecosystem services (CES) are "ecosystems' contributions to the nonmaterial benefits ... that people derive from human-ecological relations" (Chan et al., 2011, p. 206). Whether or not people are familiar with the term, the concept resonates with nearly every human

being, though precisely what resonates varies between people. A few examples of activities or experiences that might evoke CES, of millions of options, include a hunt to provide food with deep links to a valued place; a calming walk along a wind-whipped beach; a ceremony to honour a sacred water source; or watching baby robins grow in springtime. The CES concept is broad enough to encompass what many

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people find meaningful about their relationships with ecosystems. In this paper, we review peer-reviewed literature on CES to explore how this research has integrated with decision-making.

For over two decades, ecosystem services (ES) research has worked to characterize the ways that ecosystems benefit people (Millennium Ecosystem Assessment, 2005), with the primary goal of making these benefits legible and relevant to decision-makers (Daily et al., 2009). The ES literature (e.g. Daily et al., 2009), however, rarely explicitly defines “decision-makers.” In this review, we draw on Clark (2002, p. 74) and Stone (2012, p. 15) to characterize decision-makers as individuals with professional or civic powers and responsibilities to make and enforce policies. Decision-making is the process of making policies. We understand policies to constitute the rules, either public or private, that govern collective access to contributors to human well-being (Clark, 2002).

Despite both broad attention to the *idea* that ES information is decision-relevant (Fisher et al., 2008) and notable successes in using ES to inform decision-making (e.g., Goldstein et al., 2012), the few papers that evaluate overall use of ES in decision-making suggest that applying ES to actual decision processes is difficult and somewhat rare (or at least rarely documented) (Bennett, 2017; McKenzie et al., 2014). This reality is especially apparent in CES research, which confronts challenges to combining research and decision-making that differ from those of many other ES (Satz et al., 2013). Despite these challenges, researchers call for increased attention to both social and biophysical aspects of ES in policy (Bennett, 2017), and many scholars suggest that CES may be some of the most relevant ES in decision-making processes (Daniel et al., 2012).

In sum, CES research is nestled within a fundamental tension: CES may be a way to capture meaning that is crucial to people and consequently to decision-making, yet the inclusion of CES in decision-making is riddled with complications. One core aspect of this tension is that CES research attempts to represent phenomena that are notoriously difficult to characterize and measure within decision processes that emphasize science, quantitative data and empirical measurement. Currently, conservation planning draws largely on quantitative science (Clark, 2002). This leads to a mismatch between typical ES analysis and CES analysis: quantification and spatial representation are hallmarks of many ES analyses, yet CES are difficult to quantify and spatialize (Bieling & Plieninger, 2013). The methods used to represent values – by which we mean a broad concept that encompasses both worth (e.g. economic value) and meaning (e.g. moral value) – constrain and control what forms of value may be represented. As a result, a limited set of methods (e.g. solely economic or spatial methods) likely means a limited set of value types, often to the exclusion of many meaningful aspects of CES (Chan, Satterfield, & Goldstein, 2012; Jax et al., 2013).

Another complication is that many people are not consciously aware of CES – at least not much of the time. Even when people may be aware of them, CES are difficult to articulate and study for multiple reasons. These include that putting concepts such as identity into words is notoriously challenging (Schultz & Tabanico, 2007); that the language of ‘benefits of nature’ can seem inaccurate or inappropriate to describe human–ecosystem relationships (Bieling & Plieninger, 2013; Chan et al.,

2016; Comberti, Thornton, Wyllie de Echeverria, & Patterson, 2015); and that people may not want to share such meaningful personal and cultural insight with researchers (Schultz & Tabanico, 2007).

We consider these various complications as we conduct the core analysis of this paper: a review of the CES literature, with particular attention to cataloguing how it has (or has not) engaged with decision-making. We aim to understand the landscape of past engagement between CES work and decision-making, and suggest ideas for effective engagement and future areas for research. Additionally, we update selected analyses (e.g. counts of CES addressed and geographical locations of authors) from prior CES-focused reviews and thought pieces (e.g. Milcu, Hanspach, Abson, & Fischer, 2013). Through this work, we seek to inform the conundrum that Fish, Church, and Winter (2016) identify: “The challenge facing the decision-maker is how to approach culture in ecosystem management in ways that reveal, recognize, and dignify [its] inherent diversity but are also amenable to systematic appraisal in ecosystem management” (p. 214).

2 | METHODS

We included all papers that resulted from an ISI Web of Science search conducted in late April 2017. We searched for ‘Cultural Ecosystem Services’ as a topic, and included all 232 papers that resulted. To confirm that our list was not too narrow in scope – that is, that we were not missing publications that obviously addressed CES and thus could inform the review – we corroborated the Web of Science list with lists produced by other search engines (Google Scholar and JSTOR), using the same search term. We found no additional papers with other search engines and retained all papers found through the Web of Science. To confirm that the list was not too expansive – that is, that all papers in our review deal with CES in some way – we manually reviewed the papers in our list for content; all address CES.

The research team read all articles in the sample and coded many aspects of the articles to create a detailed database of article characteristics. To standardize our classification, we all read and coded a small subset of articles (five), then compared our coding and discussed ambiguous areas. Following this first ‘tuning’ work, we communicated extensively throughout the coding process. In the rare instances in which one of us encountered a study for which categorization was unclear given our definitions, we jointly discussed the case and refined our definitions and our coding for clarity and consistency. Each author thoroughly read a third of the papers. This deep reading, combined with our initial joint coding and our iterative process of refining definitions, allowed us to collectively understand and thus accurately code each paper.

For each paper, we recorded the methods used, CES studied, and author and study locations. We chose these characteristics because they allowed us to explore important trends in CES work, both conceptual and in terms of research practice, and to update summaries of the field provided in Milcu et al. (2013). Methods used and CES studied were not mutually exclusive categories; some papers used multiple methods, and many (if not most) papers studied multiple

TABLE 1 Categories of connections to decision-making, as described by authors of the reviewed studies

Category	Definition
None	Does not reference decision-making
Brief mention	References decision-making, but tangentially; does not develop or substantiate claims of relevance to decision-making
General	Discusses decision-making applications of the research, with more attention to universal findings than to findings applicable to any single context
Specific	Makes substantial reference to decision-making applications of a specific case, with attention to how the research findings might affect particular decision processes of decision-making bodies

CES. For location-based categories, as a first step we recorded all author and study locations. We then analysed the lists of locations (which, especially in the case of authors, sometimes included multiple regions of the world), and categorized them into regions as depicted and described in Figure 2 and its caption.

We used qualitative coding techniques (e.g. Patton, 2002) to classify how each study interfaced with decision-making, according to the authors' descriptions. We used our prior knowledge of decision-making applications in the CES literature to create a set of four categories that capture a spectrum of depth of interaction with decision-making. This coding was thus mostly *a priori*, but we allowed our early work to refine these *a priori* categories: we used the *a priori* categories in our early coding, and iteratively discussed our definitions to refine them as we read additional papers (Table 1). We determined decision-making implications from references to 'practice', 'decision-making', 'policy', 'real-world application', 'management', and other similar terms. We note that we did not analyse, nor do we have any way of analysing, studies' success of engagement with decision-making or engagements with decision-making not described in the published papers.

In the final stage of the coding analysis, we described connections to decision-making of the collection of papers in each of the decision-making categories (Table 1). To do this, we first reviewed our detailed notes about each paper in a given category. We then used a loose form of open qualitative coding to summarize the collective characteristics of each category by describing common themes in each (see Results2). We selected these themes carefully, such that the collection of themes for each decision-making category encompasses all papers in the category.

After coding all papers for depth of interaction with decision-making, we noticed that 12 papers described their interaction with decision-makers at some point in the research process, for example as partners in designing the research or as participants. These papers fit with multiple 'engagement with decision-making' categories. After our first round of analysis, we re-read and annotated these 12 papers to understand the nature of their engagement with decision-makers and any lessons learned or suggestions made as a result of it.

