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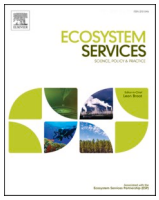

Review Paper

A systematic literature review of non-market valuation of Indigenous peoples' values: Current knowledge, best-practice and framing questions for future research

Ana Manero [a,*], Kat Taylor [a], William Nikolakis [b], Wiktor Adamowicz [c], Virginia Marshall [d], Alaya Spencer-Cotton [e], Mai Nguyen [f], R. Quentin Grafton [g]

[a] Crawford School of Public Policy, The Australian National University, JG Crawford Building, 132 Lennox Crossing, Canberra, ACT 2600, Australia
[b] Faculty of Forestry, University of British Columbia, Forest Sciences Centre 2424 Main Mall, Vancouver, BC V6T 1Z4, Canada
[c] Faculty of Agricultural, Life and Environmental Sciences, University of Alberta, 501 General Services Building, 9007 - 116 St NW, Edmonton, AB T6G 2H1, Canada
[d] School of Regulation and Global Governance, Fenner School of Environment & Society, The Australian National University, B141, B48, B48A, Linnaeus Way, Acton, ACT 2601, Australia
[e] UWA School of Agriculture and Environment, The University of Western Australia, 35 Stirling Highway, Perth, WA 6009, Australia
[f] Crawford School of Public Policy, The Australian National University, JG Crawford Building, 132 Lennox Crossing, Canberra, ACT 2600, Australia
[g] Crawford School of Public Policy, The Australian National University, JG Crawford Building, 132 Lennox Crossing, Canberra, ACT 2600, Australia

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ABSTRACT

Non-market valuation (NMV) can be effective to understand the value people place on ecosystem goods and services for which there are no market prices. Over the last 20 years, NMV has increasingly been applied to Indigenous contexts, albeit with important conceptual and methodological limitations. We conduct a global systematic literature review and detailed meta-synthesis of 63 peer-reviewed studies on NMV research applied to Indigenous peoples' values. Selected studies are categorized by methods, year of publication, geographic area and ecosystem components. Australia (n = 19), the USA (n = 9) and Canada (n = 8) account for over half of all articles. Important knowledge gaps remain in the NMV peer–reviewed literature for other geographic areas. Our taxonomy based on 'whose values' and 'which values' reveals that a large proportion of studies (n = 24) focused on values held by Indigenous peoples, predominately on direct-use values (n = 12) and total economic values (n = 10). Studies based on the general population (n = 17) typically examined altruistic and/or existence values (n = 15). Our analysis identified seven main strategies used by previous studies to overcome critical limitations of NMV when applied to Indigenous peoples' values. Strategies include: (1) engaging directly and ethically with Indigenous peoples; (2) investigating multi-dimensional values; (3) valuing health benefits; (4) adopting non-monetary payment vehicles; (5) using market prices for valuation; (6) sampling the broad population; and (7) investigating non-cumulative values. Based on this review, we provide seven critical questions to guide future NMV research: (1) What is the purpose?; (2) How does Indigenous knowledge inform NMV?; (3) Who benefits?, (4) What ethical frameworks apply?; (5) Whose values are considered?; (6) What is the expected change?; and (7) How are NMV limitations handled? Our contribution provides researchers and policy-makers with the most up-to-date review of the state-of-knowledge and suggestions for best-practice on the use of NMV methods when applied to Indigenous peoples' values.

1. Introduction

Since the 1970 s, environmental economists have been advancing knowledge and methods to assess the monetary value of ecosystem goods and services that are usually not traded in markets – an approach formally known as non-market valuation (NMV) (Flores, 2017). The concept of ecosystem goods and services, and their valuation, is controversial, with critics claiming it may reinforce an exploitative

* Corresponding author.
E-mail addresses: ana.manero@anu.edu.au (A. Manero), katherine.taylor@anu.edu.au (K. Taylor), william.nikolakis@ubc.ca (W. Nikolakis), vic.adamowicz@ualberta.ca (W. Adamowicz), virginia.marshall@anu.edu.au (V. Marshall), alaya.spencercotton@research.uwa.edu.au (A. Spencer-Cotton), nhatmai.nguyen@anu.edu.au (M. Nguyen), quentin.grafton@anu.edu.au (R.Q. Grafton).

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human-nature relationship and one that commodifies the natural world; supporters claim it emphasizes human dependence on nature and the pressing need to protect natural assets (Schröter et al., 2014). Beyond assessment of biophysical elements, the concept of ecosystem services can also be applied to value socio-cultural *relationships* between people and nature (Jackson and Palmer, 2014).

More recently, a growing number of studies has focused on the valuation of natural resources used or relied on by Indigenous peoples (Duffield et al., 2019). Natural resource managers and policymakers - including Indigenous peoples making decisions about Indigenous territories – have used NMV to inform decisions and processes regarding environmental management. These include benefit-cost analysis, impact–benefit agreements, assessment of distributional impacts, compensation for environmental damages, and trade-offs between economic, social and environmental outcomes (Cascadden et al., 2021; Choy, 2018; Plaganyi et al., 2013). NMV has also been proposed as a way to understand Indigenous peoples' values associated with the natural landscapes, and subsequently inform regional or national planning and management policies (Awatere, 2005).

In resource negotiations or advocacy by Indigenous peoples, monetizing non-market damages may help in communication with business stakeholders (McDaniels and Trousdale, 2005), and obtain the necessary information from which legal solutions may be constructed (Graben, 2014). This is apparent in trade-offs and monetary compensation that have been occurring for decades across the world, and which will likely continue into the future (Smith, 2018; Usher, 1976). For instance, in 2019, the High Court of Australia ruled in favor of a AUD $1.3 m compensation to Ngaliwurru and Nungali Peoples (Timber Creek town in the Northern Territory) for 'cultural loss' and 'spiritual harm' resulting from the extinguishment of their native title rights in 2016 (AIATSIS, 2020b). In May 2020, rock shelters in the Juukan Gorge, in the Pilbara region of Western Australia, were destroyed by one of the world's largest mining companies (Marshall, 2020; Wensing, 2020). The destruction raised calls for AUD $135 million in compensation for cultural loss of the site, which had been occupied by humans for over 46,000 years (Turner, 2020).

Despite its potential advantages, several conceptual and methodological limitations may render conventional NMV ineffective, or even unacceptable, in some Indigenous contexts (Adamowicz et al., 2004; Gregory and Trousdale, 2009). Concepts like 'natural resources' or 'ecosystems good and services', can be incongruent with Indigenous peoples' ontologies, which often understand landscapes as living entities, with whom humans hold reciprocal relationships and responsibilities (Poelina et al., 2019). Importantly, the value of such living landscapes is strongly connected to Indigenous peoples' sense of identity, spirituality and culture (Andersen et al., 2012; Moggridge and Thompson, 2021; Satterfield et al., 2013). Thus, value compartmentalization into 'market' and 'non-market' may be perceived as inappropriate and coming from a Western reductionist paradigm (Jackson, 2006; Nikolakis et al., 2013). It is for these reasons that, in certain circumstances, monetization of Indigenous peoples' values may be regarded as unethical, inappropriate or both (Choy, 2018; Daw et al., 2015; Godden, 1999).

We concur with Miller et al. (2015) and Price et al. (2020) that technical and conceptual challenges should not be ignored, but confronted to improve the accuracy and usefulness of NMV for informing environmental policies affecting Indigenous peoples. Otherwise, there is a real risk of either omitting or diminishing Indigenous peoples' values in decisions, or even having their values given an implicit value of zero (Sangha, Stoeckl, et al., 2019). For example, an expert committee responsible for determining forest values in the Niyamgiri hills, India, noted that the site had "incalculable" religious and cultural values for the Dongria Kondh tribe, yet such values were converted to zero in a benefit-cost analysis of impacts resulting from bauxite mining (Temper and Martinez-Alier, 2013). In addition, it has been shown that Indigenous values are often of high interest and attract the willingness-to-pay (WTP) of the general population, which ought to inform public policies related to protection of cultural ecosystem services (Zander et al., 2013). Yet, until now, there has been no comprehensive review of this body of literature, in particular, with regard to handling important limitations of NMV methods in Indigenous contexts. Our contribution is to provide a global, systematic literature review, including a synthesis of the current state-of-knowledge and best-practice recommendations on the use of NMV methods in relation to Indigenous peoples' values.

1.1. Indigenous peoples and values

We note there is no unanimous definition of the term *Indigenous* and that, often – but not always – the term can be used to understand historic and contemporary effects of colonial processes (Arvin, 2015). In this review, we align the term *Indigenous* with the framing underpinning the United Nations Declaration on the Rights of Indigenous Peoples (UN, 2007). We understand *Indigenous* as referring to peoples who are inheritors and practitioners of unique cultures, knowledge and ways of relating to the environment, with ancestral connections to their territories, who often have languages and socio-political systems different to those from the dominant societies in which they live (UN, 2020). It is estimated there are between 375 and 500 million Indigenous peoples worldwide (UNDP, 2019). While only representing five to six percent of the global population, Indigenous peoples officially hold 18 percent of the world's land and lay claim to far more (UNEP, 2017). Globally, traditional Indigenous territories coincide with areas that hold 80 percent of the planet's terrestrial biodiversity (Sobrevila, 2008).

We further acknowledge the existence of other terms such as 'First Peoples', 'First Nations', 'Aboriginal' and 'Native', which often appear in the literature, and whose use may be preferred or inappropriate, depending on the specific context (Younging, 2018). While the aim of this review is to provide a global perspective, where possible, we avoid over-generalizing about Indigenous peoples by providing evidence about specific groups, who have their own history and identity, e.g., *Métis* in Canada (McDaniels and Trousdale, 2005) and *Vezo* in Madagascar (Oleson et al., 2015).

