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PERSPECTIVE

Ecosystem accounting through first nations' lenses: Integrating the SEEA-EA and Indigenous knowledge systems

Silva Larson, Diane Jarvis, Ewamian People Aboriginal Corporation RNTBC and the Ewamian Ltd, Tagalaka Aboriginal Corporation RNTBC, Ryan Barrowei, Daniel Grainger, Glenn Finau, Natalie Stoeckl, Michael Douglas

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Abstract The UN System of Environmental-Economic Accounting-Ecosystem Accounting (SEEA-EA) provides a framework for integrating information about the environment and the economy, organising information about ecosystems, measuring ecosystem services, and tracking change. We explore how SEEA-EA can incorporate First Nations' conceptualisation of nature and cultural connections to traditional lands. We identify multiple entry avenues, propose key principles and suggest steps to enhance relevance of the SEEA-EA to First Nations, principally: stock accounts should reflect aspects of Country that First Nations deem important; flow accounts should depict services they consider the most significant; and, stocks and flows should be measured using physical, subjective and monetary metrics that they deem appropriate. Respectful partnership with First Nations group(s) whose Country is being accounted for—centred on their priorities and values—would yield multiple benefits. We recommend that these ideas, alongside other possible approaches, be developed and tested with First Nations groups across diverse geographic and cultural contexts.

Keywords Australia · Ecosystem services · Nature-based solutions · Natural capital accounting · SEEA EA · Traditional knowledge

MEASURING AND MONITORING CONNECTIONS TO LAND

The potential of prevailing social values and knowledge systems to capture First Nations cultural connections to land has been challenged in the literature (Beamer et al. 2021; Manero et al. 2022; Finau et al. 2023). The premise is that what is often referred to as "Western" systems, populated by Western science and knowledge, do not fully represent or include First Nations world views and knowledge systems. One such Western system currently being promoted for use, and increasingly dominant, is the System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA-EA) designed by the United Nations Department of Economic and Social Affairs (UN et al. 2021).

According to the UN 2023 Global Assessment of Environmental-Economic Accounting and Supporting Statistics (UNCEEA 2024), 90 countries on all continents were implementing the SEEA. In terms of countries' institutional frameworks for SEEA implementation, 90 per cent of implementing countries indicated that the accounts are compiled by the national statistical office, with climate change and biodiversity being the most mentioned SEEA-related policy priorities across countries. Further, 96 per cent of implementing countries plan to expand their compilation of the SEEA, and a large majority (48 out of 62, or 77 per cent) of countries that do not currently implement the SEEA intend to initiate implementation in the future (UNCEEA 2024).

The broad ambition of the SEEA-EA is to describe in a comprehensive manner the relationship between the environment and the economy. The SEEA-EA is defined as a "*spatially-based, integrated statistical framework for organising biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity…. with a focus on making visible the contributions of nature to the economy and*

people." (UN et al. 2021, p1). The basic accounting principles are applied to the organisation of environmental data in both physical and monetary terms to provide an integrated, coherent and consistent set of data. The use of an accounting approach takes advantage of the inherent structure of accounts wherein both stocks and flows are part of a single recording system.

However, in parallel to greater use of the SEEA-EA is an emerging set of literature that calls for recognition of First Nations values, and the inclusion of their views in environmental and land use management in general (Buggey 1999; Díaz et al. 2015; Hakim et al. 2023; Molnár et al. 2023), and specifically in the SEEA-EA accounting processes (Normyle et al. 2021, 2022c; Finau et al. 2023; Woodward et al. 2023; Normyle et al. 2024). As Gallhofer et al. (2000) argue, a compromise between First Nations and Western values is necessary if aiming to meld different, and at times conflicting, worldviews.

In an ideal world, two contrasting systems would be discussed in a type of Delphi situation and would result in a third codesigned system that incorporates core principles from both (Gallhofer et al. 2000). Outside of the ideal world, a "second best" option that is frequently adopted is to attempt to ensure that alternative knowledge systems are given explicit place within a dominant system (Normyle et al. 2024)—although the current accounting literature notably focuses on accounting "for" First Nations peoples rather than accounting "by" First Nations peoples (Buhr 2011).

It can be considered disrespectful to ignore the knowledge and value systems of others in any situation, but this issue is particularly pertinent in situations where First Nations peoples are the majority knowledge holder, ecosystem carer, and user of ecosystem services. Using publicly available geospatial resources, Garnett et al. (2018) calculated that First Nations manage or have tenure rights over at least $\sim$ 38 million km^2 in 87 countries or politically distinct areas on all inhabited continents, representing over a quarter of the world's land surface and intersecting about 40% of all terrestrial protected areas and ecologically intact landscapes (for example, boreal and tropical primary forests, savannas and marshes). For example, in Australia, more than 90 million hectares of land (more than twice the land size of Sweden) and 6 million hectares of sea are managed by First Nations under Indigenous Protected Areas (IPAs) arrangements (DCCEEW 2024). IPAs are promoted as a means for supporting First Nations peoples to care for their Country (DCCEEW, 2024). However, IPAs represent 50 per cent of Australia's National Reserve System (Australia's network of protected areas), under which 22 per cent of land in Australia is protected. Thus, it can be argued that IPAs, in addition to supporting First Nations peoples' care for their Country, are also supporting the Australian government meeting international environmental obligations, such as the Kunming-Montreal Global Biodiversity Framework target of protecting at least 30 per cent of lands and oceans by 2030 (Fitzsimons et al. 2023).