To explore patterns between the decision-making categories, we conducted Chi-squared tests. We used Fisher's exact test to determine whether different decision-making categories were associated with particular methods, specific CES, author locations or study locations. We selected this test because, unlike Pearson's Chi-squared test, it is robust to low sample sizes (some, between 10% and 70%, of the expected values in our analyses were less than five). We ran independent analyses for each study characteristic (e.g. each method, type of CES or location), and determined statistically significant differences using a Bonferroni correction to correct for the number of individual tests within each category. We chose to correct for each of the four categories separately to be conservative, but not overly so (Cabin & Mitchell, 2000). This resulted in the following corrected *p*-values, using a .05 initial cut-off for significance: $p = .0038$ (0.05/13) for methods; $p = .0025$ for CES categories (0.05/20) and $p = .0063$ (0.05/8) for locations. We did not statistically analyse the patterns in publication year.

3 | RESULTS

3.1 | Frequencies of engagement with decision-making by type

We present our results with respect to the decision-making categories we created. We note, however, that the diverse levels of engagement with decision-making present in the articles analysed cannot always be cleanly separated into discrete categories. Instead, engagement with decision-making might be conceptualized as existing on a spectrum; our coding divides that spectrum into sections (Figure 1). These categories are imperfect, and some papers could fit in more than one. That said, we find categorization helpful for conceptual organization. Papers categorized as briefly mentioning decision-making make up 43% of the literature, and papers that connect generally or specifically to decision-making split most of the remaining papers about evenly. Only 2% of the papers make no mention of decision-making (Figure 1).

The only statistically significant differences in study characteristics, by type of decision-making, were for literature-based methods and GIS methods (Table 2). Literature-based methods were more common for General and (to a lesser extent) Brief mention articles than for Specific and None articles (Fisher's exact test, 17.91, $p = .000$), and GIS methods were more common for Specific articles than for all other categories (12.47, $p = .004$). We found no patterns in types of connections to decision-making with respect to CES addressed or study and author locations (Figure 2).

3.1.1 | No reference to decision-making

Only a handful of papers in our review (5, or 2%) make no reference to the decision-making implications of their findings. These papers primarily address theoretical or methodological topics, and do so in strict academic language that avoids issues of application to practice. One paper that exemplifies this approach assesses CES related

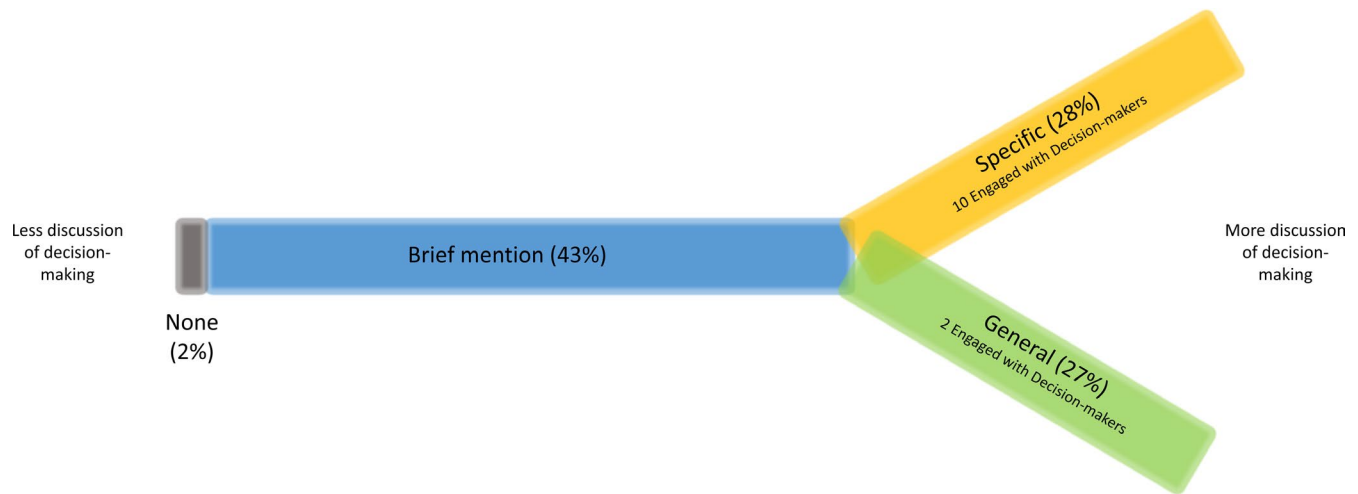


FIGURE 1 Number of papers by decision-making type, depicted as a ‘forked spectrum’ to indicate that the General and Specific categories both relate most to decision-making, but in different ways. Below each category, we note the number of papers that engaged with decision-makers during the research process, when applicable

to inspiration, as measured by references to ecosystems in popular music (Coscieme, 2015). The author's aim was to demonstrate “that cultural ecosystem services can be expressed in monetary terms as a way to achieve comparability with economic services” (p. 122), with particular attention to the hard-to-quantify inspiration benefits of nature. The author frames the paper as a theory exercise; he calls for further investigation of intersection between natural systems and artistic inspiration, but makes no mention of the decision-making implications often associated with monetary valuation of cultural ecosystem services. The additional four papers in this category similarly limit their discussions to the academic implications of their work.

3.1.2 | Brief mention of decision-making

The ‘Brief mention’ category was the largest of the decision-making type categories: we classified 100 articles (43%) as mentioning the relevance of their findings to decision-making only briefly or with minimal substantiation. Analysis of these articles revealed two main themes: that findings are, or should be, decision-relevant, and that the papers contribute to either theory or method.

Findings are or should be decision-relevant

A number of authors directly assert the relevance of their findings to decision-making contexts without discussing or deeply supporting these claims (Dluzewska, 2016; Ghermandi, 2016; Jobstvogt, Watson, & Kenter, 2014; Mocior & Kruse, 2016; Norton, Inwood, Crowe, & Baker, 2012; Schulp, Thuiller, & Verburg, 2014). One paper, for example, states that modelling the ecological conditions that underpin CES “has the potential to inform policy-makers and managers” (Graves, Pearson, & Turner, 2017, p. 425), but the authors do not explain the decision contexts or policy problems that would benefit from such modelling. Another paper similarly claims that maps of frequently-visited natural water treatment

sites “could provide useful information” to managers (Ghermandi, 2016, p. 303). These claims may be valid, and authors may have engaged more deeply with decision-making, but articles in this category provide little evidence of further thought or action regarding those connections.

Nearly a third of the ‘Brief mention’ articles describe more specific decision-making implications and provide some explanation for their assertions (e.g. Tenerelli, Demšar, & Luque, 2016). Although the authors justify their assertions in some way, those justifications do not include sufficient detail to merit classification as articles with ‘General’ relevance to decision-making (see definitions of decision-making categories in Table 1). One study developed a map of recreational resources in Ireland's forests, and the authors assert that this map “can assist in forest planning as it identifies where resources may be lacking and thus facilitates the targeting of forest expansion or the opening of existing forests for recreation” (Upton, Ryan, O'Donoghue, & Dhubhain, 2015, p. 75). The authors do not further assess the implications of this map for resource planning.

Other authors argue that decision-makers *should* consider the values or ideas assessed in their research (Bolund & Hunhammar, 1999; Casalegno, Inger, DeSilvey, & Gaston, 2013; Gould et al., 2014; López-Santiago et al., 2014; Mangi, 2013; Plieninger, Dijks, Oteros-Rozas, & Bieling, 2013). They address relevance to decision-making by claiming that if the values and dynamics they examine were considered in decision-making contexts, better decisions would result, yet they do not explain the details of this causal chain. One example is the statement that “cultural ecosystem services should not be overlooked or undervalued, for they contribute to the Healthy People 2020 social determinants of health in a variety of ways” (Jennings, Larson, & Yun, 2016, p. 8). Another example is the argument that policy-makers should understand the role of biodiversity in affecting human health and well-being if they hope to create policies that benefit both humans and non-human biodiversity (Pett, Shwartz, Irvine, Dallimer, & Davies, 2016).