When referring to 'intangible' values, we align our definition with UNESCO's Convention for Safeguarding of the Intangible Cultural Heritage (UNESCO, 2003). This includes ancestral traditions or living expressions, such as oral literature, performing arts, social practices, rituals, festive events, knowledge and skills. In many Indigenous ontologies, such intangible values are strongly associated with local ecosystems holding a cultural and spiritual (even religious) importance, beyond its bio-physical elements. For example, the Ktunaxa Nation in British Colombia (Canada) regard their territory as home to Grizzly Bear Spirit (Qat'muk), to which cosmological knowledge and religious activities are attached (Supreme Court of Canada, 2017).

1.2. Existing guidance documents

From a global perspective, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) have provided guidance for the assessment of the multiple values of nature and its benefits to people, in accordance with internationally recognized rights of Indigenous Peoples, and relevant commitments to local communities (IPBES, 2016; IPBES, 2017). While IPBES does not provide

specific guidance on the practical application and limitations of NMV, it offers useful advice on scoping and engagement with Indigenous Peoples and local communities. According to IPBES, valuation should clearly identify the types of values being assessed, the scale of the values in the landscape, the appropriate social engagement processes and the practical considerations of available time, costs, and effort to undertake the valuation (IPBES, 2016; IPBES, 2017).

Further guidance exists, within specific national contexts. Guidance on the valuation of American Indian land and water resources, issued in 2002 by the US Department of the Interior, had a strong focus on the consideration of the worldview within which the values are held (Hammer, 2002). The guidebook provides valuable insights for improving survey design and data collection with Indigenous peoples. Recommendations for valuation of Indigenous peoples' values are also discussed by Farr et al. (2016), within the specific context of northern Australia. Where traditional neoclassical approaches are not suitable, the authors propose alternative methods to understanding Indigenous peoples' values, including 'life satisfaction' approach, cognitive mapping and multi-metric measures using subjective scaling. Similarly, through the use of qualitative research (semi-structured interviews and participatory mapping), Bélisle et al. (2021) developed a 'landscape valuation framework' that corresponds with the values and perspectives of First Nations in boreal Quebec, Canada. Further, Choy (2018) proposes a holistic value assessment approach, which is informed by relational and non-market values held by the Indigenous people of Sarawak, Malaysia.

A broad set of literature exists on the understanding and recognition of environmental values that are particularly important for Indigenous peoples and, in certain cases, for local communities too (Austin and Drye, 2011; Cuni-Sanchez et al., 2016; Fish et al., 2016; Fraser et al., 2016; Giuliani et al., 2012; Jackson and Barber, 2013; Moggridge and Thompson, 2021; Reyes-García et al., 2019; Richards, 1997; Sangha, Russell-Smith, et al., 2019; Schnegg et al., 2014; Sheil and Wonder, 2002; Tengberg et al., 2012; UNEP, 2017). However, as recently noted by Duffield et al. (2019), there is limited literature providing specific guidance for doing NMV of Indigenous peoples' values (one exception being Venn and Quiggin, 2007).

1.3. The limitations of conventional NMV methods within Indigenous contexts

Conventional NMV approaches entail important data collection and methodological challenges in their application to Indigenous peoples and their values (Adamowicz et al., 2004; Gregory and Trousdale, 2009; Price et al., 2020). Such challenges are particularly problematic in stated preference (SP) methods, such as contingent valuation (CV) and discrete choice modelling (DCM), which aim at estimating economic values through responses to survey questions - often under hypothetical situations that may be disconnected from reality (Johnston et al., 2017). Below we outline key limitations found in the literature and provide a summary in Table 1.

First, Indigenous peoples' values associated with the environment are typically relational, meaning that benefits to humans are imbedded in desirable relationships including those between humans and non–human nature (Gould and Schultz, 2021; Himes and Muraca, 2018). In a certain way, 'relational values' constitute a departure from common value classifications, like Total Economic Value (TEV) framework (Fig. 1). According to the TEV concept, economic values over goods and services can be classified into *use values* (*direct and indirect*) and *non-use* or *passive use values* (*altruism, bequest* and *existence*) (Segerson, 2017). Values associated with future uses that are currently unknown (e.g., future discovery of medicinal plants), are referred to as *option values,* which reflect the value of preventing irreversible damages (Baker and Ruting, 2014).

In many Indigenous ontologies, humans' relationships with the environment are not reducible to a use or service ('gaining from nature'), but are fundamental for one's identity ('living for nature' and 'living in nature') (Arias-Arévalo et al., 2018). The pluralistic and relational nature of Indigenous peoples' values means that, from an ontological and ethical perspective, it is problematic (if not unacceptable) for such values to be considered separately from and traded-off against each other (Daw et al., 2015). This is particularly important in discrete choice modelling, where survey respondents are asked to consider trade-offs between non–monetary attitudes that are seemingly independent under a 'Western' worldview (for example between environmental and social objectives), but that may be inseparable according to Indigenous ontologies (Venn and Quiggin, 2007).

A second limitation of NMV methods is the lack of substitutes for sacred goods and services, making it difficult or impossible to establish

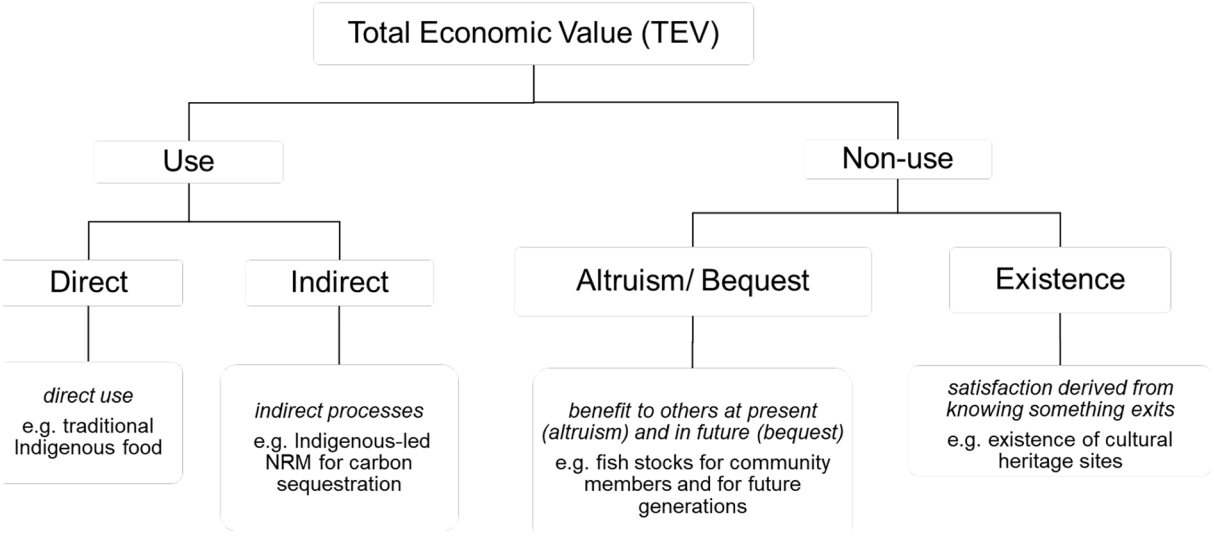

Fig. 1. Total Economic Value (TEV) Framework and examples related to Indigenous peoples' values.

trade-offs – an integral part of many NMV techniques (Adamowicz et al., 1997; Venn and Quiggin, 2007). In addition, certain trade-offs that pit sacred values against other sacred values can be considered as 'taboo': morally unacceptable choices that make respondents uncomfortable (Daw et al., 2015). Another challenge in the design of NMV models is the selection of an appropriate payment vehicle (Casey et al., 2008). Cash may be relevant for people living within a market economy - which is the case for many Indigenous peoples - but for those operating within customary economic systems, other payment vehicles may be preferred (Awatere, 2005).

Utility theory (Thurstone, 1927) underpinning some NMV methods assumes that individuals make choices in order maximize their individual utility (i.e. satisfaction). In its general form, utility maximization assumes that individuals prefer more consumption of goods and services than less (Adamowicz et al., 1998). Conversely, when individuals are likely to follow alternative rationales for making choices, the utility maximization assumption is challenged (Bockstael and McConnell, 2007). In some Indigenous cultures, personal accumulation of goods is disfavored beyond a certain threshold, while ever-increasing amounts of certain environmental attributes may not be relevant or desirable (Adamowicz et al., 1998).

Conventional survey methods, such as those eliciting personal information, may be inappropriate or irrelevant if they do not respect Indigenous peoples' intellectual property rights. Hence, access to cultural and ecological knowledge can be restricted and should not be sought by researchers. Moreover, Indigenous peoples may rightfully object to participate in research for many reasons (Tuck and Yang, 2014). For example, if an environmental management process frames Indigenous people as 'one of many stakeholders', this can be inconsistent with Indigenous views of sovereignty and territorial rights (Gregory and Trousdale, 2009). Furthermore, NMV may be unfeasible from a statistically standpoint, given that such methods typically require large sample sizes (hundreds of respondents) for analytical precision and validity of results (Boyle, 2017). Some Indigenous communities may be too small in size or the response rate may be too low to yield sufficient responses for adequate statistical analysis.

Importantly, heterogeneities among Indigenous peoples (e.g., language groups, gender, income or generation) may pose significant difficulties in aggregating responses (Andersen et al., 2012; Venn and Quiggin, 2007). Further, communal property rights among Indigenous peoples may preclude NMV approaches that assume individual utility structures (Adamowicz et al., 1997; Nikolakis et al., 2016). Common NMV methods reliant on aggregation of individual responses may fail to recognize how community member perceive collective benefits or impacts associated with changes in their ecosystems. Finally, integration of Indigenous and non-Indigenous values can be problematic given differences in perceptions, currencies used, political structures and incomes levels (Adamowicz et al., 1998).

Table 1
Summary of limitations of conventional NMV techniques.