Rather than accepting current second-best practices, in this paper we explore what a compromise or melding between First Nations and Western values and worldviews could potentially look like, specifically in the context of the UN SEEA-EA. We systematically explore the SEEA-EA guidelines (UN et al. 2021) for opportunities to incorporate First Nations worldviews and values. We clarify our understanding of what is and what is not meant to be captured in the SEEA-EA system of accounts, and specifically, the aspects of the SEEA-EA that have potentially substantive implications to First Nations peoples. Our insights are based on the current literature, and also upon our numerous years and projects working at the intersection of Western economic valuations and accounting; and knowledge and value systems of First Nations in Australia. Our First Nations authors, Ewamian People and Tagalaka People from Far North Queensland and Mungguy People of Jawoyn language group in the southern region of Kakadu National Park in the Northern Territory, that codesigned and participated in a number of previous natural resources managements and valuation projects, bring to this paper a deep insight into the limitations and opportunities of the current SEEA-EA. Western scientists also contribute perspectives on where the SEEA-EA could benefit from a First Nations worldview. While at times, the world view of First Nations and Western science can appear to contest one another, there are notable alignments that we highlight in this paper.

The SEEA-EA is an environmental-economic accounting system, intended to enable the monitoring of the health of the environment, and activities undertaken to improve its health. Several key issues need consideration if aiming to make these accounts relevant to—and for—First Nations people. In "General spatial and temporal context and principles of the SEEA-EA and their relation to First Nations mental models, values, and connections to land" section, we first explore general principles of the SEEA-EA, organised around spatial and temporal considerations. Then in "Considerations for specific accounts" section, we move on to more specific considerations of each of the four related accounts which explicitly monitor (1) the extent and type of various ecosystems across the landscape—extent accounts; (2) the condition of those ecosystems—condition accounts; (3) the benefits that those ecosystems provide to humans—ecosystem services flow accounts; and (4) expenditure (or associated activity) for environmental protection and resource management. We close the paper with a discussion of key emerging points ("Learnings"

section), recommendations for weaving together knowledge systems and implications ("Continuing to weave together" section) and draw final conclusions for policy and decision makers ("Conclusion" section).

GENERAL SPATIAL AND TEMPORAL CONTEXT AND PRINCIPLES OF THE SEEA-EA AND THEIR RELATION TO FIRST NATIONS MENTAL MODELS, VALUES, AND CONNECTIONS TO LAND

Guiding principles of relevance to the potential collaboration of First Nations peoples in the SEEA-EA process have been summarised by Jarvis et al. (2025). Principles include respectful partnering (empowering First Nations people to lead, collaborating with the true and recognised representatives of the Nations, respecting traditional knowledge and customary protocols, etc.), recognising that the process by which accounts are developed can be of greater importance than the final accounts (with the views and values of the First Nations included at every stage of the co-design process), and ensuring that the accounts which produced are of relevance and benefit to the First Nation (as a means of, for example, furthering their self-determination, raising funds or achieving other socio-economic and cultural goals). In addition, respectful and meaningful engagement with First Nations partners requires sufficient and long-term funding and resources (including funding for First Nations partners) to be made available (Woodward et al. 2023).

Spatial issues

The SEEA-EA accounting system represents the biophysical environment in terms of distinct spatial areas each representing a specific ecosystem type (UN et al. 2021, parag. 1.27), such as forests, grasslands, wetlands, cultivated areas, etc. Each spatial area within a region, performing particular ecosystem services, is treated as an ecosystem asset. Delineating "assets" in this way can conflict with First Nations conceptualisation of nature as a holistic entity (Stoeckl et al. 2018). Nature is interconnected in both a biophysical and cultural manner and this interconnectedness is a value in itself. Whole-of-landscape approaches (McKemey et al. 2022), which treat the entire First Nations Country as one unit, might be needed; or it may be that separating Country into distinct types is only appropriate when considering specific circumstances or threats (Monero et al. 2022; McKemey et al. 2022). Most importantly, the distinct spatial area(s) to be included in the accounts—Country or determined parts of the country—need to be agreed upon with the First Nations partner(s) as part of the accounts design stage (Normyle et al. 2022a; 2022b).

As noted in parag 1.57 (UN et al. 2021), it is possible to compile Ecosystem Accounts in different ways, although there is arguably a trade-off with practitioners needing to choose between geographic scale and topical detail. They can provide spatially-explicit data with a high level of detail for relatively small geographic areas, or a less detailed overview of large areas, e.g., describing broad trends in key ecosystem types and services, typically through the use of remote sensing (such as from satellite) data. Further, parag 1.58 suggests that the choice of approach will depend on "*(i) the policy focus; (ii) the availability of source data; and (iii) the resources available for compilation. In general terms, increasing the level of spatial detail has the potential to increase the level of robustness of the accounts*".

The high costs of data collection and compilation are well documented in the literature (Pacheco-Romero et al. 2022) and accounts are often dominated by remote sensing data which is relatively cheap to collect (Richards et al. 2023; Stewart et al. 2023; Richards et al. 2024). Remote sensing is an efficient and reliable method for monitoring changes in vegetation and ground cover (Kennedy et al. 2009), however, it cannot detect many of the aspects of importance for First Nations peoples such as the presence of "right" wildlife, sounds and smells; whether the ecosystem is behaving "as it should", whether it is following seasonal calendars in the way the First Nations expect; the condition of physical cultural and art sites (Larson et al. 2023; Woodward et al. 2023). As the primary focus of First Nations peoples for the development of the SEEA-EA accounts is to monitor changes in their Country over time, a high level of local culturally nuanced spatial detail is preferred. Accuracy assessment is a critical step when incorporating remote sensing data into any map or analysis, including within ecosystem accounts (Congalton and Green 2019). Specifically, this requires ground truthing where in situ data are collected and used to assess the accuracy and reliability of other data, model performance, and classification systems (Foody 2002; Olofsson et al. 2013). For the ground truthing component, rather than being carried out by field technicians or researchers, the on-ground data collection should be conducted by First Nations people themselves on their own Country (Woodward et al. 2023).