TABLE 2 Results of Fisher's exact test for associations between connections to decision-making and CES addressed, method and locations

	None	Brief mention	Specific	General	Fisher's exact test	Exact sig. (two-sided)
CES addressed (corrected <i>p</i> -value: .0025)						
Recreation and tourism	4 (2.8)	55 (56.0)	38 (36.4)	33 (34.7)	1.43	0.714
Aesthetics	0 (2.5)	50 (50.4)	41 (32.8)	26 (31.3)	10.9	0.009
Cultural heritage	2 (1.7)	30 (33.2)	25 (21.6)	20 (20.6)	1.59	0.689
Learning/education	0 (1.4)	31 (28.1)	19 (18.3)	15 (17.2)	2.30	0.522
Spiritual	0 (1.4)	33 (27.7)	17 (18.0)	14 (16.9)	3.51	0.293
General	0 (1.2)	24 (24.6)	12 (16.0)	21 (15.2)	5.16	0.139
Social capital	1 (0.9)	15 (18.1)	14 (11.8)	12 (11.2)	1.56	0.660
Sense of place	0 (0.9)	21 (17.7)	9 (11.5)	11 (11.0)	1.82	0.599
Inspiration	1 (0.8)	17 (15.9)	12 (10.4)	7 (9.9)	1.80	0.586
Mental health	0 (0.6)	15 (12.1)	7 (7.8)	6 (7.5)	1.25	0.720
Identity	1 (0.6)	11 (11.6)	7 (7.6)	8 (7.2)	1.11	0.765
Nature appreciation	0 (0.5)	7 (9.1)	10 (5.9)	4 (5.6)	3.77	0.252
Bequest	0 (0.4)	7 (8.6)	6 (5.6)	7 (5.3)	1.07	0.750
Intrinsic	0 (0.4)	8 (8.6)	6 (5.6)	6 (5.3)	0.33	0.945
Existence	0 (0.3)	5 (6.9)	5 (4.5)	6 (4.3)	1.55	0.636
Knowledge systems	0 (0.3)	4 (6.5)	7 (4.2)	4 (4.0)	2.96	0.351
Stewardship	0 (0.2)	3 (3.9)	4 (2.5)	2 (2.4)	1.48	0.739
Cultural diversity	0 (0.2)	2 (3.4)	2 (2.2)	4 (2.1)	2.56	0.414
Option	0 (0.2)	1 (3.4)	5 (2.2)	2 (2.1)	5.17	0.131
Security	0 (0.1)	2 (1.3)	0 (0.8)	1 (0.8)	2.30	0.647
Methods used (corrected <i>p</i> -value: .004)						
Survey/interview	3 (2.2)	49 (51.1)	41 (40.2)	29 (28.5)	1.03	0.818
Literature	0 (1.6)	37 (32.8)	10 (21.3)	29 (20.3)	17.91	0.000*
GIS	0 (1.6)	26 (32.3)	32 (21.0)	17 (20.0)	12.47	0.004*
Monetized	0 (0.3)	10 (6.9)	5 (4.5)	1 (4.3)	4.99	0.153
Social media	0 (0.3)	10 (6.9)	5 (4.5)	1 (4.3)	4.48	0.186
Observation	0 (0.4)	6 (7.3)	9 (4.8)	2 (4.5)	5.20	0.146
Modelling	0 (0.3)	5 (6.0)	8 (3.9)	1 (3.7)	6.14	0.093
Ecological fieldwork	1 (0.2)	4 (4.7)	3 (3.1)	3 (2.9)	3.02	0.397
Choice experiment	0 (0.2)	6 (4.7)	5 (3.1)	0 (2.9)	5.40	0.129
Case studies	0 (0.2)	1 (3.9)	5 (2.5)	3 (2.4)	5.26	0.128
PPGIS	0 (0.2)	3 (3.9)	4 (2.5)	2 (2.4)	1.48	0.739
Workshop/deliberative	0 (0.1)	1 (2.6)	2 (1.7)	3 (1.6)	2.96	0.418
Photos, arts-based	0 (0.1)	3 (1.7)	1 (1.1)	0 (1.1)	2.48	0.616
Locations (corrected <i>p</i> -value: .006)						
Study-Europe	3 (1.9)	38 (38.8)	29 (25.2)	20 (24.1)	3.08	0.398
Author-Europe	3 (3.1)	66 (62.1)	35 (40.3)	40 (38.5)	2.78	0.447
Study-North America	0 (0.9)	12 (18.1)	17 (11.8)	12 (11.2)	6.22	0.085
Author-North America	1 (1.2)	18 (24.6)	20 (16.0)	18 (15.2)	4.54	0.189
Study-Asia	0 (0.4)	7 (7.8)	7 (5.0)	4 (4.8)	1.09	0.779
Author-Asia	0 (0.3)	4 (5.6)	6 (3.6)	3 (3.5)	2.16	0.536
Study-South America	1 (0.3)	4 (6.0)	5 (3.9)	4 (3.7)	3.45	0.316

(Continues)

TABLE 2 (Continued)

	None	Brief mention	Specific	General	Fisher's exact test	Exact sig. (two-sided)
Author-South America	1 (0.3)	4 (5.6)	4 (3.6)	4 (3.5)	3.16	0.350
Study-Africa	0 (0.2)	6 (4.7)	3 (3.1)	2 (2.9)	0.79	0.891
Author-Africa	0 (0.2)	4 (4.3)	2 (2.8)	4 (2.7)	1.21	0.723
Study-Aust./NZ/Oceania	0 (0.2)	3 (3.0)	3 (2.0)	1 (1.9)	1.422	0.752
Author-Aust./NZ/Oceania	0 (0.2)	5 (4.3)	3 (2.8)	2 (2.7)	0.58	0.937
Study-Middle East	0 (0.1)	2 (1.3)	1 (0.8)	0 (0.8)	2.21	0.804
Author-Middle East	0 (0.1)	4 (2.2)	1 (1.4)	0 (1.3)	3.09	0.402
Study-Global	1 (0.3)	8 (6.9)	0 (4.5)	7 (4.3)	10.4	0.010
Author-Global	0 (0.2)	4 (3.9)	3 (2.5)	2 (2.4)	0.59	1.000

Note: Numbers in parentheses indicate expected values. Asterisks indicate results that are significant after the Bonferroni correction.

Contributions to theory or method

Many papers provide theories or methods that could aid decision-making, again mentioning that incorporation of these methods or ideas would improve decision-making and/or land management, but providing very little explanation of how they would do so. Contributions to theory in this category consist primarily of critiques of the positivist Western perspective that measurable benefits flow from ecosystems to people. Multiple articles suggest that CES-related constructs be viewed as bi- or multi-directional (rather than uni-directional) relationships between people and nature (Comberti et al., 2015; Fischer & Eastwood, 2016). Authors also propose alternative frameworks, including one that suggests taking a pluralistic approach by using multiple valuation methods (Scholte, Teeffelen, & Vergburg, 2015). Several authors also argue that using socio-ecological frameworks that assess feedbacks between ecosystems and people may be best suited to CES research for decision-making application (Mastrangelo et al., 2015; Russell et al., 2013).

Methods contributions in the 'Brief mention' category also range widely; authors present methods to collect quantitative, qualitative and spatial data, among other types. As a few examples, authors who briefly mention links to decision-making suggest the use of: 'folksonomies' to assess laypeople's knowledge of important landscape characteristics (Derungs & Purves, 2016); Q methodology to assess relative values of CES (Pike, Wright, Wink, & Fletcher, 2015); and specific protocols for mapping, visualization or interviews (Frank, Fürst, Koschke, Witt, & Makeschin, 2013; Hernández-Morcillo, Plieninger, & Bieling, 2013; Kenter, 2016; Klain, Satterfield, & Chan, 2014; Orenstein, Zimroni, & Eizenberg, 2015; Pert et al., 2015; Szücs, Anders, & Bürger-Arndt, 2015).

3.1.3 | General connections to decision-making

We classified 62 papers (27%) as connecting to decision-making in well-substantiated and conceptually or geographically broad (i.e. General) ways. Papers in this category display two main themes: (a) they make conceptual points; and (b) they present tools or frameworks.