Main limitations	Specific limitations†
Definition of non-market values and trade-offs	Value classification frameworks may be inadequate for relational values Lack of substitutes for revered goods and services Inappropriate monetary payment vehicles Individual utility maximization assumptions may not apply
Data collection	Potentially inappropriate survey methods
Aggregation of responses	Aggregation of individual responses regarding collective values Integration of Indigenous and non-Indigenous values

†Source: adapted from Adamowicz et al. (1998) andVenn and Quiggin (2007)

1.4. Aims and scope of the study

The specific objectives of this systematic literature review include: (1) characterizing the non-market valuation literature depending on *whose* and *which* values have been studied, and by method, geography and ecosystem components; (2) review limitations of conventional NMV and discuss strategies to overcome such limitations; and, (3) reflect on possible ways forward for NMV, prioritizing ethical considerations as the foundations for best-practice. The scope of this literature review is limited to Indigenous peoples' values associated with 'natural resources' or 'ecosystem goods and services'. Thus, our study excludes research on constructed heritage values, such as ancient temples (e.g., Tuan and Navrud, 2007).

We review the peer-reviewed literature to gain insights on conceptual and methodological questions, as well as to draw lessons from best-practice. We choose to limit our meta-search to the peer–reviewed literature for its merit in being transparent and replicable, as well as yielding a manageable set of results, the validity of which has been scrutinized through the peer-review process. Nonetheless, we acknowledge the existence of potentially relevant studies in the grey literature (e.g., Andersen et al., 2012; Awatere, 2005; Dikgang and Muchapondwa, 2013) and the inherit bias in restricting meta-analyses to peer-reviewed studies (Mathur and VanderWeele, 2021).

We also acknowledge the existence of a large body of literature on values associated with the environment, Indigenous Peoples and Local Communities. Here, we examine a subset of this NMV literature that specifically addresses Indigenous Peoples' values through quantitative, monetary estimates. While this is only a subset of all the existing knowledge, it is an important component that can inform decision–making processes, such as frameworks to determine water or land use policies.

We do not aim to report or discuss monetary figures provided in previous studies. We do this for several reasons, in line with best-practices for meta-analysis in environmental and natural resource economics (Nelson and Kennedy, 2009). First, we question whether a monetary meta–analysis fits with the problem definition. We conclude that a monetary meta-analysis of Indigenous values, by itself, would not advance knowledge on current conceptual and methodological limitations. Second, a hypothetical monetary meta-analysis would be severely hampered (if not impeded) by "factual and methodological heterogeneities" across the reviewed studies (Nelson and Kennedy, 2009, p. 348). These include, but are not limited to differences in Indigenous ontologies, values assessed, surveyed populations and monetization methods. Thus, we contend that a report and meta-data of monetary results from previous studies is best addressed in a separate study. Finally, we warn against the use (and abuse) of meta-data in benefit transfer studies, which aim to use existing data to draw monetary estimates in new contexts (Rosenberger and Loomis, 2017). While best-practices can be followed in benefit-transfer studies (e.g. Akter and Grafton, 2010; Richardson et al., 2015), re-use of monetary information may be inappropriate for Indigenous values, given the large differences across Indigenous peoples, and the ethical mandate to safeguard Indigenous intellectual property rights.

Our paper is structured as follows. The *Protocol for systematic literature review* section explains the protocol and selection process for the systematic literature review. The *Results* section provides an overview of the characteristics of the selected studies and then the findings of the meta-synthesis in response to our research question, i.e., how do reviewed studies handle limitations of NMV for Indigenous people's values. In the *Discussion*, we examine the implications of our findings and provide recommendations for future research. In the *Conclusions*, we summarize our findings and offer our advice for future NMV research.

2. Protocol for systematic literature review

Our systematic literature review was completed in the form of a

state-of-the-art review, which sought to understand the current state of knowledge, and offer insights for future research (Grant and Booth, 2009). We also conducted a meta-synthesis to identify commonalties across primary studies in order to answer our research question on ways to overcome key limitations (Levitt, 2018). To define the main steps in our review, we drew from theoretical frameworks for systematic literature reviews (Haddaway et al., 2020; Koutsos et al., 2019; Martín-Martína et al., 2018; Timulak, 2014), as well as recent, high-quality examples (Brisbois and de Loë, 2016; Markkula et al., 2019; Mengist et al., 2020; Rakotonarivo et al., 2016). We followed six steps, as summarized in Fig. 2 and described below.

First, the *scoping and definition of the protocol* phase consisted of defining our research question, searching for previous systematic reviews and identification of the search terms. We did not find any previous systematic reviews of non-market valuation studies, specifically and critically addressing Indigenous values. Farr et al. (2016) conducted an international review on valuation literature, but only four out of 127 reported studies applied NMV to monetize Indigenous ecosystem-related

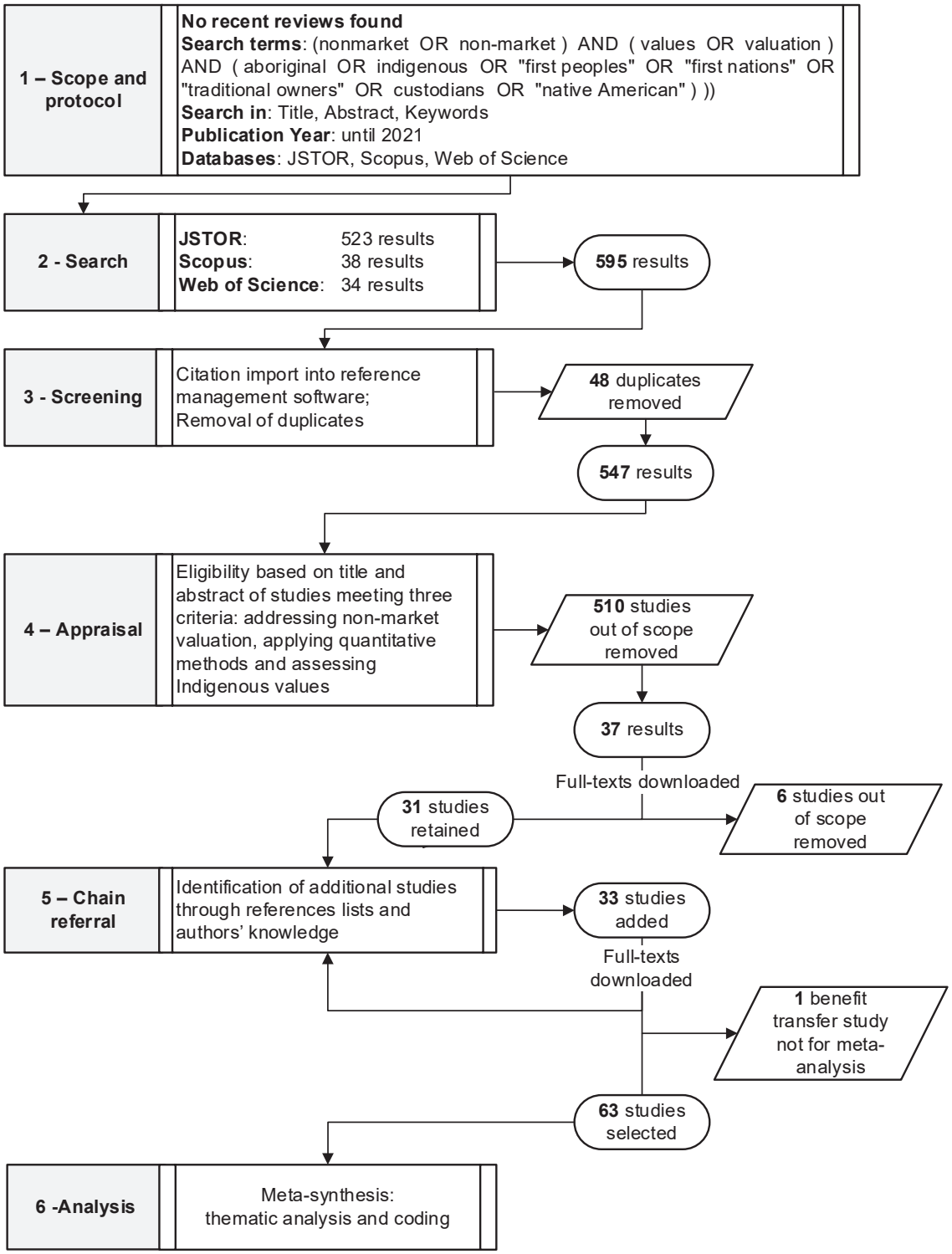

Fig. 2. Overview summary of the literature search and article selection process.

values. Noonan (2003) carried out a review of contingent valuation studies on cultural resources (such as archeology, the arts and historical sites), which excludes other NMV methods and does not explicitly identify Indigenous values. Blackwell et al. (2019) undertook a literature review of the commercial or market value of Indigenous Knowledge, but not those broadly related to 'natural resources'. Milcu et al. (2013) reviewed the literature on cultural ecosystem services (including spiritual, cultural, bequest, intrinsic and existence values), but did not address specific issues on NMV or Indigenous peoples' values.

Our search keywords were informed by preliminary review of the literature and the authors' expert knowledge. We used the following combination of terms and Boolean operators: (nonmarket OR non-market) AND (values OR valuation) AND (Aboriginal OR Indigenous OR "First Peoples" OR "First Nations" OR "Traditional Owners" OR custodians OR "Native American"). We tried variations of this string, but found alternative combinations to be less accurate, yielding up to thousands of studies, the vast majority of which were unrelated to our research question. Our search was limited to peer-reviewed journals. We did not set restrictions based on the year of publication to uncover possible trends and insights from early works in the field. To avoid overlooking studies from non–English speaking regions, we set no exclusion criterion based on language or geographic area. The systematic scoping and search tasks were undertaken in October 2020 and, therefore, do not identify studies published beyond that date.

Second, during the *search* step, we applied the defined protocol to studies' title, abstract and keywords, using JSTOR, Scopus and Web of Science Core Collection. We also ran the search in Google Scholar, which yielded over 13,400 of studies. Upon examination of the Google Scholar results, we found that, while some results included relevant search terms, the vast majority did not follow the Boolean logic inputted. Among the first 200 Google Scholar results, we found no relevant studies for our research, in addition to those found in the other three databases. Given the very high volume of out-of-scope results, we concluded that Google Scholar would not be included in our systematic review. Thus, our computerized search resulted in 595 results. To account for relevant studies that may have been missed, we conducted a thorough chain-referral process in step 5.