Temporal issues

The use of the SEEA-EA envisages comparable, regular and ongoing measurement. The connection between the stock and flow components of the framework can be embodied in the concept of ecosystem capacity. Broadly,

the capacity of an ecosystem asset refers to the ability of an ecosystem to provide services into the future (UN et al. 2021, parag 2.18). Thus, in practice, longitudinal recording of stocks and change in stocks, and flows, is required (parag 1.28). For First Nations peoples, however, time is perceived as a continuum of past, present, and future (Stoeckl et al. 2021). Moreover, the "now" might not be as important as either the past or the future (Woodward et al. 2023). The question here is, what impact do such considerations of time, and in particular, the importance of past and future human lives and landscapes, relative to now (Hakim et al. 2023), have on utility of the SEEA-EA accounting to First Nations peoples? A possible way forward would be to discuss appropriate timeframes with First Nations in the early stages of the codesign, as consideration of time is important across the accounts. For example, for stock accounts, it is so particularly with regard to the reference state against which condition is compared (as discussed in "Condition accounts" section). For flow accounts, timelines are potentially impacting both the First Nations conceptualisation of the important services to be accounted for, as well as the measurement of these services.

CONSIDERATIONS FOR SPECIFIC ACCOUNTS

Extent accounts

Ecosystem extent accounts (UN et al. 2021, Chapters 3 and 4) focus on the type and extent of different "ecosystems" (for example, forests—10 hectares, wetlands—5 hectares, urban areas—2 hectares). The entire system includes both an opening extent account (hectares of each type at the beginning of a period) and records of changes in extent (additions and reductions in areas), which together allow for the estimation of closing accounts (hectares of each type at end of period). General spatial considerations of the trade-off between area considered and detail provided; and conceptualisation of timelines (relevant starting and ending periods), discussed in the previous section, are of high relevance to First Nations peoples for these accounts.

An additional issue of critical relevance to First Nations peoples relates to the classification of "ecosystem types" which is pre-determined in the current system (the SEEA-EA recommends IUCN Global Ecosystem Typology[1] be used). We are not proposing structural changes to the type of accounts but note that it may be important to use classifications that are relevant to First Nations peoples in the first instance rather than starting with Western science classifications and later attempting to incorporate the views of the First Nations where and if they fit (Woodward et al. 2023; Addison et al. 2019). We argue this can be effectively achieved by co-designing the extent accounts, with the First Nations determining the types and extent of ecosystems to be recorded. Examples from practice show that, in some instances, First Nations peoples have classified ecosystem types on their Country primarily on geophysical features (for example, Esperance Tjaltjraak Native Title Aboriginal Corporation in their Healthy Country Plan (ETNTAC 2019) classify ecosystem types on their Country as: cultural sites; granites; wetlands, lakes and rivers; coast; and islands), or on animals or plants linked to a particular ecosystem (for example, the Wunambal Gaambera Healthy Country Plan describes Gurnduli (agile wallaby) Country, Walamba (antilopine kangaroo) Country, Jebarra (emu) Country, Monyjon (monjon) Country and Julwun Country (which includes bush turkey, sand and plains goanna, and euro and rock wallabies) (Wunambal Gaambera Aboriginal Corporation 2010)). Beyond potentially developing ecosystem types based upon the culturally significant entities (a term that encompasses both culturally significant species and culturally significant ecological communities (Goolmeer et al. 2024)), information on the quantity and health of these species and communities, and changes over time, would inform the condition accounts, and could also form the basis for biodiversity and/or species accounts.

Another important issue to consider here relates to the fact that the SEEA-EA system is essentially reductionist, focusing on numerous 'parcels' of (implicitly separable) pieces of land—the accounts do not allow (inseparability induced) interactions between ecosystems and/or people, so do not consider Country, and its connections to people, as a whole. For First Nations, Country is more than an assemblage of ecosystems: it is ancestral home, source of identity and belonging (Stoeckl et al. 2018, 2021), and family (Salmon 2000). For many Australian First Nations the colonial trauma of being removed from Country with ownership over Country reassigned, adds to the reality of limited or refused access to parts of, or to the entirety of, their Country. Adding a holistic variable "Country" with associated variables that consider factors such as "extent of access to Country", "extent of Country under First Nations management" to the accounts, would provide a much richer picture of changes in extent, over time (Addison et al. 2019).

Condition accounts

Condition accounts (detailed in Chapter 5 of the UN et al. 2021) attempt to record the 'quality' of various ecosystems—the intention being to capture data relevant to protection, maintenance and restoration. Various metrics that are used to describe condition derive from the SEEA-EA

[1] https://global-ecosystems.org/.

Ecosystem Condition Typology using groups of variables that are intended to describe the abiotic, biotic, and landscape level characteristics of each ecosystem. The relevance (or not) of 'condition' accounts to First Nations peoples, is thus critically dependent upon the relevance of selected characteristics and associated variables.

General Western conceptualisations of various biotic characteristics that describe condition, in particular Class B1: "*Compositional state characteristics"* of presence/abundance of key species (UN et al. 2021, Table 5.1, p90) can be meaningfully applied to First Nations conceptualisation. However, both the key species and the desired reference levels must be defined by First Nations peoples, and not externally imposed. This is not to say that species deemed as important by Western science (for example, species listed in IUCN red list) are to be disregarded, merely, that additional variables with key species of importance to First Nations, might need to be added to the tables (similarly, for group (c) Landscape and seascape characteristics, it is characteristics that are MEAningful to First Nations that need inclusion, Woodward et al. 2023).