Conceptual points

Many papers make conceptual points about how CES data interact with decision-making. A few authors discuss issues that complicate the applicability of CES research; we summarize most of these in the introduction (Blicharska et al., 2017; Satz et al., 2013). Yet many authors write positively about the potential applications of CES analysis. Some suggest that CES can help inspire or enable decision-making because they are, in many cases, the ES about which people are most passionate (Daniel et al., 2012; Milcu et al., 2013). Others suggest that CES can serve as a gateway for addressing environmental management – a 'foot-in-the-door' topic that resonates intuitively with many people and thus incites interest in the environment. This effect may be particularly salient in urban areas, where CES can be more obvious to people than the biophysical ES with which they intertwine (Andersson, Tengö, McPhearson, & Kremer, 2015; Belaire, Westphal, Whelan, & Minor, 2015).

Additionally, many papers suggest that systematic characterization of CES might help to deal with ecosystem management that confronts diverse human perspectives, relationships with ecosystems and cultural preferences (Riechers, Barkmann, & Tscharnke, 2016; Soy-Massoni, Langemeyer, Varga, Sáez, & Pintó, 2016; Winkler & Nicholas, 2016). Some of these papers argue that CES analysis can illuminate potential alignment or conflict (Sarkki, Ficko, Grunewald, & Nijnik, 2016) and lead to more comprehensive planning because it allows those decisions to account for a wider array of values or benefits, including across time periods and across stakeholder groups (Darvill & Lindo, 2016; Plieninger et al., 2015).

Authors also raise multiple ethical issues associated with incorporating this wide array of values and benefits into decision-making. They point out that different ES can be in conflict, and decision-makers sometimes have to make choices between them (Quilliam, Kinzelman, Brunner, & Oliver, 2015). Authors emphasize that not considering cultural diversity in assessments of non-material values risks that some values will not be taken into account in policy (Botzat, Fischer, & Kowarik, 2016). Authors also convey an important, yet often overlooked, point about value heterogeneity: that we cannot assume that simple membership in a given social group

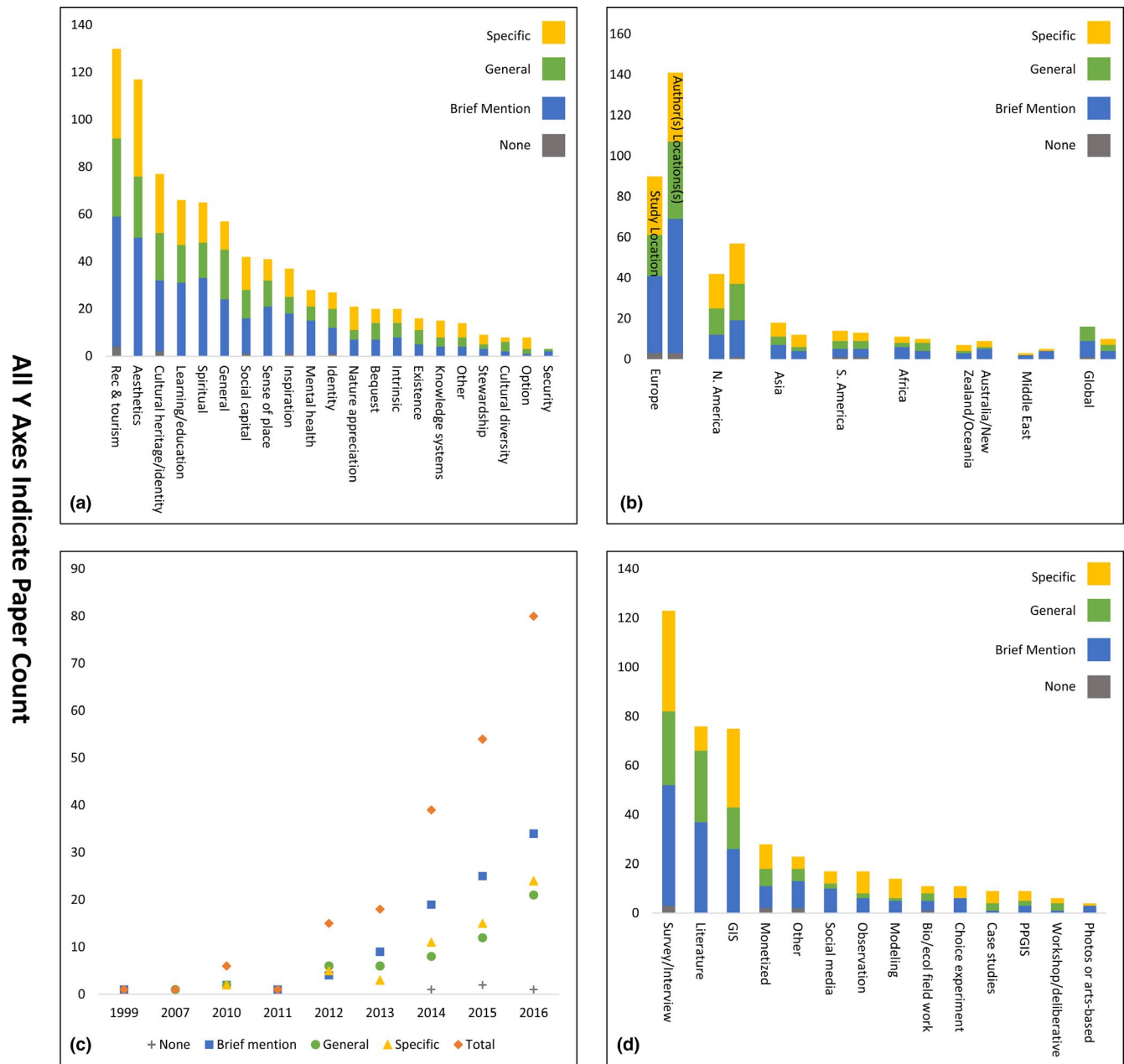


FIGURE 2 Charts that assess the state of the CES field and update the most recent systematic review (Milcu et al., 2013). Charts depict: (a) CES addressed; (b) methods used; (c) study and author locations by region; and (d) publication year through 2016, the last year in our review for which we had complete data. Bar heights indicate the number of papers in each category and bar shading indicates proportions of papers in each decision-making type. In panel (b), the first bar for each region indicates study location; the second indicates author location

or sector defines values; there also may be heterogeneity within groups (MacDonald, Murray, & Patterson, 2015).

Another challenge in bringing values to the decision-making table is the complex nature of values. Authors discuss how scholars' understanding of values is still developing (Kenter, Bryce, et al., 2016), which greatly complicates efforts to include them in decision-making. Clearly, values often exist prior to data collection efforts, yet they can also be affected by efforts to elicit or understand them. An approach to assessing values that simply assumes that they are 'out there' to be measured does not accurately reflect the essence of values (Kenter,

Bryce, et al., 2016). Some researchers suggest that a promising way to bring these complex issues into decision-making is a combination of individual-level valuation and deliberative approaches (Daniel et al., 2012), or, viewed through a more epistemological lens, employing both statistical/positivist approaches and communicative/interpretivist approaches (Raymond, Kenter, Pleninger, Turner, & Alexander, 2014). Each type of approach has benefits and drawbacks; when they are combined, authors claim, each can help cancel out the others' drawbacks, which allows a wider array of benefits to be represented in decision-making (Raymond et al., 2014).

Because individual, statistically based methods are more common in the ecology and economics fields central to ES work and thus generally accepted, some authors also discuss and justify the importance of other types of CES characterization for decision-making. Deliberative methods can be beneficial, authors suggest, for two reasons. First, they may better reflect the collective implications of decisions (as opposed to aggregating individual surveys, for instance). Second, deliberative methods can be helpful in revealing the often subtle and implicit details of CES (Kenter, Jobstvogt, et al., 2016). Work in this vein also emphasizes the need for pluralistic assessments of ES values (Cooper, Brady, Steen, & Bryce, 2016; Quintas-Soriano et al., 2016) and suggests that future research should explore both differences in how values are understood and what kinds of values can be represented by various elicitation processes. A primary goal of this pluralism would be to help represent diverse and often marginalized interests in decision-making (Chan et al., 2016; Chan, Satterfield, et al., 2012).