Third, in the *screening* step we exported the search results (n = 595) into the reference management software Mendeley and removed duplicates (n = 48). In the fourth step, *appraisal*, we assessed eligibility of studies (n = 547) based on title and abstract. Guided by our research questions, we only selected studies (n = 37) that fulfilled all of the following three criteria: addressing non-market valuation, applying quantitative methods and assessing Indigenous peoples' values. The rest (n = 510) were removed for being out of scope. The *appraisal* step revealed a body of literature focused on farming communities in Latin American, Africa, Asia and the Middle East. Although these populations were not always referred to as *Indigenous*, we decided to include these studies in our literature review given the importance of vernacular values for our research question (Tilley, 2010) and their ancestral ties to the natural environment, often through provisioning ecosystem services, such as woodfuel, shelter or subsistence food, or cultural services, namely traditional and spiritual values (Baker et al., 2019; Oleson et al., 2015; Shyamsundar and Kramer, 1996).

Indigenous Peoples and Local Communities often appear in the literature under the acronym IPLCs, defined conjunctively as ethnic groups descending from and identifying themselves with the original inhabitants of a certain region (Posey and Dutfield, 1996; Reyes-García et al., 2019). We repeated the systematic search including the terms IPLC and IPLCs, but this protocol did not yield any new eligible studies that had not been previously identified following Steps 1–4 (Fig. 2). Thus, full–texts were downloaded for those studies selected during the appraisal step (n = 37). While reviewing full texts, six (n = 6) studies were removed, as they did not meet our three eligibility criteria: addressing non-market valuation, applying quantitative methods and assessing Indigenous peoples' values.

In the fifth step, *chain-referral,* we searched for additional eligible studies by checking reference lists in already selected studies (n = 31), and through the authors' own knowledge. The chain referral process resulted in a relatively high number of additional studies (n = 33), more than doubling our final selection. We propose that relevant papers not being found in the computerized search was due to: i) an inconsistent use of terminology across NMV studies and, ii) the non-inclusion of Indigenous terms in searchable parts of published articles. For instance, studies using terms specific to their method (e.g., choice experiments or stated preferences, instead of 'value' or 'valuation') would not be returned by our computerized search. Further, studies examining Indigenous peoples' values, but not as the main focus of the research, (e.g. as one of many attributes in a choice experiment) may not refer to these values in the title, abstract or keywords, thus rendering the paper 'invisible' to the computerized search. Upon reaching this conclusion, we revised the search protocol to include more specific terms, but this resulted in tens of thousands results from all possible combinations of terms, thus rendering detailed, systematic analysis of each study impossible. The chain referral process was stopped as the results reached the point of data saturation, where the new studies repeated themes and learnings identified hitherto (Saunders et al., 2018). One study (Ulibarri and Ulibarri, 2010) used the benefit transfer method to estimate the value of petroglyph heritage site in the USA. Because two of the three primary studies were already included in our review (Boxall et al., 2003; Rolfe and Windle, 2003), we removed this benefit transfer study (Ulibarri and Ulibarri, 2010) from our classification and analysis to avoid double-reporting.

The sixth and final step in our systematic literature review was the *analysis* of selected studies (n = 63), which is reported in the *Results* section. While we acknowledge that these results may not cover all the existing information on quantitative NMV studies of Indigenous peoples' values, we contend that our review provides the most comprehensive state-of-the art analysis to date.

In our meta-synthesis, we conduct thematic analysis to categorize and summarize key concepts in the data set that help answer our research questions (Ayres, 2008). For our classification questions (i.e. *whose values?, which values?*), specific statements found in reviewed papers were categorized into common themes (i.e. codes), following the process of thematic mapping (Creswell, 2017). The Computer Assisted Qualitative Data Analysis Software (CAQDAS) NVivo was used in the meta-synthesis, given its ability to support classification of documents, thematic mapping and annotation (Dalkin et al., 2021).

3. Results

In this section, we provide an overview of the reviewed studies, starting with a description of the general characteristics by geographic area, ecosystem components, research methods, publication year and venue. Then, we present a classification and discussion according to two key questions: *Whose values?* and *Which values?* are addressed in each study. In the Supplementary Materials, we provide a full database, where the 63 reviewed studies are classified according to each of the abovementioned characteristics and questions. Finally, we answer the question: *How have NMV studies addressed key limitations of conventional methods?*

3.1. Summary of the characteristics of the reviewed studies

Our systematic literature review resulted in the selection of 63 peer-reviewed studies published across 39 journals, covering environmental science, environmental economics, land policy, water management, as well as other disciplines. *Ecological Economics* (n = 11), *Ecology and Society* (n = 5), *Ecosystem Services* (n = 3) were the most common publication venues, while the other 36 journals only yielded one or two studies each.

The reviewed studies emerged from 22 different countries, with

Australia (n = 19), the USA (n = 9) and Canada (n = 8) accounting for over half of all articles (Table 2). No other country was found with such a high number of studies, with the next most numerous one being Madagascar (n = 3). Two articles were found for each of Brazil, Honduras, Nepal, Nicaragua and South Africa, while only one emerged from each Chile, Colombia, Costa Rica, Ecuador, Ethiopia, Fiji, Honduras, India, Jordan, Kenya, Mexico, Nepal, New Zealand, Nicaragua and Spain. We found no study that included more than one country. For ease of presentation, in Table 2, we have grouped studies by geographic region, except for the three countries yielding a disproportionality large number of studies.

The high concentration of studies from Australia, the USA and Canada may be a result of the recent increased attention from researchers and policy-makers (Jackson and Barber, 2013), as well as common law and growth of Indigenous peoples' rights in these countries (Nikolakis et al., 2019). Further, such skewedness may be a reflection of systematic flaws in publication processes, including unconscious bias by reviewers in rating studies from low-income countries (Harris et al., 2017). In addition, because many peer-reviewed journals only accept articles written in English, works from non-Anglophone regions may remain unpublished, unless research teams are able write in English, or pay for manuscript translation (Angulo et al., 2021).

In terms of classification by ecosystem component, *forests* is the most common theme (n = 21), including one or several of the following aspects: timber, firewood, native plants, wildlife, wild foods, shelter, agroforestry enterprises, water protection, carbon sequestration, aesthetics and traditional tribal culture. A common trait across most forests studies in Africa, Asia and Latin America is their focus on direct-use values, such as non-timber forest products (Campbell et al., 1997; Murthy et al., 2005; Shackleton et al., 2002) and conservation/afforestation (Allen and Colson, 2019; Dikgang and Muchapondwa, 2012; Plumb et al., 2012). While these studies acknowledge other intangible benefits, such as spirituality or continuity of ancestral cultures, these are not specifically accounted for in the valuation. Conversely, forests studies in Canada (Adamowicz et al., 2004; Nikolakis et al., 2016; Spyce et al., 2012) explicitly note existence and cultural values of forests, in addition to their material importance. One Australian study (Griffiths et al., 2003) estimated the economic value of a rainforest tree species commonly used for sculpture in Aboriginal art industry.

Freshwater is the second most common ecosystem component (n = 15), with almost half of the *freshwater* studies being located in Australia. Out of these, five studies use a common attribute in their choice experiments: the number of important waterholes for Aboriginal peoples that are protected. These studies emerged from two surveys: one in relation to groundwater in the Pilbara region of WA (Hatton MacDonald et al., 2019; Legg et al., 2020) and one focused on Australia's northern tropical rivers (Zander et al., 2010; Zander et al., 2013; Zander and Straton, 2010). Other freshwater values found in Australian and the USA are: cultural and spiritual values (Armatas et al., 2018; Jackson et al., 2019; Mueller et al., 2017), customary fishing (Duffield et al., 2019; Jackson et al., 2012) and affordable hydro-electric power (Jones et al., 2016).

Biodiversity studies (n = 10) across multiple geographies have estimated values placed on diversity of plant and animal species, for food (Arslan and Taylor, 2009; Barrena et al., 2014; Golden et al., 2014; Scarpa et al., 2003; Usher, 1976) and conservation purposes (Carson et al., 1994; Hoyos et al., 2009; Zander and Garnett, 2011).

We found eight studies assessing use and non-use values derived from coastal territories and marine resources, such as fish. The heading *Coasts* in Table 2, captures these studies, most of which emerge from Australia (Sangha, Stoeckl, et al., 2019; Spencer-Cotton et al., 2018; Windle and Rolfe, 2005) and the USA (Duffield, 1997; Duffield et al., 2014, 2021), with only one from Madagascar (Oleson et al., 2015) and one from Fiji (O'Garra, 2009).

We have grouped under *Culture* a suite of studies (n = 6) that refer to Indigenous values in generic terms linked to culture, such as "Aboriginal sites" (Gillespie and Bennett, 2012; Gillespie and Kragt, 2012; Rolfe and Windle, 2003); "Native American Culture" (Carson et al., 2020); or "Indigenous social and cultural losses"(Gregory et al., 2020); as well as those studies explicitly investigating the value of cultural artefacts, such as petroglyphs (Boxall et al., 2003). Finally, a small group of studies (n = 4) addresses the values associated with Indigenous territories in a holistic way, without necessarily distinguishing between land, water, biodiversity or other ecosystem components (Campbell et al., 2011; McDaniels and Trousdale, 2005; Sangha et al., 2017; Zander et al., 2013). For this category (three Australian studies and one Canadian), we adopt the Aboriginal Australian term *Country*, which is recognized as an animate, relational entity (Poelina et al., 2020) and that exists intertemporally such that it connects the past to the present and to the future. In Aboriginal English, the word *Country* refers to a place providing a sense of belonging to a certain identity group, who both care for and are also cared for by their Country (Redvers et al., 2020).