Specific examples of ecosystem condition variables provided in the SEEA-EA accounts are such as the number of bird species or percentage of tree coverage, and the criteria for selecting particular metrics and indicators is provided (parag 5.42 and Annex 5.1, UN et al. 2021, based on Czúcz et al. 2021). To be of relevance to First Nations, the selection criteria need to be broadened to include traditional knowledge. For example, intrinsic relevance is currently described as "*reflect the existing scientific understanding, supported by the ecological literature*"—this could be broadened to also recognise First Nations expertise; while instrumental relevance suggests that the "*highest priority services should be favoured*"—there is a need to ensure that priorities are not only set by Western science, but ensures a process for the contemporaneous elicitation of priorities of First Nations peoples. Following from the First Nations perception of Country as a whole, introduced previously, parag 5.38 includes provision for quantifying "*how an ecosystem asset is connected to other ecosystem assets of the same ecosystem type*". Condition accounts have the potential to provide for "whole of Country" condition scoring, where appropriate.

An important step within the measurement process is to report existing conditions relative to a reference condition (UN et al. 2021, parag 5.66), with the expert opinion as one method proposed for identifying and/or setting the reference condition of individual indicators. Although an expert´s opinion may be expressed semi-quantitatively, qualitative articulation is probably most common (European Commission 2003). This provision for condition scoring by experts (parag A5.11) might potentially result in different reference conditions and different scorings in different regions/countries. The important question from First Nations perspective is, who sets reference levels?, that is, who are the experts? Essentially, if condition accounts are to be used as a measure of "healthy Country", then only First Nations can expertly describe what a "healthy Country" looks like; considering the particular First nations discourse and notion of "health Country" (Brugnach et al. 2017). Traditional First Nations expert knowledge can guide narratives and possible avenues for quantifications of reference condition and levels. Our proposal is to acknowledge the First Nations as the true experts of their Country and use their knowledge and expertise for the formation of condition accounts. What a reference condition is (what "healthy Country" looks like) would likely be different for different First Nations groups and would likely result in a different condition score in different regions/countries.Ecosystem services flow accounts.

Ecosystem services (ES) flow accounts record the contributions of ecosystems to society—monitoring their supply and use in economic and other human activity (UN et al. 2021, parag 6.9), by households, enterprises and government (parag 2. 41). As for other accounts, a hierarchical classification system is used to categorise various ES, with the highest-level distinguishing three broad categories of services:

- Provisioning services, including food, fresh water, wood, fibre and fuel
- Regulating and maintenance services, including natural processes that control flood and disease, purify water, reduce erosion and store carbon
- Cultural services, including passive enjoyment, in situ and remote interactions

ES classification was developed by combining findings from previous work (including Millenium Ecosystem Assessment (MEA 2005), Common International Classification of Ecosystem Services—CICES (Potschin and Haines-Young 2018) and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services—IPBES (Díaz et al. 2015)), with each ES defined to avoid double-counting (crosswalk tables are provided between the SEEA-EA and other approaches, see excel download file at[2]).

Identifying relevant services

Just as it may be important to ensure that First Nations peoples have the opportunity to determine the 'types' of ecosystems that are used within the *extent* accounts, so too is it important to provide them with the opportunity to

[2] https://seea.un.org/ecosystem-accounting.

identify categories of services that are relevant to them, as literature suggests that several ES categories that are relevant in Western contexts are of little relevance to First Nations people (Stoeckl et al. 2021; Jarvis et al. 2022). Notably, all Western-defined ES flows are derived from a combination of natural, manufactured (e.g., cars, access roads) and social/institutional assets (see, for example, Fig. 1. Costanza et al. 2021). Different cultures will have different 'assets' available to them, so one should expect to observe interactions, interdependencies and flows that are context-specific.

Hakim et al. (2023) argue that the sub-categories of provisioning services identified in many ES accounting systems, are reductionist, and focus primarily on instrumental values, addressing the lower layers of Maslow's hierarchy of needs such as need for shelter or need for food and water. However, the value attached to some foods goes far beyond the instrumental (caloric)—starkly evident, for example, by the Inuit's description of some traditional foods as being "*soul food*"—and are thus perhaps better described as being associated with both provisioning and cultural services, rather than provisioning services alone. Evidently, accounts should seek to go beyond purely instrumental values and seek to capture relational values of nature that are addressing higher-level self-actualising type requirements for human wellbeing, in particular First Nations wellbeing. Literature exploring First Nations peoples' values describe their strong relational and spiritual values, and a sense of place for people who live in, from, with, and/or as nature (Kenter and O'Connor 2022; Hakim et al. 2023).

Some sections of the documentation associated with the SEEA-EA suggest that non-use values should not be treated as ES, but other parts expressly direct users to consider them. For example Sect. 6.122 notes that "*a separate class—ecosystem and species appreciation—has also been included in the reference list to allow for recording data on non-use values*." Two key non-use values, bequest value where the value is based on ensuring the ecosystem is available to future generations; and existence value where the value is based on the knowledge that the ecosystem is present now, are of high importance to First Nations. Also relevant are the cultural benefits arising from sharing knowledge, stories and practices about Country (Jarvis et al. 2021). Further work with First Nations is required to determine the most suitable ways of recording, measuring and monitoring these, and other relevant values.