Some of these papers make specific suggestions about how to better meld CES analysis and decision-making. One proposed framework describes how CES might be incorporated into multiple phases of decision-making processes (Chan, Guerry, et al., 2012). Another suggests modifications of the CES idea, such as using the alternate term and concept 'environmental spaces and cultural practices' (Fish et al., 2016). One paper suggests that ES can inform decision-making if they are embedded in social processes, such as when discussion of ES can increase farmers' awareness of the non-food services ecosystems provide (Nahuelhual, Carmona, Laterra, Barrena, & Aguayo, 2014). Another suggests social valuation of ES, in which people identify and then rank ES (Felipe-Lucia, Comín, & Escalera-Reyes, 2015).

Tools or frameworks

Some papers that connect to decision-making in general ways present models, instruments, or processes that they suggest may be used in various management contexts. Some develop indicators (La Rosa, Spyra, & Inostroza, 2016; Tratalos, Haines-Young, Potschin, Fish, & Church, 2016); others suggest specific permutations of more traditional approaches, such as using a vetted open-ended qualitative interview protocol (Gould et al., 2015) or transferring survey results from one area to predict CES values in a different, but culturally similar, region (Brown, Pullar, & Hausner, 2016).

Multiple papers suggest mapping-related tools or approaches for connecting to decision-making. Some focus on methods such as recreational supply and demand (Paracchini et al., 2014; Peña, Casado-Arzuaga, & Onaindia, 2015), participatory GIS and traditional GIS (Bagstad, Semmens, Ancona, & Sherrouse, 2017), and weighting spatial areas for levels of value and threat (Klain & Chan, 2012). A number also draw on or summarize results from widely available data, including pre-existing GIS data (Schirpke, Timmermann, Tappeiner, & Tasser, 2016) and social media photos (Daniel et al., 2012). Another paper cautions against unreflective inclusion of mapping-related results in decision-making processes due to mapping's shortcomings in addressing certain kinds of CES (e.g. those related to forest spirits; Nahuelhual, Benra Ochoa, Rojas, Díaz, & Carmona, 2016).

Many papers also engage with monetary valuation and reflect on its usefulness to decision-making. Some provide detailed examples of standard application of these methods, and reflect on the general implications of these methods for CES research and application (e.g. Sander & Haight, 2012 apply hedonic pricing methods). One study questions offset banking models as narrow, monetized ways to understand value (Mann, 2015). Another applies willingness-to-pay (WTP) in a novel way, assessing WTP at three locations of varying distance from the focal ecosystem; this study makes the important, though not uncommon, point that monetary methods are often quite convincing to decision-makers, but have drawbacks and should be used in concert with other methods (Barrena, Nahuelhual, Báez, Schiappacasse, & Cerda, 2014).

3.1.4 | Specific connections to decision-making

Papers categorized as 'Specific' (65 papers, 28%) address questions dealing with the decision-making relevance of CES in well-defined contexts. These studies often focused on a specific management decision or natural resource, or developed an analytical tool. We categorized these papers as 'Specific' because their primary analyses are site-specific (though authors often acknowledge broader implications or applications). Common themes in these studies include the methods used (currently common to ES and relatively new to ES) and motivations for the studies (academic motivations and management motivations).

Methods used

Many of these studies apply tools commonly used in ES analysis to specific situations and decision-making contexts. Tools used include GIS analysis (Broekx et al., 2013; Havas, Saito, Hanaki, & Tanaka, 2016; Westcott & Andrew, 2015), monetization (Barrena et al., 2014; Lankia, Kopperoinen, Pouta, & Neuvonen, 2015; Ruiz-Frau, Hinz, Edwards-Jones, & Kaiser, 2013) and a combination of the two (Decler et al., 2016). A study conducted on the U.S. Great Lakes exemplified this approach. The authors note that CES are "often directly experienced by the public, [and as such are] a powerful justification for ecosystem restoration and investment," and argue that efforts to draw CES into decision-making are best supported by spatially explicit data (Allan et al., 2015, p. 418). Another study monetizes CES benefits and argues that forest management planning in Finland should include assessments of recreation-based economic growth alongside the contributions of more traditional forest products (Lankia et al., 2015).

Other studies in this category use methods that have been, until recently, less common in ES analyses. Many involve modifications of tools commonly used in other fields – for example, stakeholder surveys (Schmidt, Sachse, & Walz, 2016), interviews (Campbell, Svendsen, Sonti, & Johnson, 2016), participatory mapping (Darvill & Lindo, 2016) and focus groups or brainstorming sessions (Frank, Fürst, Witt, Koschke, & Makeschin, 2014). Several projects draw on multiple methods (García-Llorente, Rossignoli, Iacovo, & Moruzzo, 2016; Ranger et al., 2016).

One example of an interview technique with creative context-specific applications is found in a study among the Pacific

Northwest's Quinault people. The authors use key informant interviews to identify hard-to-quantify well-being factors, and then suggest concrete approaches to including these factors in a tribal forest management plan (Amberson, Biedenweg, James, & Christie, 2016). Another study combines literature review and field data to inform new estimates of post-harvest recovery time in terms of CES provided by forests, with implications for revised approaches to timber harvest and forest management prescriptions (Sutherland, Bennett, & Gergel, 2016).

Motivations for the studies

Another theme in papers with specific applications to decision-making involved the apparent motivations behind the research. Some papers aimed to address academic questions that originate from the ES framework and used a specific context or case to develop theoretical or methodological insights needed to address those questions. As one example, CES hotspot mapping work in Chile aims to fill a gap in the methods used to study CES and analysed the spatial patterns of CES distribution based on cultural perception (Martínez Pastur, Peri, Lencinas, García-Llorente, & Martín-López, 2016).

Other projects frame their work as related to a specific management goal, rather than an academic question, and use a CES lens to understand nonmaterial impacts of potential interventions in a specific location or context. One study, for example, uses CES to understand whether a government proposal to control flooding by channelizing a river in Indonesia accounts for the full range of benefits that area residents gain from the unchannelized river (Vollmer, Prescott, Padawangi, Girot, & Grêt-Regamey, 2015). They use the finding that residents value certain cultural benefits from the river in its unaltered condition to inform alternative river management scenarios that better meet the needs of all stakeholders.

Many studies, of course, demonstrate elements of both academic and management motivations. One study, for example, uses a CES lens to better understand the values of Midwestern forest landowners (Hendee & Flint, 2014). The project advances the application of CES in the forestry field – an academic development. Yet the primary purpose of the project was to meet a specific conservation goal that aligns well with CES: to increase forestry researchers' ability to identify and serve clients' values.

3.2 | Engaged with decision-makers

We classified several papers as 'engaged with decision-makers', a label that transcends our four decision-making categories and indicates whether the authors reported interacting with decision-makers while executing their study. Twelve studies (5%) engage decision-makers in study design and, sometimes, analysis. Engagement with decision-makers most commonly takes one of two forms: incorporating staff from management and planning agencies directly involved with decision-making on the research team (e.g. Campbell et al., 2016); and preliminary meetings with decision-makers and managers to discuss desired end-products and/or experimental design (e.g. Broekx et al., 2013). The remaining

studies either use decision-maker/expert insight to refine study questions, or employ collaborative workshop exercises in which researchers and decision-makers interact and observe each other through several iterations.

The degree of purposefulness with which these 12 studies engage with decision-makers varies. A plurality (six studies) do not explain their rationale for involving decision-makers in the research process. Of the six studies that explicitly address this point, researchers cite the benefits of including decision-makers in the research and planning process in terms of improving understanding of local communities' policy priorities (e.g. Oleson et al., 2015) or accessing key informants and facilitating interviews (e.g. Amberson et al., 2016). One study (Casado-Arzuaga, Onaindia, Madariaga, & Verburg, 2014) also cites some degree of pre-existing interest or demand from stakeholders for assistance with ES-centric planning.

Five studies report a direct impact on decision-making (Broekx et al., 2013; Campbell et al., 2016; Casado-Arzuaga et al., 2014; Frank et al., 2014; Ranger et al., 2016). These outcomes range from reports of decision-makers using a decision support tool designed by the researchers (Broekx et al., 2013), to revisions of local regional plans (Frank et al., 2014), to inclusion of qualitative baseline data in park planning (Campbell et al., 2016).