Across all publication years (Fig. 3), and particularly since the late 2000 s, stated preference discrete choice modelling has been the most commonly used method (n = 28). By contrast, early NMV studies of Indigenous peoples' values used contingent valuation and, separately, pricing approaches. Overall, contingent valuation is the second most applied method (n = 12), together with market prices (n = 12). A recent resurgence in equivalency analysis (n = 4) is observed, after 20 years since its first application to the estimation of compensation for Indigenous losses (Duffield, 1997). Replacement cost methods (n = 3) have been applied to traditional foods, although the estimates do not reflect intangible values associated with customary hunting and fishing. A small body of work has employed other methods (n = 4), such as travel

Table 2
Number of studies by region and ecosystem service/feature (light to dark cell shading indicates relative number of studies).

	Geographic area							
	Africa	Asia-Pacific (excl. Australia)	Australia	Canada	Latin America	Middle East-Europe	USA	Total
Biodiversity	3		2	1	2	1		**9**
Coasts	1	1	3				3	**8**
Country			3	1				**4**
Culture			3	2			1	**6**
Forests	4	2	1	4	9		1	**21**
Freshwater		2	7		1	1	4	**15**
Total	**8**	**5**	**19**	**8**	**12**	**2**	**9**	**63**

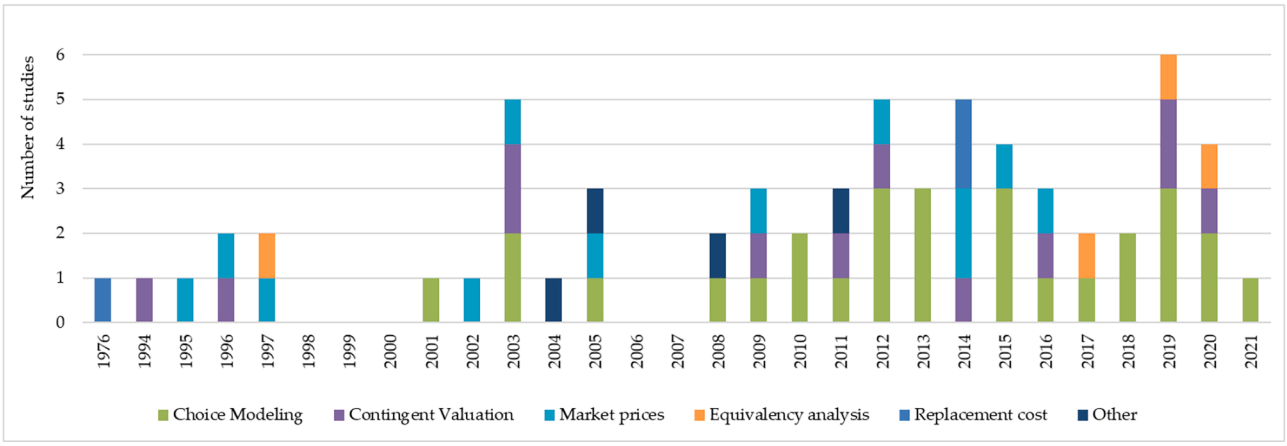

Fig. 3. Number of studies by method and publication year.

costs, public savings from improved health and joint production economics.

3.2. Taxonomy of the reviewed studies

Out of the 63 reviewed studies, 44 examined Indigenous peoples' values as the core aim of the research, while the remainder considered their values as one component part of a broader analysis (see Supplementary Material). A clear distinction also exists in the studies depending on who the value holders are (Fig. 4). In 24 studies, the value holders were Indigenous peoples reflecting on their own values. Half of these (n = 12) focused on *direct* uses, such as fishing, hunting and use of forest products, which in many cases comprise both consumptive (e.g., food) and non-consumptive (e.g., culture) uses. A smaller group of studies (n = 10) aimed at estimating the Total Economic Value (TEV), including both *use* and *non-use* values. For example, Gregory et al. (2020) estimated compensation for Indigenous losses considering multiple attributes such as health, social cohesion, knowledge, incomes and access to significant places. Further, two studies were found focusing on *bequest* values held by Indigenous peoples associated with preserving customary fishing for future generations.

Twenty-two of the 63 reviewed studies surveyed the local population, comprising both Indigenous and non-Indigenous residents. In these cases, the predominant focus was the *direct* use of agricultural (n = 5), forest (n = 4) and wetland (n = 1) products. Interestingly, three studies (in Ecuador, Honduras and Mexico), assessed agro-forestry products, both for the market value as cash crops and their *non-use* values. These included cultural significance of traditional maize varieties in Mexico (Arslan and Taylor, 2009), maintenance of *Miskito* identity in Honduras (Plumb et al., 2012) and preservation of native plants and animals for their "beauty" in small–scale cacao agroforests in Ecuador (Blare and Useche, 2015). Further, *indirect uses* were the focus of two studies that examined willingness to accept payment for ecosystem services. In four other studies, the *use* or *non-use* facet of the values depended on each respondent's view point, given that the same survey instruments were used for Indigenous and non-Indigenous respondents (see further detail

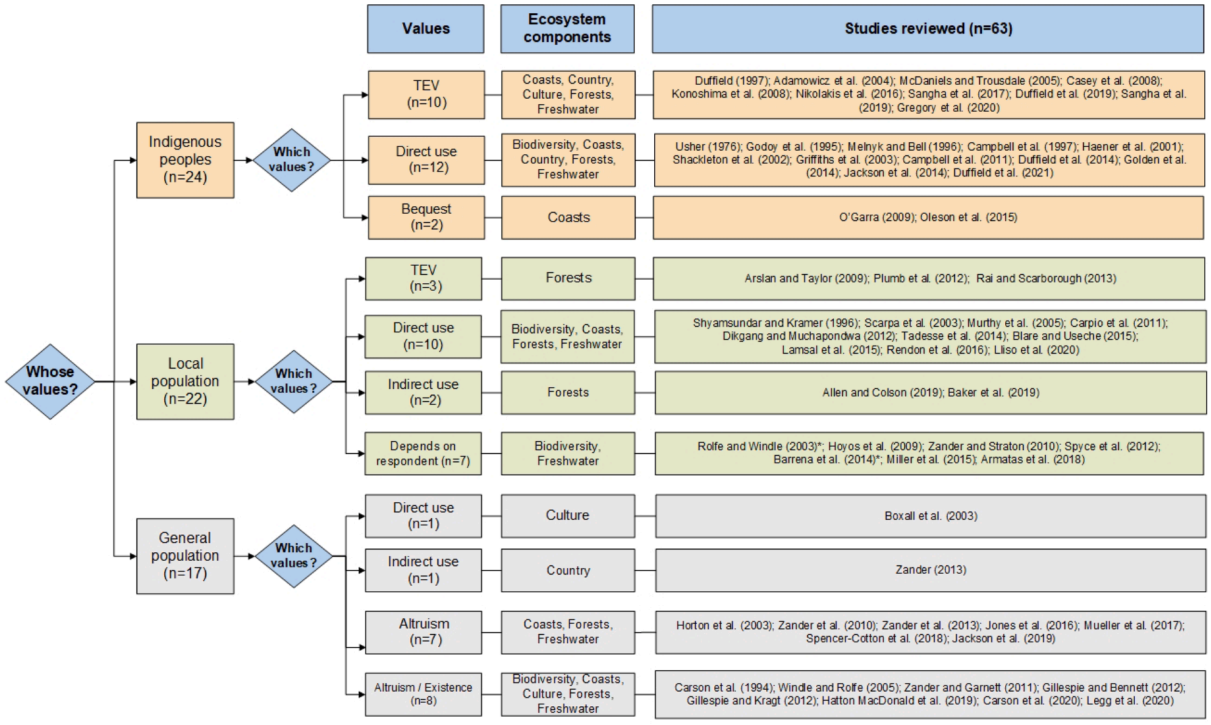

Fig. 4. Taxonomy of the reviewed studied by population of value holders and types of values.

in the last paragraph of Section 3.3).

A relatively large body of literature (n = 17) focused on the values held by non-affected individuals, including the general population of the country in question or populations in urban areas distant from where the Indigenous values emerge. These studies did not exclude Indigenous perspectives, as Indigenous peoples are part of the broad populations who were surveyed. However, Indigenous participants in these studies were not directly affected by the environmental changes investigated because they did not have a connection to the area in question. Only one study (Zander, 2013) surveyed the general population regarding the *indirect* benefits they would derive (e.g. biodiversity and reduced greenhouse gas emissions) from ecosystem services provided through Indigenous-led programs. Altruistic values (i.e. personal satisfaction derived from the benefit provided to Indigenous peoples) were the focus of seven studies, while a larger number (n = 8) appealed to a combination of altruistic and existence values (i.e. personal satisfaction derived from knowing that cultural heritage places continue to exist). Some surveys of the general population (e.g., Gillespie and Kragt, 2012; Rolfe and Windle, 2003) asked respondents about their preferences regarding Indigenous heritage sites, without detailing whether the sites in question were (or not) used by Indigenous peoples and to which degree they were accessible by others. In such cases, we cannot discern whether respondents reflected on their altruistic or existence values, or a combination of the two.

Across the reviewed studies, we did not find mention of different forms of altruism and their implications. *Paternalistic altruism* refers to the situation where an individual is concerned with someone else's consumption of a particular good or service, irrespective of the beneficiary's preference (Flores, 2002). The altruist may even be selfish about the means whereby others derive their welfare (Vázquez Rodríguez and León, 2004). By contrast, *pure (or non-paternalistic) altruism* occurs when an individual values the welfare of another, irrespective of how the level of welfare is obtained (Jones-Lee, 1992). The distinction is important given that both pure and paternalistic altruism can be problematic for different reasons. As a general rule, pure altruism should not be taken into account in benefit-cost analysis as its inclusion would lead to double counting of the benefits (Johansson, 1992). Concerns around self-determination and sovereignty may be raised when NMV of Indigenous peoples' values is based on non-Indigenous paternalistic altruism. This is because paternalistic altruism is determined by the altruist's preferences, and not the choices of the beneficiaries (Flores, 2002).