Use of "logic chains" is recommended in the SEEA-EA to understand the flows of services from ecosystem assets to benefits and beneficiaries (UN et al., 2021, Sect. 6.2.6; see also parag 6.41). Logic chains for selected ecosystem services are presented in an expansive 4-page table (UN et al. 2021, Annex 6.1 p154), however we note that only three logic chains are provided for cultural services: recreation-related services; amenity and science; and education and research. No example logic chains are provided

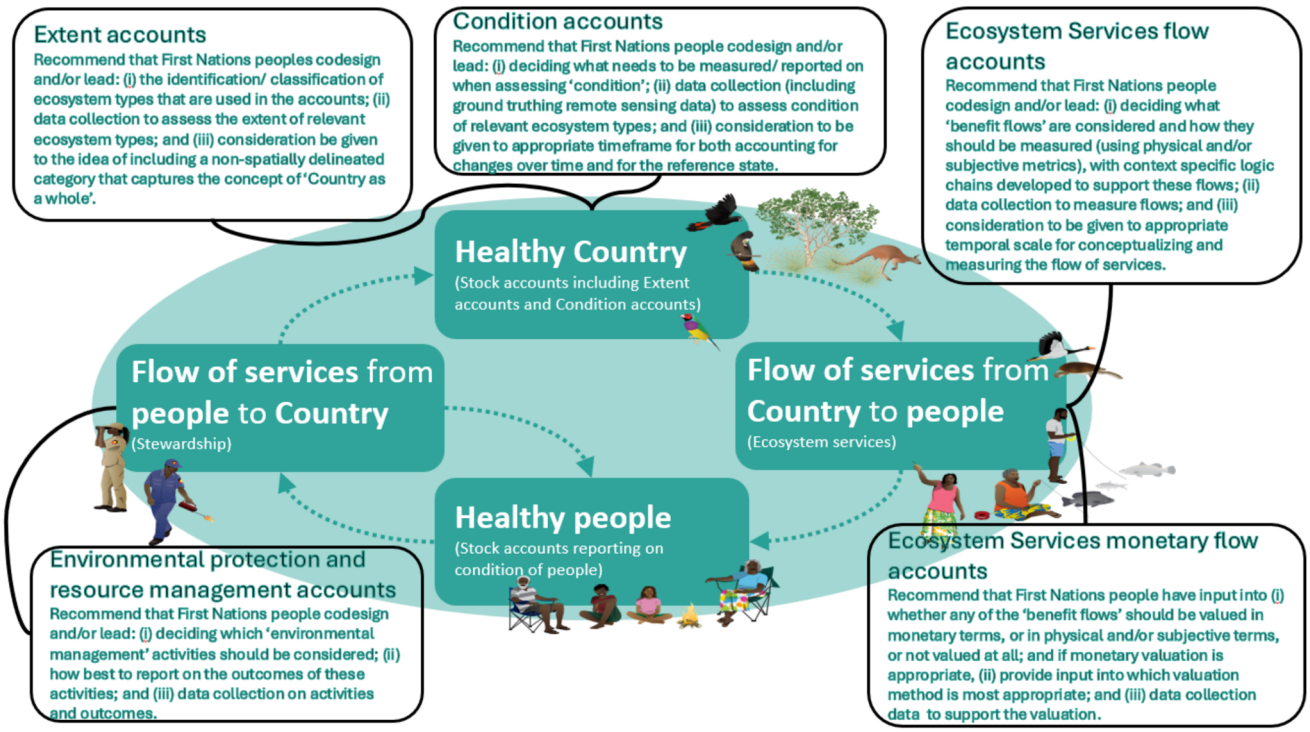

Fig. 1 First Nations perspective approach to the SEEA-EA. Symbols courtesy of the NESP Resilient Landscapes Hub, nesplandscapes.edu.au

for bequest or existence values, spiritual and religious services nor species appreciation—ecosystem services arguably most pertinent to First Nations peoples. The key issue here is that different perspectives /different mental models will provide differing logic chains. Importantly, logic chains might not only differ between First Nations and non-First Nations people, but also among different First Nations (Woodward et al. 2023; Nursey-Bray et al. 2023; Coggan et al. 2024). We thus propose that logic chains need to be built from the First Nations perspectives and mental models, so that benefits of importance to them are highlighted (Larson et al. 2019; De Valck et al. 2023).

Measuring services

ES flows are recorded in physical terms (e.g., the tonnes of wood harvested from a particular area) and also using monetary estimates of the 'value' of those flows, when data are available. The SEEA-EA was intentionally developed with a direct connection to the System of National Accounts (SNA), an international statistical standard with specific guidelines on how to compile a set of interrelated accounts to record national economic activity; and went beyond the conventional SNA to also reflect the interactions between humans and nature (UN et al. 2009). So, the values reported in the SEEA-EA accounts, like the SNA, are exchange values. The SEEA-EA accounts report on the per unit (exchange) price of the ES, in contrast to the environmental values reported on within cost–benefit-analysis, which instead measure the welfare benefits. Whilst using prices (exchange values) to measure ES values makes it easy to compare values (since all are measured similarly), not all ES are readily described by exchange values.

For example, most provisioning services have readily observable prices; and related prices can be readily identified for many regulating services (e.g., the 'price' of purified water can be used to estimate water purification values), but for many/most cultural values, there are no observable prices. Moreover, First Nations people may have identified context-specific service flows that cannot be readily classified as a type of (Western) ES. Whilst there are numerous techniques for generating estimates of ES and other environmental values, some goods and services are simply not amenable to valuation (Stoeckl et al. 2018) and are not fully or even partially reflected in accounts. Therefore, the SEEA-EA monetary values should not be considered to provide, and do not intend to estimate, a complete "value of nature" (UN et al. 2021, parag 1.30). The SEEA-EA guide is very clear on this limitation, stating that "*assessing the importance of ecosystems will therefore require consideration of a wide range of information beyond data … presented in SEEA-EA*" (UN et al. 2021, Sect. 1.2).

This is a key issue for First Nations peoples since many of the benefits that First Nations peoples derive from nature are immeasurable in monetary terms: this may be due to them having infinite value, because it is culturally taboo to monetise them (Daw et al. 2015), because environmental values are inextricably linked to other values—as is the case for *complex social goods* (Stoeckl et al. 2018), or some other reason. The dominant environmental paradigm (stemming from the Millenium Ecosystems Assessment, MEA 2005) is that of the contribution that nature makes to people's wellbeing. From the First Nations perspective, this prompts a key question: how much of the total wellbeing that First Nations peoples derive from nature can be appropriately captured by a monetary value? And conversely, can the SEEA-EA accounts still be "valid" from First Nations peoples' point of view if they capture only a low, and, importantly, unquantified, percentage of the total value First Nations peoples bestow on nature?