4 | DISCUSSION

We aimed to understand how existing academic research on CES interfaces with decision-making. We analysed 232 papers about CES and categorized how they describe their findings' interactions with decision-making. We created four categories to describe how authors discuss the interaction with decision-making, and found that 2% of the papers made no mention of decision-making, 43% Briefly mentioned it, 27% made General comments or suggestions and 28% connected their findings to Specific decision-making contexts. We also found 12 studies (5%) that engage with decision-makers during the research process. In addition to these results about decision-making interactions, we summarize CES studied, methods used and geographic areas that studies and authors we review represent. We also display the number of CES paper across time. We present these results as divided by type of connection to decision-making, and find no patterns between types of connection to decision-making and these study characteristics.

We observed only two patterns in types of connection to decision-making as related to CES studied, methods used or location. Our two statistically significant results – that literature-based methods were more common for General connections to decision-making and GIS methods more common for Specific connections to decision-making – are logical: literature-based studies tend to reach general conclusions, whereas GIS is (except in global analyses) inherently place-based. We expected that we might find additional patterns – for instance, that studies that monetized results might be more apt to discuss connections to decision-making. Yet this is not evident in our results. Given the unsurprising nature of our

two statistical findings, we thus focus discussion on broad themes in types of connections to decision-making, and, relatedly, how the collected papers address and inform some of the challenges of CES research and the future development of CES research.

4.1 | ES as anthropocentric and instrumental, and what that means for CES in decision-making

Deeper consideration of the links between CES research and decision-making in the 232 papers reviewed here brings to the forefront two fundamental characteristics of the ES framework: that the framework is anthropocentric, and that it is based on instrumental values of ecosystems. These two linked features are central to the ES concept, and also central to many critiques of the concept. Our review suggests that the study of CES may be capable of facing these critiques holistically – and that in this way, CES may help to strengthen ES approaches. In this section, we discuss those fundamental orientations of ES and then suggest that the papers in our sample address these orientations in three main ways.

Scholars have debated the unapologetically anthropocentric and instrumental nature of the ES framework issue for years. Primary critiques centre on the ethical shortcomings of considering only needs of and benefits to humans (McCauley, 2006; Spash, 2008); rebuttals describe how the ES concept leaves room for intrinsic value and other ethical considerations (Schröter et al., 2014). Yet in all this debate, scholars seldom address the likely reason behind the anthropocentric and instrumental core of ES.

The ES approach, it may be argued, is human-centred because scholars designed it to fit the logic of Western human decision-making strategies. ES research is designed to represent for decision-making the value(s), in a philosophically instrumental sense, of ecosystems to humans (Daily, 1997). ES work is thus partly a pragmatic response to the reality that centuries of decision-making in many Western contexts strongly suggest that human-made policy focuses on *human* well-being (Clark, 2002). Very little policy aims to improve, or even maintain, the well-being of other-than-humans. Exceptions certainly exist; for example, in 2008 Ecuador granted legal personhood to Pachamama (loosely translated as Mother Nature; Espinosa, 2015), and New Zealand recently recognized a mountain and a river as legal persons, with more such recognitions pending (Studley & Bleisch, 2018). Important to note is that in these examples, indigenous peoples and worldviews either led or ideologically supported the landmark legal changes (Espinosa, 2015). In contexts where Western post-enlightenment rationality does not dominate, the pattern of human-made decisions strongly prioritizing human well-being often breaks down. Yet despite these recent developments, it remains the case that in many current contexts, decision-makers attend most to supporting human well-being. In other words, in many if not most situations, instrumental approaches towards anthropocentric ends resonate with decision-makers, and the ES framework strategically and pragmatically responds to this reality.

The ES framework in general thus offers anthropocentric presentations of instrumental values; our findings, however, suggest that

some CES research may push the boundaries of that understanding and question how adequately those orientations capture what really matters to people. The conceptual scope of CES includes types of value that de-privilege human benefit – that is, that deviate from human-centred and instrumental values. A number of the papers in our review address this deviation. As one prime example, spirituality is mentioned in nearly all CES typologies (Gould & Lincoln, 2017), and the spiritual values of ecosystems are often intertwined with non-instrumental approaches to the meaning of those ecosystems (Comberti et al., 2015; Taylor, Wieren, & Zaleha, 2016). As another important example, many of the concepts that emerge when people discuss CES are not instrumental benefits that flow from ecosystems to humans, but are instead values based on relationships, reciprocal interaction, emotional connection, or similar phenomena (Arias-Arévalo, Martín-López, & Gómez-Baggethun, 2017; Chan, Pascual, & Gould, 2018; Diver, Vaughan, Baker-Médard, & Lukacs, 2019; Gould et al., 2015; Himes & Muraca, 2018). These values intertwine with the ideas of co-production – that is, that humans ‘work with’ ecosystems to support those systems and provide desired services (Fischer & Eastwood, 2016). This makes it problematic to include many constructs associated with the CES concept (e.g. spiritual value; cultural heritage; ceremonial value) within a strictly anthropocentric, instrumental framework that separates human action and ecosystem action.

The papers we reviewed offered a range of responses to the anthropocentric and instrumental nature of ES, and by extension, of CES. We can divide responses into three broad categories. First, many authors do not address these two characteristics at all. Second, some find them so grave as to call the entire concept of CES into question. And third, some address them with attention to how to confront and overcome the shortcomings they create. Below, we discuss these three approaches, with two closely related caveats. First, this distinction did not emerge until we had concluded our coding, so we discuss these approaches in a general sense (i.e. we did not code every paper as falling into one of the three categories). Second, these approaches represent conceptual categories that we find helpful for broad understanding; they are not mutually exclusive, nor do they perfectly describe many of the studies in our review.

Many authors do not question the anthropocentric and instrumental nature of ES, and create new data to integrate into existing ES frameworks without noting potential complications. These approaches innovate and expand CES research in multiple ways: they collect new forms of data, collect new data that conform with existing data forms, use existing data in new ways and create new tools that lead to new data. These studies use both GIS and monetization methods (e.g. Decler et al., 2016), which are common in ES work generally. They also use a variety of other techniques that are common in social science work generally, such as surveys and interviews (e.g. Plieninger et al., 2013). Many studies (including Decler et al., 2016 and Plieninger et al., 2013) combine multiple approaches. Potential benefits of approaches that create new data to include in existing frameworks include that gaining traction in decision-making

may be easier when working with a framework that is understood and respected (at least by some), or that when using these approaches, all resources can focus on creating useful data for existing systems rather than creating new structures. Some potential drawbacks of these approaches are described in the many critiques of the CES framework – notably, that the conceptual orientation of ES, and the limited methods and forms of data associated with that orientation, limits the range of values that can be adequately characterized (Jax et al., 2013).

A few authors of papers we reviewed focus on complications that arise within a strictly anthropocentric and instrumental framework. They discuss both complications described above and additional ones. They heavily critique the CES concept, and often suggest that we jettison it and work to address the non-material values related to ecosystems using other frameworks (James, 2015; Leyshon, 2014; Spash, 2008; Winthrop, 2014). Authors vary in the extent to which they propose or discuss possible alternative frameworks; some only offer critique.

Located between these two conceptual extremes is a third approach. Some studies suggest new ways to think about CES (or the types of meaning that underlie CES) and how decision-making might incorporate that meaning. Many of these studies work within the ES framework to address and try to make space for ideas that are not entirely anthropocentric and instrumental. They bring up the shortcomings of different approaches, but with an air of working to better incorporate these other types of value (e.g. Nahuelhual et al., 2016). These studies identify promise in the core idea encapsulated by the CES concept: that nature is important to human well-being for non-material reasons (not all of which rely on instrumental logic). They thus try to innovate ways to address core critiques of CES and yet retain the ‘non-material contributions to well-being’ essence of the concept. Some suggest new ways to think about constructs that the CES concept attempts to capture, and how decision-making might incorporate those ideas (see Kenter, Bryce, et al., 2016 and the Special Issue it introduces). Others offer novel twists on features of existing processes – such as indicators developed from qualitative interviews with indigenous residents (Amberson et al., 2016). Other examples include arts-based methods (Edwards, Collins, & Goto, 2016); approaches that recognize humans’ services to ecosystems in addition to ecosystems’ services to humans (Comberti et al., 2015); and approaches that propose relational values as a complement to instrumental (and intrinsic) value approaches (Chan et al., 2018, 2016; Himes & Muraca, 2018; Muraca, 2016).