3.3. How do reviewed studies handle limitations of NMV for Indigenous peoples' values?

Among the reviewed studies, many limitations of conventional NMV methods applied to Indigenous peoples' values (see Section 1.2) were avoided by not targeting Indigenous respondents, but instead surveying the general population (n = 17). Surveying those who are not directly affected by the environmental change has the advantage that it may provide information about existence and altruistic values, often widespread among the general population. Further, investigating national WTP for ecosystem goods or services may serve to address the question of 'free-riding', whereby the wider population benefits from *indirect* uses (e.g. conservation or carbon sequestration) derived from ecosystem goods and services 'cared for' by Indigenous peoples (Zander, 2013). Nevertheless, only sampling the wider population raises concerns in relation to paternalistic and non–paternalistic altruism, which should be considered in stated preference studies (Vázquez Rodríguez and León, 2004). Another limitation of only sampling the wider population is the likely mischaracterization or underestimation of Indigenous values, given differences in rights, interests and power of Indigenous and non–Indigenous peoples (Gratani et al., 2016).

Among those studies centered on the affected Indigenous population (n = 24), purposeful sampling was a common approach to engage with a particular sub-set of the population. These included, for example, those individuals who are responsible for decision-making (Duffield et al., 2021) or more likely to be interested in the survey (Jackson et al., 2014). Thus, this approach may not be concerned with the general lack of willingness to participate when methods are deemed inappropriate. Nevertheless, there is a risk of overlooking important heterogeneities within the local Indigenous population by gender, generation, incomes level, social status or land tenure (Rendon et al., 2016). For example, men and women may be affected differently by ecosystem losses, as their roles in ecosystem-based livelihood activities may vary (Blare and Useche, 2015). This may also be true for the poorer members of the local groups, who may have a greater dependence on ecosystem services, but who may be excluded from decisions on common resources (Tadesse et al., 2014).

In the remainder of this section, we provide commentary on specific studies and how they responded to key limitations. It is not our goal to critique all the literature for its efforts in NMV of Indigenous peoples' values. Rather, our aim is to draw attention to a selection of practices that we consider are methodological and conceptual advances. Thus, in Table 3, we summarize key limitations and possible strategies to overcome them, alongside featured examples drawn from our systematic literature review. Ultimately, Indigenous peoples are diverse and, thus, limitations and recommendations may or may not be relevant to each specific context (Spyce et al., 2012).

3.3.1. Value classification frameworks may be inadequate for relational values

As Indigenous peoples are the experts about their value systems, co-designed research can improve the validity of the method and meaningfulness of results. For example, following a series of workshops with *Métis* community members in Canada, McDaniels and Trousdale (2005) identified four fundamental values that had been reportedly impacted by oil exploration: traditional, bush, community and economic values. The careful engagement approach served to create a multi-attribute value index, where different values were assigned different weights. Similarly, Gregory et al. (2020) estimated the total compensation owing to two *Dene Nations* (Canada) through a multi-dimensional approach, where relative weights were attached to losses of health, societal connection, knowledge, livelihoods and access to places. Further, Adamowicz et al. (2004) and Nikolakis et al. (2016) directly engaged with *Métis* and *First Nations* members in Canada, to better understand their multiple forest values.

A group of studies have used generic definitions of the ecosystem services being investigated, without detailing the environmental change and what this change meant for the affected Indigenous populations. Examples include "waterholes culturally important to Aboriginal people" (Hatton MacDonald et al., 2019; Legg et al., 2020; Zander et al., 2013) or "Aboriginal heritage sites" (e.g., Gillespie and Kragt, 2012); Rolfe and Windle (2003). Generic attributes may accommodate a large portion of the general population who are likely remote and unfamiliar with the Indigenous values they are surveyed about (Legg et al., 2020). At the same time, there is a risk that less than precise terms or definitions fail to convey the depth, richness and complexity of the values associated with these places. Idealliy, details about the environmental changes and their significance should be explained in the contextual information provided to respondents, as part of the questionnaires.

3.3.2. Lack of substitutes for revered goods and services

Where no substitutes exist for revered goods or services, difficulties in eliciting respondents' preferences may be circumvented by comparing two real settings where part of the population has access to the revered goods or services in question, while the other segment does not. This approach was applied in a remote community in Arnhem Land (Northern Territory, Australia) by Campbell et al. (2011), who compared physical health outcomes experienced by Aboriginal Australians participating in 'Caring for Country' activities with those who did not. Such activities included spending time on Country, controlled grass

Table 3
Summary of limitations, possible methodological approaches and selected examples.

Main limitations	Specific limitations	Approaches to overcome limitations						
		Board-based or Multi-dimensional values	Health benefits	Non-monetary payment vehicles	Market-based pricing of consumable goods	Sample broad population	Bequest values	Direct, ethical engagement with Indigenous peoples
Definition of non-market values and trade-offs	Value classification frameworks may be inadequate for relational values	Legg et al. (2020); McDaniels and Trousdale (2005)						
	Lack of substitutes for revered goods and services		Campbell et al. (2011)					
	Inappropriate monetary payment vehicle			O'Garra (2009); Rai and Scarborough (2013)				
	Utility theory assumptions do not apply						Haener et al. (2001); Oleson et al. (2015)	
Data collection	Potentially inappropriate survey methods				Jackson et al. (2014); Melnyk and Bell (1996)	Jackson et al. (2019); Rolfe and Windle (2003)		Adamowicz et al. (2004)
Aggregation of responses	Communal vs. individual property rights							Nikolakis et al. (2016)
	Integration of Indigenous and non-Indigenous values					Miller et al. (2015); Zander and Straton (2010)		

burning, collecting traditional foods and medicines, protecting sacred areas, taking part in traditional ceremonies and producing artwork. Importantly, estimates by Campbell et al. (2011) were limited to savings in the cost of primary health care of chronic diseases and, thus, cannot be considered a welfare measure.

Valuing health requires the ability to first, establish a connection between access to revered goods and services and differences in health status, and second, the monetary equivalent of the measurable health improvements (see details in Chapter 7 in Freeman et al., 2014). If measures of physical benefits were combined with relevant indicators of Indigenous wellbeing (e.g., Yap and Yu, 2016), it may be possible to obtain a more holistic valuation of market and non-market economic benefits of a healthier population.

3.3.3. *Inappropriate monetary payment vehicles*

Two stated preferences studies used non-cash payment vehicles by Indigenous respondents, including employed labor (Rai and Scarborough, 2013) and time contributions (O'Garra, 2009). A caveat of these in-kind payment vehicles is that they tend to overestimate WTP, given that they are not (and should not be) coercive (Koemle and Yu, 2020). In studies of compensation for losses, non-monetary payments included rice (Shyamsundar and Kramer, 1996), fuel (Casey et al., 2008) and improvement in education, health and infrastructure services (Casey et al., 2008; Nikolakis et al., 2016). Payment through fuel for motor boats and chain saws (Casey et al., 2008), as compensation for an oil spill in the Amazon river, may also be problematic, given that the demand for boats and saws is precisely driven by the availability of wild foods, which would be inevitably reduced in case of an oil spill. Thus, the payment mechanism may be endogenous to the other attributes.

It is crucial to note that, in the studies cited, the selection of alternative payment vehicles was determined via careful processes of consultation and/or research co-design with the Indigenous peoples. We remark that the appropriateness of alternative payments vehicles is context-specific and can only be assessed by Indigenous peoples themselves. Also, the selection of the appropriate payment vehicle should ensure that incentive compatibility and truthful demand revelation are possible (Hassan et al., 2018). We, therefore, warn against the use of the above summary as an 'off-the-shelf' list for future research to 'pick and choose', in applications elsewhere.

3.3.4. *Potentially inappropriate survey methods*

Three distinct approaches were found in the literature to deal with inadequate conventional survey methods: a) adopt best-practices in the engagement with Indigenous peoples, b) use market-derived information; and c) sample populations beyond the affected individuals. Adamowicz et al. (2004) assessed the impacts of changes in forest management as perceived by Aboriginal hunters in Saskatchewan, Canada. This study documented data collection and valuation processes, and the approaches employed to overcome survey limitations. In particular, the data collection was based on trust, reciprocity and appropriate communication. This included a story-telling format for interviews, which were conducted by a resident in each community, employed as part of the research team. Culturally appropriate offerings, as well as sharing research results and maps of special sites, were essential in establishing a respectful and mutually-beneficial relationship between communities and researches.

A body of studies (n = 15) reduced the need to elicit highly sensitive or sacred information from research participants, by using market-derived information. These included, for example, crops (e.g., Arslan and Taylor, 2009), fish and wildlife (e.g., Golden et al., 2014; Jackson et al., 2014), forest products (e.g., Campbell et al., 1997; Griffiths et al., 2003; Melnyk and Bell, 1996) and carbon sequestration (e.g., Plumb et al., 2012). Market–based monetary equivalents are useful to understand tangible benefits (e.g., food or incomes), but not the TEV. For example, Arslan and Taylor (2009) showed that the value held by Mexican farmers for their traditional maize crops was higher than the market price of such crops. Similarly, Jackson et al. (2014) undertook a thorough valuation of aquatic river species in Northern Australia that reflected their "shop value"; while a higher TEV would result if cultural significance were accounted for in their study. Another disadvantage of

replacement costs and market prices is that they do not provide insights into determinants of behaviors related to traditional customs (Haener et al., 2001).