One avenue for addressing this problem is to capitalise on the flexibility provided in the SEEA-EA guidelines which recommend that alongside the release of monetary accounts, associated (bio)physical data (e.g., hectares of land in good condition) also be presented, to aid interpretation and application of the monetary data in policy and decision making. The SEEA-EA guidelines also present another option: to produce accounts in physical terms only, rather than as an accompaniment to monetary accounts (UN et al. 2021, parag 1.12). Many more First Nations peoples' values are suitable for recording in physical terms than can be expressed in monetary terms, flagging this as a potentially viable solution to the problem of 'valuation'.

To further increase the relevance of the accounts to First Nations peoples, beyond monetary and physical accounts, "spiritual accounts" could be included, since a number of values expressed by First Nations peoples are neither monetary nor physical. Outside of the SEEA-EA, spiritually important factors and subjective connections have been successfully measured and expressed in terms of levels of satisfaction using Likert scales (Larson et al. 2019, 2020; Jarvis et al. 2021), shown to be suitable for longitudinal measure (Klemm 2022). Thus, in addition to accounts presenting measures of worth in monetary units and in physical measures (based on a mix of the biophysical metrices such as numbers, tonnes, km^2 etc.), there is room for measures of "spiritual worth", being subjective measures potentially expressed on Likert scales.

Considerations of values at scales beyond individual values is also of high relevance when discussing First Nations worldviews (Stoeckl et al. 2018). IPBES (2022) proposes two possible ways of arriving to societal values: aggregating individual or group values into social values,

which can, if necessary, be weighted to account for power or income differences between stakeholder groups; or expressing shared social values through deliberative processes (Delphi processes or talking circles). Both approaches are of potential relevance and utility to SEEA-EA and are worth further testing.

We note that the SEEA-EA talks about both ecosystem services and ecosystem "disservices" (Sect. 6.3.5); essentially two different sides of the same coin. These are relevant to a concept commonly voiced by First Nations of "Healthy Country – Healthy People" (Garnett et al. 2009), where the health of people is interlinked with the health (condition) of the Country. Not only is improvement in physical and mental health linked to both being on Country and Country being in a good condition; current high levels of social ills and poor mental and physical health of First Nations people are linked to the trauma of removal from their Country and destruction of Country (in an accounting sense, a concept similar to health issues arising from environmental pollution). Improved health of the country would therefore reduce ecosystem disservices and lead to improved health of the people. This suggests that indicators of both the physical and mental health of people might be reliably used to monitor the 'value' of ecosystem (dis)services that are available—and accessible—to people on Country.

Expenditure on environmental protection and resource management

The SEEA-EA requires that, in addition to the information on the extent and condition of ecosystem assets, data about expenditure on environmental protection and resource management, and data on economic activity, should be recorded (UN et al. 2021, parag 6.6). Indeed, this point is of high relevance to First Nations peoples, where a holistic view of nature-people relationships encompasses both "what nature does for people" (i.e. ecosystem services) and "what people do for nature" (i.e. stewardship) (Díaz et al. 2015; Pascual et al. 2017; Kadykalo et al. 2019; Stoeckl et al. 2021). We propose that such data should go beyond recording monetary expenditures, and capture all the co-benefits (Barber and Jackson 2017; Stoeckl et al. 2019) and resulting wellbeing from being able to work on, and improve the condition of Country (Stoeckl et al. 2021; Larson et al. 2022). Furthermore, not all expenditure is of equal value, and some might even be harmful for the First Nations wellbeing (i.e. if conducted by inappropriate people in an inappropriate way or time, Larson et al. 2023). Benefits to First Nations peoples and their communities from caring for Country are maximised when traditional knowledge is used in deciding on the activities and their timing, and when these activities are conducted in culturally appropriate ways (Stoeckl et al. 2021; McKemey et al. 2022; Larson et al. 2023).

LEARNINGS

The SEEA-EA provides a large amount of information in support of economic and environmental policy and decision-making. However, for the SEEA-EA accounts to be relevant and meaningful to First Nations, they need to be developed in the spirit of respectful partnering and co-design, which will inevitably result in modifications to the system prescribed. A fundamental question is 'why' accounts are being prepared (going beyond 'how' or 'what should they contain') (Woodward et al. 2023). For First Nations peoples to fully invest in the accounting process, they must perceive a benefit from the process and/or the outputs. Benefits might be in the form of raising funds from government and philanthropic organisations for Caring for Country (Normyle et al. 2023) but also as a means for furthering their self-determination (Addison et al. 2019) and achieving their socio-economic and cultural goals (Jarvis et al. 2018; Stoeckl et al. 2019). By seeking an accounting *by*, rather than on accounting *for* First Nations peoples (McNicholas and Barrett 2005; Buhr 2011), the process can serve to empower (Jacobs 2000) and focus on what matters to them, rather than commencing from previously determined metrics. This approach must also acknowledge the challenges of representation, inequity and asymmetric power relations among the actors affected, is also acknowledged (IPBES 2022). It is essential that knowledge and information shared by First Nations partners be valued and protected during and after the accounts design, development and preparation process, appropriately recognising and acknowledging First Nations peoples' rights to their Indigenous Cultural and Intellectual Property (ICIP), as covered in the UN Declaration on the Rights of Indigenous Peoples (declaration 61/295 of 2007) and the World Intellectual Property Organisation Treaty on Intellectual Property, Genetic Resources and Associated Traditional Knowledge (WIPO 2024).