We, and – as our review indicates – many other CES researchers, hope that CES research can address some of the social ‘blindness’ that conservation-focused land management is accused of wearing. A primary goal of this work is more equitable management processes and results (Riechers et al., 2016; Soy-Massoni et al., 2016; Winkler & Nicholas, 2016). Approaches that foreground equity, however, may interact in complex ways with the anthropocentric and instrumental orientation of ES. It is conceivable that new forms of CES data could help existing (anthropocentric, instrumental) decision processes to better include social justice concerns; work that precedes traditional

willingness-to-pay surveys with group deliberation provides one example of such a dynamic (Martínez Pastur et al., 2016). Still, some argue that these approaches do not go far enough in encouraging substantive change to outdated systems and adequately incorporating diverse worldviews (Fish et al., 2016; James, 2015; Leyshon, 2014; Spash, 2008; Winthrop, 2014). Two new trends adjacent to CES – social values and relational values – may be paving the way towards a middle ground that works within yet also attempts to push the anthropocentric and instrumental boundaries of current decision-making practices.

4.2 | Challenges and solutions in connecting CES to decision-making

Connecting scholarship and decision-making is rarely simple. Entire fields (e.g. Policy Analysis and, at a more general level, Science, Technology, and Society studies) study this interface; extensive academic work addresses its nuance (Clark et al., 2016; Jasanoff, 2011; Pielke Jr, 2007); and international bodies exist largely to increase the connection (e.g. FutureEarth and the Intergovernmental Platform on Biodiversity and Ecosystem Services). More specifically, scholars have identified multiple concerns related to connecting ES science in particular to decision-making, such as the importance of institutions equipped to support the use of ES data (Daily & Matson, 2008) and the multiple ways that ES data are used in policy processes (McKenzie et al., 2014). In general, ES scholars increasingly attend to ‘what happens’ with ES science; a computer-aided review of over 14,000 ES publications found that since the ES term first entered widespread use in the 1990s, discussion of governance has increased markedly in ES-related peer-reviewed publications (Droste, D’Amato, & Goddard, 2018).

Connecting CES scholarship to decision-making presents a number of unique challenges, as summarized in the introduction. The papers in our review suggest multiple ways to address these recognized challenges, and also reveal new obstacles. Here we discuss our distillation of four of the primary challenges – intertwining and incommensurability, connections to ecosystem features, mismatches in spatial scale and the nature of values – and how recent scholarship does or does not address them.

CES are often intertwined with each other and with material ES and, even when they can be separated, are often incommensurate with each other and with material ES (Chan, Guerry, et al., 2012; Tilliger, Rodríguez-Labajos, Bustamante, & Settele, 2015). These features greatly complicate their inclusion in techno-scientific processes. Our review highlights papers that explore deliberative approaches as a primary response to this complexity (Kenter, Bryce, et al., 2016; Orchard-Webb, Kenter, Bryce, & Church, 2016). Another approach, and one that can be effectively used in concert with deliberation, involves indicators that attempt to parse CES and, in some cases, the ecosystem components with which they associate; one paper conducts a detailed review of CES indicators and their quality (Hernández-Morcillo et al., 2013). This approach has potential; creative research has developed indicators that are culturally tailored

and that measure both ecosystem characteristics and human well-being (Amberson et al., 2016; Satterfield, Gregory, Klain, Roberts, & Chan, 2013). Work to integrate these indicators with decision processes is ongoing (e.g. Biedenweg, 2017), and provides a promising avenue for connecting CES and decision-making.

A second major challenge is the lack of specific connections between CES and landscape elements – that is, making concrete links to the *ecosystem* portion of *cultural ecosystem services* (Tilliger et al., 2015). Not fully understanding these connections, or even when they do or do not exist, makes it difficult for decision-makers to account for the complex interplay between land management actions and CES. Our review included only a few papers that concretely and specifically connect biophysical features or processes and CES. A review of indicators of CES finds that just 23% of them are spatially explicit – which is one important way of connecting to biophysical features (Hernández-Morcillo et al., 2013). One study analyses a set of subjective well-being indicators used in an online survey, and finds a few biophysical characteristics (e.g. presence of species of conservation importance, seals or birds, and certain habitats such as those with rocky intertidal zones) to be positively correlated with CES (Bryce et al., 2016). Another paper addresses this concern at a more general level and does not see the lack of specific connections as a problem: it catalogues how the CES concept adds in helpful, meaningful ways to landscape management and planning even without one-to-one correspondence between CES and landscape features (Plieninger et al., 2015). Given that informing such decisions is a, if not the, primary goal of CES research, the scarcity of these approaches is surprising and suggests that if CES research is to be optimally useful for many land-use decision-making processes, this direction is a core need in future CES research.

Some work has connected non-material benefits to specific landscape elements, but without using the term CES (as a result, these studies were not included in this review). Much of this work either considers all non-material benefits together under terms like ‘well-being’ or ‘cultural values’ or focuses only on recreation and aesthetics. One study, for instance, explored the well-being benefits provided by coastal landscapes and identified particular elements of the landscape that contribute to participants’ overall sense of well-being (Bell, Fox-Kämper, & Keshavarz, 2016). Another study explored correlations between visitation for recreation and water clarity (Keeler et al., 2015). Another used participatory mapping to assess connections between multiple types of non-material benefits and specific landscape elements in Tanzania, and found considerable heterogeneity in benefits across participants (Fagerholm, Käyhkö, Ndumbaro, & Khamis, 2012). Such heterogeneity is (as mentioned above) a consistent challenge for incorporating these kinds of values into decision-making.

Additionally challenging is the fact that CES may be experienced or evaluated at scales that poorly match decision-making scales. Because CES are often context- and place-specific (Díaz et al., 2018), and can be time-consuming to evaluate, many studies assess CES across relatively small spatial scales (e.g. Belaire et al., 2015; Gould et al., 2014; Klain & Chan, 2012; Sohel, Ahmed Mukul, & Burkhard, 2015). This scale of evaluation may not be particularly useful or appropriate

for national (or global) decision-making, though it can provide highly pertinent information to local or regional decision-makers. Efforts to evaluate CES at broader spatial scales include, notably, employing proxies for CES from social media, such as photographs of recreation or outdoor education (Keeler et al., 2015; Richards & Friess, 2015). Many such studies have been published in the past year (e.g. Oteros-Rozas, Martín-López, Fagerholm, Bieling, & Plieninger, 2018; Van Berkel et al., 2018), and thus were not included in our review. Social media may be an imperfect tool to assess CES, but is a growing frontier in resource-efficient assessment of these values.

An additional suite of challenges relates to the intimate connections between CES and values. Characterizing CES often involves discussing or characterizing values, in the sense of the principles or priorities that are important to people (Cooper et al., 2016). This sense of value differs from conceiving of value as a composite of ‘things nature does for us’ (i.e. as instrumental values), as is common in ES analyses. The study of values is, as noted previously, difficult and complex for many reasons. These reasons include that scholarly understandings of values are both incomplete and vary by field, and that it is difficult to fully incorporate values into decision-making if researchers, analysts, and decision-makers are not entirely sure what values are or how they operate (Kenter, Bryce, et al., 2016).

The field of CES dips its toes into systematically incorporating these complex and deeply meaningful phenomena into decision-making. This is, to put it mildly, a challenging task. Most of the papers in our study follow what Raymond et al. (2014) call ‘instrumental’ approaches – that is, approaches in which research is done largely independently of decision-makers, then presented to them with the hope, or assumption, that it will be useful. Raymond et al. suggest combining instrumental with ‘deliberative’ approaches that involve decision-makers earlier in the research process. This integration of academic and non-academic actors and approaches is, by many definitions, the defining characteristic of transdisciplinary approaches (e.g. Toomey, Markusson, Adams, & Brockett, 2015). Our review found only a handful of studies (those described in the “Engaged with decision-makers” Results section) that took such an approach.