In some stated preferences studies surveying Indigenous populations, small samples were an impediment for detailed analyses, such as testing statistical differences across age groups (Haener et al., 2001) or between different individuals holding use and non-use values (O'Garra, 2009). Acknowledging the sensitiveness of recruiting Indigenous participants, Duffield et al. (2021) determined that the relevant sample would consist of knowledgeable tribal elders, who were surveyed in-person, in small groups, as recommended by the National Oceanic and Atmospheric Administration (NOAA) blue-ribbon panel on contingent valuation (Arrow et al., 1993). Other effective recruitment strategies reported in the reviewed studies (e.g., Casey et al., 2008; Oleson et al., 2015) included employment of local enumerators who are fluent in the local language and have a deep understanding of the culture and social dynamics. As reported in Section 3.1, a common sampling approach is surveying both affected (Indigenous) and non-affected individuals. In one of the of the earliest studies of its kind in Australia, Rolfe and Windle (2003) surveyed the Indigenous community and the general community about their WTP for protecting Aboriginal cultural heritage sites in the nearby Fitzroy River, in the state of Queensland. The survey instrument was the same for all respondents, which (as the authors reported) required considerable effort to ensure it was acceptable to all members of the population. Careful design, including focus groups with Aboriginal participants, not only demonstrated respect but also may improve the quality of the survey tool by reducing 'non-response' bias.

3.3.5. *Individual utility maximization assumptions may not apply*

Across the reviewed studies, utility theory is the prevailing framework, generally assuming that individuals prefer more consumption and accumulation of goods and services to less. This framework, however, becomes problematic when an individual derives more utility from consuming less, following the principle of 'taking only what is needed' and the social practice of gifting. Such issues may be resolved when acknowledging that, within the TEV framework, increases in utility can occur across both use and non-use values, instead of just from greater consumption. Besides utility maximization, other economic theory frameworks exist (e.g., Levitt and List, 2007a, 2007b), which incorporate moral and social norms as determinants of decision-making. Thus, individuals may opt for a lower level of utility (e.g. income) if such choice is determined by their desire to 'do the right thing' or when the individual is subject to the scrutiny of others (Levitt and List, 2007b).

An approach that circumvents the assumptions of individual utility maximization is found in O'Garra (2009), where the contingent valuation was based on bequest values. Instead of eliciting responses about goods or services that would be consumed directly be respondents, Fijian coastal villagers were asked about their WTP for future generations to have customary fishing rights (known as *iqoliqoli*), even though access was denied for themselves. This approach assumes respondents would maximize utility for future generations. Bequest values were also investigated by Oleson et al. (2015) in a choice experiment of fishing values in Madagascar, regarding the preservation of the traditional *Vezo* way of living. The choice experiment also included "social cohesion" - an attribute that is desirable by the local people and consistent with utility maximization theory, given that more "social cohesion" would always be preferable to less.

3.3.6. *Communal vs. individual property rights*

It is recognized that Indigenous individual and collective values are difficult to aggregate, and few studies have explicitly responded to this limitation. In a study of land use by members of two Canadian *First Nations* (Tla-o-qui-aht and Ahousah), Nikolakis et al. (2016) carried out a two-staged choice experiment to understand how individual preferences vary before and after communication in a group setting. The results found that following collective deliberations, there was a convergence in land use preferences among individuals. Between the first and second survey rounds, those respondents who had communicated with the group were statistically more likely to switch their land use preference from the *status quo* to *tourism promotion,* in recognition of greater collective benefits, and emphasizing the importance of collective outcomes. Collective deliberation both mediates and is critical for understanding land use preferences. The combination of valuation methods and deliberative approaches is often referred to as "deliberative monetary valuation" or DMV. It is argued that DMV offers potential for improving valuation of ecosystem services, although theoretical and empirical challenges still remain (Bunse et al., 2015).

3.3.7. *Integration of Indigenous and non-Indigenous peoples' values*

A key challenge with aggregation of Indigenous and non-Indigenous peoples' values is that values emerge from different ontologies, which cannot be easily reconciled. This remains a theoretical and methodological gap that has not been thoroughly addressed in the literature. Importantly, integration of multiple societal values is not an exclusive challenge of NMV or economics, but a question that warrants attention at a much broader scale. Regardless of how values are measured, decision-making process should recognize diverse cultural value frameworks and resolve those discrepancies that hamper reconciliation of different value systems.

To account for both Indigenous and non-Indigenous perspectives, a large body of studies surveyed the general population (including all identities) or local residents (reflecting the mixed population) (see Fig. 4). Generally, these two approaches collected data through one common survey tool, which served to inform measures of the 'collective' value. Insightfully, a small number of studies (e.g., Armatas et al., 2018; Hoyos et al., 2009; Miller et al., 2015; Spyce et al., 2012; Zander and Straton, 2010) attempted to address the question of heterogeneity, by testing preferences depending on whether respondents self-identified, or not, as Indigenous. For example, Miller et al. (2015) found that, compared to the general sample of Canterbury (New Zealand) residents, Māori respondents had a 40% higher WTP for water quality that would support *mahinga kai* – an inclusive term for gathering of traditional food and resources. Conversely, Spyce et al. (2012) detected no differences in WTP between Canadian Aboriginal and non-Aboriginal populations.

4. Discussion: Key questions to ask when undertaking best-practice in NMV of Indigenous values

In this review, we examined the growing body of quantitative studies applying NMV to Indigenous peoples' values across the world. We found that three countries (Australia, the USA and Canada) account for over half of the studies within the scope of our review. Consequently, a limitation of our meta-synthesis is that our results and learnings are skewed towards those countries dominating the current peer-reviewed literature. We recognize the important knowledge gap regarding Indigenous values across other geographies and strongly suggest future research addresses the present shortcoming. In particular, we suggest future research engages in ways that are more sensitized to Indigenous peoples and local communities in contexts such as Latin America, Africa, Asia and the Pacific, where the rights and interests of local communities and Indigenous peoples are less distinct from the mainstream.

We concur with previous studies that, in certain circumstances, conventional NMV may be inappropriate, and even ethically illegitimate and methodologically flawed (Awatere, 2005; Gregory and Trousdale, 2009). Nevertheless, we also argue these considerations do not necessarily preclude the use of NMV methods in Indigenous contexts. Instead, such limitations compel researchers to question both how and why NMV is being used. In-line with the guidance from IPBES (2016), we contend that before NMV is applied, there are some questions researchers should ask, but which are often unexamined by the NMV literature. In the following sections we provide some reflections upon seven critical questions.

4.1. What is the purpose?

When reflecting on the concerns associated to NMV, McCollum (2003, p. 483) wrote:

> "If a tree falls in the forest and no one is around to hear it, does it make a sound? Likewise, if a nonmarket valuation study is done and it is not used to affect or inform policy or management, does it serve a purpose?"

Here, we argue that clearly defining the purpose of NMV research is a necessary (but not sufficient) condition for best-practice. Thus, we propose that "*What is the purpose?"* should be the first question to guide conceptualization of future NMV of Indigenous peoples' values. McCollum (2003) noted that a common purposes of NMV studies is to influence on policy or management decisions. This can be tackled directly by addressing management issues or policy questions, or in an indirect, long-term manner by advancing methods for estimating non-market values. Identifying the intent of NMV research is fundamental, as this will determine *whose values* and *which values* ought to be studied and, ultimately, the research outcomes.

As noted by Rogers et al. (2015), there are several reasons why decision-makers may choose not to use information from NMV studies, including conceptual issues and methodological constrains. As elaborated throughout our *Introduction* and *Results* sections, NMV of Indigenous peoples' values presents particular limitations, which may further hamper its ability to influence decision-making. Therefore, we propose that future studies whose purpose is to inform policy and management should carefully outline how exactly they will overcome difficulties in achieving such goal, such as through a 'Theory of Change' (Larson et al., 2019).

4.2. How does Indigenous knowledge inform NMV?

The design of NMV studies should be agreed upon with the Indigenous peoples and directed by the affected populations themselves. This will include the purpose of the research, as well as the methods and assumptions used. It is important that Indigenous knowledge informs research design, as weaknesses in NMV practice often arise from the researchers' choice of methods and assumptions. For example, defining monetary compensation for environmental losses or damages is a common purpose of NMV of Indigenous peoples' values (Allen and Colson, 2019; Casey et al., 2008; Duffield, 1997; Duffield et al., 2021; Gregory et al., 2020; Gregory and Trousdale, 2009). But we argue that unless compensation is sought by the affected population, this should not be the purpose of NMV.

Conducting focus groups is a standard step in best-practice survey design for NMV, for any population (Champ et al., 2017), yet within Indigenous contexts, specific focus groups approaches may be warranted to ensure the process is culturally appropriate and ethically sound (Dawson et al., 2014). Improved ways of formulating NMV studies of Indigenous peoples' values can be guided by research co-design and collaboration principles. Further, whenever NMV is applied to Indigenous peoples' values, it is paramount that the research is consistent with the principles of self-determination and free, prior and informed consent (OHCHR, 2013). In addition to co-design with the Indigenous communities affected by the environmental change in question, we recommend that NMV design is informed by the growing body of Indigenous scholarly knowledge (e.g., Awatere et al., 2017; Marshall, 2021; Moggridge and Thompson, 2021; Poelina et al., 2019; Reed et al., 2021).

4.3. Who benefits?

There are increasing concerns in NMV research of Indigenous peoples' values questioning who the real beneficiaries are (Stoeckl et al., 2013). Are the primary beneficiaries researchers themselves? Or indeed the affected populations? Is it possible that spillover effects end up benefiting the general population the most? This debate around *Who benefits?* is not limited to NMV, but indeed is pronounced in the broader literature concerning Indigenous populations (e.g., Bainbridge et al., 2015). In her book, *Decolonizing Methodologies,* Linda Tuhiwai Smith (Ngāti Awa and Ngāti Porou, Māori) (2012) calls for the academy to recognize and respect Indigenous knowledge, and to abandon paradigms of subordination. Importantly, Tuhiwai Smith (2012) puts forward a proposal for an Indigenous research agenda that is directed by Indigenous peoples and that serves their needs. This is particularly important given that researchers and Indigenous community members may often have different expectations from the research process and its derived benefits (Eriksen et al., 2021).