Other international initiatives, such as Kunming-Montreal Global Biodiversity Framework (CBD 2022) that fosters full and effective contributions of Indigenous Peoples and reaffirm rights of Indigenous Peoples, could also provide some guidance. The important roles and contributions of Indigenous Peoples and local communities as custodians of biodiversity and as partners in its conservation, restoration and sustainable use is acknowledged, with the Framework stating that "the implementation must ensure that the rights, knowledge, including traditional knowledge associated with biodiversity, innovations, worldviews, values and practices of Indigenous Peoples

and local communities are respected, and documented and preserved with their free, prior and informed consent, including through their full and effective participation in decision-making, in accordance with relevant national legislation, international instruments, including the United Nations Declaration on the Rights of Indigenous Peoples, and human rights law…Nature embodies different concepts for different people. Nature's contributions to people also embody different concepts, such as ecosystem goods and services and nature's gifts" (Section C, articles 7a and 7b, CBD 2022).

The central and pervasive role that culture plays in defining all links between people and nature is also recognised and promoted by IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services), who emphasise and operationalise the role of Indigenous and local knowledge in understanding nature's contribution to people (IPBES 2017). In their recent assessment of the diverse values and valuations of nature, IPBES (2022) argue that the type and quality of information obtained from valuation depends on how, why and by whom valuation processes are designed and implemented. They acknowledge that the valuation process, including valuation methods selected, is at least in part determined by power relations in the society, and that these power relations influence which and whose values of nature are recognised (IPBES 2022).

Several national governments have heeded multigovernmental, international level calls for inclusion of Indigenous values in the discussions related to valuations of nature and its contribution to human wellbeing. For example, New Zealand Manatū Mō Te Taiao (Ministry for the Environment 2022) stated in 2022 that a key aspect of the Ministry's work to improve the Environment Reporting Act 2015 is giving a stronger voice to Te Tiriti o Waitangi, te ao Māori and mātauranga Māori, including exploring how mātauranga Māori, data, evidence, knowledge and science could be shared, collected, managed and protected in environmental reporting. In Canada, government has issued a statement of recognition that Indigenous self-government and laws are critical to Canada's future, and that Indigenous perspectives and rights must be incorporated in all aspects of this relationship (Department of Justice Canada 2025).

Ecosystem accounting has several key features that can be built upon. We propose that in addition to accounting in physical terms (e.g., hectares, tonnes) and in monetary terms, accounting in terms of subjective wellbeing and life satisfaction is needed for at least some types of values: by definition, ES describe the numerous different ways that ecosystems support human wellbeing. These services (however one might call or categorise them) are an essential part of people's identity, belonging and connection (Stoeckl et al. 2018). Attention to the critical importance of time, as well as different conceptualisation of space, also need to be addressed (Stoeckl et al. 2018). Inter-relationships between various ES and the inter-relationships between people and Country, need stronger emphasis to properly capture views of First Nations. Further, it is not only the services that nature provides to people that enhance wellbeing, but the act of 'looking after Country' and ensuring that extent and the condition of the country are maintained for future generations: human–nature relationships in First Nations mental models are not linear but cyclical (Stoeckl et al. 2021; Jarvis et al. 2022; Larson et al. 2023; Finau et al. 2023).

Many of the descriptors and themes identified in the previous work with the First Nations (Stoeckl et al. 2018, 2021; Jarvis et al. 2022; Normyle et al. 2022b) can be integrated within the SEEA-EA since many of the concepts that describe ES also describe some values of the First Nations (Lyver et al. 2017). What the actual modification to the current system will be, will differ for different First Nations, based on their histories, needs, and mental models, but importantly, need to be decided upon *with them*. We strongly recommend that the SEEA-EA First Nations accounts development should not be done as an accounting exercise additional to or separate from the Western accounting at the same area, resulting in a "complementary account" similar to ones proposed for biodiversity and climate change. Such an approach would further the segregation, rather than weaving, of approaches and knowledges. While this may impede comparability, Finau et al. (2023) argue it is important to note that the decision-making purposes of the First Nations are not to compare their Country with that of another groups', but to ensure that the "health" of their Country (which includes them) is maintained.

CONTINUING TO WEAVE TOGETHER

In this section, we further address our overarching research question: how can First Nations peoples' knowledges be reflected within (or alongside) the SEEA-EA? and propose one possible approach in Fig. 1.

For the SEEA-EA accounts to be compliant with the First Nations worldviews, they need to capture the interconnected and non-separable worldview and be developed together with First Nations peoples (Fig. 1). Segments of the First Nations worldviews are however well aligned with the SEEA-EA. First Nations conceptualisation of "Healthy Country" is well aligned with the notion of stock accounts (Fig. 1). What stock accounts could capture is the extent of different features/ ecosystems/ aspects of culture and Country, including the current and reference condition, of

relevance to First Nations conceptualisation of their Country. Flow accounts would then depict key flows (supply and use) between people and Country, measured using physical, subjective and monetary metrics as determined appropriate by First Nations peoples. Subjective measures, potentially expressed on Likert scales, could be conceptualised as measures of "spiritual worth", being subjective satisfaction with the flow of culturally important services. Some flows may reflect ecosystem services (flow of services from Country to people), others may reflect stewardship (flow of services from people to Country), Fig. 1. Both types of flows, ecosystem services and the stewardship have an impact on the condition, health and wellbeing of people. As for Healthy Country, Healthy People accounts could capture the extent of different features/ aspects of individual and societal wellbeing connected to the culture and country (Fig. 1).

One of the major challenges today and into the future is to maintain or enhance beneficial contributions of nature to a good quality of life for all people (Diaz et al. 2018). In relation to the SEEA-EA, calls have been made to include recognition of Indigenous perspectives as a new item on the SEEA-EA research agenda, and for the Indigenous Peoples to become part of the UN processes governing the SEEA-EA, via their inclusion in the UNCEEA (Normyle et al. 2022c). On a multinational level, the Partnership on Cooperation on Nature Capital Accounting, Environmental-Economic Accounting, and Related Statistics, signed between Canada, the United States of America and Australia in 2023 (Joint Statement 2023), calls for the decision makers to account for the many values of nature when making plans and policies, and explicitly states the intent of the Partners to share experiences, methods, and learnings on weaving in of diverse cultures, including those of First Nations.