Recent scholarship related to CES, however, has begun to engage deeply with issues of decision processes, representation, and value elicitation (Kenter, 2016; Kenter, Jobstvogt, et al., 2016). This new research blurs the line between Science, Technology and Society research and more traditional observational, descriptive or experimental social science work that describes human interactions, often at the individual level, and then presents them to decision-makers. This type of research, and the applications with which it intertwines, suggests that our decision-making processes can, and often do, handle more complex interactions than strictly economic-economic comparisons (Cooper et al., 2016). This trend aligns with both longstanding and newly emergent inquiries in policy analysis that describe how policy processes often depend heavily on approaches that are non-systematic (Stone, 2012), performative (Moffitt, 2016) and narrative (Fischer, 2003). Multiple papers we reviewed reached similar conclusions, and propose ways to move CES research towards acknowledging and incorporating this decision-making reality

(Orchard-Webb et al., 2016; Raymond et al., 2014); this suggests that CES research may help the ES field more broadly engage in nuanced ways with political theory, which may in turn have important impacts on decision-making processes.

These suggestions portend a frontier of CES research: using interdisciplinary perspectives to explore the constructed nature of values, and how values impact ecosystem-related decision-making. New approaches in many fields recognize that the separation between value formation, value elicitation, value-related data collection and decision-making can be inexact and fluid. The details depend on scores of factors, including who is involved in those multiple processes and how the processes connect to one another. The CES field must also recognize that the original quantitative and economic orientation of ES research can be difficult to meld with existing approaches that have studied similar issues for decades and contributed deeply to understandings of value, meaning, identity and other themes crucial to CES work. These approaches are rooted in diverse social science fields; cultural geography and the study and valuation of cultural heritage provide two examples (Leyshon, 2014; Tengberg et al., 2012). Relatedly, the tendency in early ES scholarship towards (often quantitative) approaches that entirely separate data collection from decision-making contrasts (often qualitative) approaches that recognize deliberative decision processes as forms of data collection. These deliberative approaches, which posit that value formation and elicitation can be intertwined with decision-making, are increasingly common in ES scholarship and provide intriguing new approaches to transdisciplinary work (Arias-Arévalo, Gómez-Baggethun, Martín-López, & Pérez-Rincón, 2018; Kenter, Jobstvogt, et al., 2016).

The papers we reviewed draw from diverse fields and thus provide solid evidence of the potential for CES to embrace and bring into ecosystem management a wide array of theoretical traditions and intellectual pursuits. Our review suggests that even within the CES field, this expansion to include other perspectives is occurring. Although we did not categorize the primary intellectual fields of authors (partly because it would have been difficult to do so accurately in many cases), we noticed that the diversity of academic fields addressing CES has expanded considerably in the past decade, or even half-decade. In 2012, most collaborations with social scientists in the ES field were with economists (Daniel et al., 2012). Our review of the current literature suggests that CES work now draws from, relates to, and is critiqued by scholars from a wide variety of fields, from critical geography to philosophy. Yet despite involvement from a wide variety of fields, as many of the scholars we review describe, the CES field falls short of adequately incorporating many concerns and approaches that emerge through engagement with these other fields. Many scholars studying CES are, like the authors of this review, scholars who address CES questions from interdisciplinary environmental science or environmental studies perspectives. Deep integration is developing with fields that have for decades, and in some cases centuries, been studying the issues of meaning wrapped up in CES, and we hope to see that development continue. The social values and relational values concepts provide two promising avenues towards this integration (Chan et al., 2018; Kenter et al., 2019).

4.3 | Limitations

Even as we conducted this review, discussions of other forms of value blossomed in the international research and decision-making spheres. This blossoming of concepts relates to a potential limitation of our review: our search term. In our analysis, we reviewed only papers that used the term 'cultural ecosystem services'. We thus only captured variation in value types if researchers explored those other value types under the banner of, or in concert with, the ES framework. We do not systematically address two notable concepts – social values and relational values – that aim to understand meaningful, rich alternative types of value. Social values arose to encompass a diversity of conceptions of value that are not held by or are not primarily relevant to individuals (Kenter et al., 2015, plus see the 2019 Special Feature in *Sustainability Science*). Relational values arose to encompass empirical findings that people's values towards ecosystems do not always separate easily into intrinsic or instrumental value, but that a third class of values – those pertaining to relationships – are also important to human well-being and our relationship to ecosystems (Chan et al., 2016, 2018; Muraca, 2016; Pascual et al., 2017; plus see the 2018 Special Issue in *Current Opinion in Environment and Sustainability*).

Another limitation stems from the fact that academic papers may not provide the forum in which authors discuss relevance to decision-making. Our review concerns only how researchers wrote about decision-making in describing their studies – not whether or how the research impacted decision-making. It is possible that some of the studies we analysed had more connection to decision-making than indicated in the peer-reviewed report. This likely occurred in at least a few cases. Yet given the ES field's orientation towards producing science that is relevant to decision-making (Daniel et al., 2012), we feel that it is likely that most scholars using an ES frame would mention applications of their work to decision-making if they knew about them at the time of publication. A related limitation is that outside the few papers we classified as 'engaged with decision-makers', the papers we analysed rarely specified where they fell (or might fall) within the range of decision-making contexts (e.g. local to global; public to private). Future research could be more intentional about these connections and their specifics; it could explore how decision-makers in various contexts perceive and use a variety of types of CES research.

There are additional reasons that the premise of this study may be faulty. First, the academic context in which much ES research is published is one that prioritizes generalizability and universal applicability; in these venues, it is difficult to publish results about specific places and specific contexts, and much decision-relevant research may occur in these contexts. It is also difficult – and often unrewarded – to publish results that report using (rather than developing) a particular tool. Funding agencies often support the creation of transferable tools. Though tools themselves may be published, we may not have a peer-reviewed record of application of the tools. There is also a pragmatic consideration: publishing in academic journals that are often difficult to access and understand may not be the most effective means to reach decision-makers.

4.4 | Conclusions

A definite trend in many of the papers we reviewed is the call to expand the methods and disciplines at play in the CES field. Many authors call for new frameworks and methods, and stress the importance of multiple and diverse stakeholders. We agree, and suggest that the most important steps forward for these bodies of thought may be inclusivity and creativity – two characteristics that research shows are closely linked (Page, 2017).

Work that aims to meaningfully include culture in ecosystem management decisions is complex, difficult, and arguably constitutes one of the most central efforts humans may make and are making. An effort this rich, and this crucial to our well-being, cannot be constrained by particular disciplines, by methods and techniques that currently exist, or by a limited set of perspectives. It requires a diverse community of researchers and transdisciplinary partners (Barrena et al., 2014) and the innovative thinking these teams can produce. We, and others, see notable progress in this area (Barrena et al., 2014; Chan, Guerry, et al., 2012; Martin-Lopez, Gomez-Baggethun, Lomas, & Montes, 2009; Nahuelhual et al., 2016). We have to combine ideas in new ways, look at existing data with fresh eyes, and garner insights from entities that we previously did not see as data. Perhaps we should get together with a few new colleagues from different backgrounds, take a walk through some trees (which will likely, via a cultural ecosystem service, increase our creative capacity (Oppezzo & Schwartz, 2014)) and then get to it.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTIONS

R.K.G. conceived of the idea for the paper, led database construction and analysis, conducted the statistical analysis and wrote first drafts of the paper's introduction, methods, sections of the results and discussion. J.M. helped to refine the conceptual framework, analysed a third of the articles reviewed, drafted sections of text (notably in the results section), created the final figures and edited the full paper multiple times at every stage. A.A. helped to refine the conceptual framework, analysed a third of the articles reviewed,

drafted sections of text (notably in the results section), created initial versions of the figures and edited the full paper at every stage.

DATA AVAILABILITY STATEMENT

The database we created to record characteristics of the 232 articles analysed is available in the Open Science Framework repository ("Cultural Ecosystem Services and Decision-making", <https://osf.io/24r5k/>, Gould, Morse, & Adams, 2019).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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