Based on Indigenous-centric research paradigms (Marshall, 2021; RiverOfLife et al., 2021; Moggridge and Thompson, 2021; Perez and Longboat, 2019; Tuhiwai Smith, 2012), we recommend future NMV to clearly articulate who the intended or likely beneficiaries will be. Typically, academic research ethics protocols would not be granted unless the communities involved indicate that they agree with and perceive benefits in the study. When questioning beneficiaries, it is equally important to understand *who may be negatively affected?* Although researchers have a responsibility to cause no harm (Cochran et al., 2008), past research has been the source of distress for communities, as identified by several Indigenous scholars (e.g., Schnarch, 2004; Tuck and Yang, 2014). By answering the question *who benefits?,* NMV researchers are incentivized to review potential impacts of their work, as well as scrutinize whose needs and interests have been taken into account.

4.4. What ethical frameworks are followed?

Indigenous epistemologies provide specific ethical frameworks for research and knowledge sharing. Although appropriate protocols vary within and across regions and are context-specific, relevant international and national guidance exists. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2016) emphasizes on understanding the worldview within which the values are being assessed, and the broader social context, including the implications of valuation on institutions and governance.

Researchers working within the 'Western' academy should, at

Fig. 5. Essential ethical research principles, as outlined by AIATSIS (2020a) in relation to Australia's Aboriginal and Torres Strait Islander peoples.

minimum, comply with relevant ethical standards of their institutions and jurisdictions. For instance, the Government of Canada's Panel on Research Ethics provides guidelines on Research Involving the First Nations, Inuit and Métis Peoples (Government of Canada, 2018). These guidelines establish an ethical framework for dialogue between researchers and Indigenous communities regarding shared their interests and points of difference. In Australia, these include the AIATSIS Code of Ethics for Aboriginal and Torres Strait Islander Research (AIATSIS, 2020a) and the Ethical conduct in research with Aboriginal and Torres Strait Islander Peoples and communities: Guidelines for researchers and stakeholders (NHMRC, 2018). Both guidelines emphasize respect, reciprocity, equity and free, prior and informed consent (see example in Fig. 5).

Cultural and intellectual property, as well as data sovereignty are also critical issues for the Indigenous Peoples and must be respected in the research design. Thus, Indigenous data ownership, control, access and possession should be a first priority (Kukutai and Taylor, 2016; Schnarch, 2004). Here we are not prescriptive about what ethical, culturally appropriate research should be, but we recommend that researchers become familiar with the guidelines or policies relevant to their location. Indigenous organizations often have their own protocols. For example, an Indigenous representative body in Australia, the Kimberley Land Council, has a research guide, application process and an intellectual property policy (KLC, 2011).

4.5. *Whose values are being considered?*

A clear distinction across NMV studies exists in terms of *whose values* are being studied, i.e. Indigenous peoples, local residents or the general population. Each of these cohorts will provide a different perspective, and possibly a different valuation. Investigating perspectives of the general population can serve to better understand altruistic or indirect use values (Zander et al., 2013), as well as non-Indigenous demand for cultural goods and services associated with the environment (Blackwell et al., 2019). As a general rule, however, non-Indigenous perspectives should not be used as a substitute for values held by Indigenous peoples. Research built on non-Indigenous perspectives may implicitly reinforce the colonial presumption that Indigenous peoples' resources, territories and culture belong to nobody, or everybody, or are property of the state. For example, within the context of Australia, the idea of overturning *Aqua Nullius* - by Wiradjuri Nyemba scholar Dr Virginia Marshall – calls for new concepts of water tenure that prioritize Aboriginal rights, which are largely unrecognized by Australian law (Marshall, 2017). Ultimately, Indigenous peoples' right to their cultural identity heritage and livelihoods should be enshrined, in line with fundamental principles of justice (UN, 2007).

The criticality of defining *whose values are being considered?* is evident in three studies that found negative or unsupportive views held be the general population of Australia. Rolfe and Windle (2003) found that the general non-Indigenous population of Rockhampton and Brisbane preferred low levels of protection for Aboriginal heritage sites (10% above current levels), compared to greater protection (30% above current levels). This does not imply the general population does not value Aboriginal heritage, but it shows that they preferred low levels of heritage protection, when faced with other environmental and financial trade-offs. In another Australian study, Zander (2013) reported that 55% of nation-wide respondents were "uninterested" in Aboriginal culture, and that respondents living closer to the program area (northern Australia) had lower WTP for an Indigenous payment for ecosystem services (PES) program. Over half of those unwilling to pay for the program did not believe the PES would work or Indigenous people should not be paid to provide ecosystem services. This study also reports qualitative data reflecting how some Australians hold negative views about Indigenous heritage conservation, although Aboriginal heritage remains protected by law (Library of Congress, 2020) and "Aboriginal and Torres Strait Islander people are the Custodians of their heritage" (HCOANZ, 2020).

4.6. *What is the expected change?*

Carefully defining the proposed environmental changes in NMV surveys is fundamental to good practice, as unclear definitions may lead to estimation inaccuracies, due to potential biases or large variances (Bishop and Boyle, 2019). As elaborated in Section 3.3, for a survey to be easily understood by respondents unfamiliar with Indigenous peoples' values, it is often necessary to provide very careful explanation of the values in question and how these are impacted by environmental changes. For example, a certain change in river water quality, may affect the presence of native fish species associated with cultural values, such as totems. While biophysical changes (e.g. water quality or species density) can be defined with relative ease through conventional scientific methods, Indigenous knowledge is paramount to understand what that change actually means from an Indigenous perspective. Thus, NMV designs should be informed by Indigenous conceptualizations of the system and the expected change, in a way that reflects Indigenous ontologies and relational values tied to the environment (Baker et al., 2019; Oleson et al., 2015).

4.7. *How are limitations handled?*

In our systematic literature review we found examples of NMV studies that clearly outlined the limitations encountered, both conceptual and methodological (e.g., Adamowicz et al., 2004; Gregory et al., 2020). We recommend that future NMV studies of Indigenous values adopt the same principle of transparency and document key limitations. We acknowledge that there is not a single approach to address all limitations and that some approaches will only be useful in certain contexts, but not others. In this review, we present a suite of strategies that may help address key limitations. Our list of limitations is not exhaustive and thus, NMV studies should consider other possible challenges. In addition to the prevailing theory of utility maximization, future NMV studies could consider alternative frameworks to explain individuals' behaviors, including important determinants such as social norms (Levitt and List, 2007a, 2007b). This also raises important questions when aggregating individual responses, given that individuals who follow different value frameworks will typically make different choices when faced with the same decision question (Levitt and List, 2007b). In cases where NMV is not statistically feasible, time and resources could be redirected towards meaningful and respectful engagement that facilities alternative research approaches suited for small populations, e.g. qualitative approaches (Bélisle et al., 2021; IPBES, 2016; Stoeckl et al., 2021).

5. Conclusions

In this study, we provided the most up-to-date and comprehensive review of the academic literature on NMV of Indigenous peoples' values. Our global systematic literature review produced 63 studies, which we categorized by methods, year of publication, geographic area and ecosystem components being studied. Discrete choice modelling was the most common method (n = 28), particularly over the last decade. Forests (n = 21) and freshwater (n = 15) were the two most common ecosystem components being valued. We also provide a taxonomy of reviewed studies according to *whose values?* and *what values?* were investigated. We found a large proportion of studies (n = 24) focusing on values held by Indigenous peoples. These focused predominately on understating direct use values (n = 12) and total economic values (n = 10). Studies based on the general population (n = 17), typically queried altruistic and/or existence values (n = 15). Further, a group of studies (n = 22) targeted values held by local Indigenous and non–Indigenous populations, chiefly direct use values (n = 10).

In the results section, we highlight key limitations of NMV when applied to Indigenous peoples' values and provide some

recommendations. Then, we discussed a suite of strategies found in the literature that may serve to improve the adequacy and reliability of NMV of Indigenous peoples' values (Table 3). We also discussed some challenges associated with these approaches and their practical implications. By no means do we wish our synthesis to become the basis of future 'copy-and-paste' research designs, but we hope that our recommendations and selected examples will assist researchers to adopt best-practices in NMV of Indigenous peoples' values. We acknowledge that insights from this meta-synthesis are predominately informed by Anglo-Saxon contexts, given that over half of all reviewed studies originate in Australia (n = 19), the USA (n = 9) or Canada (n = 8). While our guidance aims to be of global relevance, we highlight the current knowledge gap and recommend that future peer-reviewed studies help inform best–practice in NMV of Indigenous peoples' values across areas that remain understudied, such as Africa and Asia.

Our discussion section presented a series of questions that should guide researchers in their future efforts to undertake best-practice in NMV within Indigenous contexts. These include:

- *What is the purpose?*
- *How does Indigenous knowledge inform NMV?*
- *Who benefits?*
- *What ethical frameworks are followed?*
- *Whose values are being considered?*
- *What is the expected change and how is it perceived by Indigenous peoples?*
- *How are limitations handled?*

In cases when NMV is deemed inappropriate, this approach should not be used, but instead alternative processes ought to be considered. These may include, among others, negotiated agreement, resolution of land tenure claims or convening advisory groups. If NMV is appropriate for the particular situation, a key consideration is the need to clearly identify the limitations that may apply. In closing, we argue for a 'bespoke' approach to Indigenous NMV and an acceptance that current research design has weaknesses. Nevertheless, we contend that with the seven key guiding questions, and the sharing of practices and methods, Indigenous NMV will improve over time and if undertaken appropriately can deliver better outcomes for Indigenous peoples.

CRediT authorship contribution statement

Ana Manero: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Writing - Review & Editing, Visualization, Supervision, Project administration. **Kat Taylor:** Conceptualization, Writing - Original Draft. **William Nikolakis:** Conceptualization, Methodology, Writing - Original Draft, Writing - Review & Editing. **Wiktor Adamowicz:** Conceptualization, Methodology, Writing - Review & Editing. **Virginia Marshall:** Conceptualization. **Alaya Spencer-Cotton:** Writing - Review & Editing. **Mai Nguyen:** Writing - Review & Editing, Visualization. **Quentin Grafton:** Conceptualization, Methodology, Writing - Original Draft, Writing - Review & Editing, Supervision, Funding acquisition.

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Appendix A. Supplementary data

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