At the national level, examples of links between the SEEA-EA and First Nations are limited. For example, SEEA-EA for Brazil acknowledge that traditional knowledge from Brazil's Indigenous Peoples has been important in bringing the value of more than 50 non-timber forest products to domestic and international markets (IBGE 2021). However, these products are accounted for in terms of their economic value to the national economy and includes provisioning services only, without accounting for any other values or benefits they might be providing to the Indigenous People themselves. Cultural services flows in the SEEA-EA accounts developed for South Africa include "experiential fulfilment associated with active or passive use, through any type of activity ranging from adventure sport to birdwatching to religious activities or cultural ceremonies." However, the actual accounts are developed for "experiential value: nature's contribution to tourism and property values" only (South African National Biodiversity Institute and Statistics South Africa 2021). Australia has experimented with bringing First Nations peoples' perspectives into environmental accounting at the regional and local levels (Normyle et al. 2021; Woodward et al. 2023; Jarvis et al. 2025), but national accounts are developed using mainstream Western statistical approaches (ABS 2021). Examples provided in this paper open potential avenues for initial incorporation of values of First Nations, that could then be expanded in future accounting periods.

With the First Nations managing millions of km^2 of land and sea in 87 countries on all inhabited continents (Garnett et al. 2018), and the SEEA framework being implemented or planned for implementation in 138 countries (UNCEEA 2024), integration of the First Nations knowledge and value systems into the SEEA-EA framework would be beneficial to all, First Nations, wider community and the rest of nature.

CONCLUSION

In this paper we have described the aims and requirements of the SEEA-EA approach exploring the relevance and fit of the SEEA-EA conceptualisations to those that emerge from the perspective and traditional knowledge systems of First Nations peoples.

We propose that developing Ecosystem Accounts within a respectful partnership with the First Nation group(s) whose Country is being accounted for, and focusing on their priorities and values, multiple benefits (social, cultural, economic, environmental, policy) could emerge. We describe the key principles that should be adopted in the account development process and suggest steps that could be taken to improve the relevance of the accounts and the accounting process to First Nations peoples.

The recognition of First Nations perspectives, values and knowledges within Ecosystem Accounting systems such as the SEEA-EA is still in its infancy, but significant benefits could be realised from progressing this work. We recommend that the ideas described in this paper, alongside other possible approaches, should be developed and tested with First Nations groups in a variety of contexts (geographic and cultural) to further explore how future accounting processes can be codesigned to encompass activities and deliver outputs that are meaningful to both First Nations and non-Indigenous stakeholders and policy makers.

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Declarations

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AUTHOR BIOGRAPHIES

Silva Larson (✉) is a Senior Research Fellow with University of the Sunshine Coast and is associated with the James Cook University. Her main interests are in livelihood and wellbeing improvements, in particular monitoring and evaluation of social-ecological change.
Address: School of Science, Technology and Engineering, University of the Sunshine Coast, Building H1, Sippy Downs, Maroochydore, QLD, Australia.
e-mail: silva.larson@gmail.com

Diane Jarvis is Associate Professor at James Cook University. Her research interests lie in exploring the complex and reciprocal nature of the people-environment relationship, including benefits the natural environment provides to human wellbeing, and the (positive and negative) impacts that human activity has on the natural environment, in both Indigenous and non-Indigenous contexts, then using this understanding to inform policy relating to environmental conservation and natural resource management.
Address: College of Business, Law and Governance, James Cook University, Room 216, Building A1, Nguma-Bada Campus, Cairns, QLD, Australia.
e-mail: Diane.jarvis1@jcu.edu.au

Ewamian People Aboriginal Corporation RNTBC and the Ewamian Ltd Ewamian People Aboriginal Corporation and The Ewamian Limited People Aboriginal Corporation RNTBC (EPAC) is the corporate entity established by the Ewamian People holding their native title rights and interests since their determination in 2013. EPAC represents the Ewamian People for all matters relating to native title and cultural heritage. Ewamian Limited is the operational entity that provides administrative corporate services and governance on behalf of the Ewamian corporate groups. The main services provided are land management through a ranger program based on country and native title and cultural heritage management. EL performs the operational functions for Ewamian People, it manages the office and assists EPAC and the Ewamian People's Charitable Trust.
Address: Mareeba, QLD, Australia.
e-mail: admin@ewamian.com.au

Tagalaka Aboriginal Corporation RNTBC The Tagalaka Aboriginal Corporation RNTBC administers land on behalf of the Tagalaka people. Their native title rights and interests were first recognised in the Tagalaka People and Tagalaka People #2 native title determinations on 10th December 2012. Tagalaka Country covers various lands in the Gulf Savannah region around the townships of Croydon, Normanton and East Hayden.
Address: Croydon, QLD, Australia.
e-mail: tagalakaoffice1@gmail.com

Ryan Barrowei is from the Wurrkbarbar clan group in the southern region of Kakadu. Ryan is the Acting Chair of Kakadu National Park Board of Management, and has a wealth of knowledge and demonstrated governance experience. Ryan is also a member of both the Jawoyn Association and the Nitmiluk National Park Board of Management.
Address: Traditional Owner of Kakadu National Park, Jabiru, NT, Australia.

Daniel Grainger is a senior research scientist and economist for the CSIRO. He has experience in market valuation, non-market valuation and prioritisation of human and natural assets. His primary research interest has been the development of new quantitative estimation methods for the valuation and prioritisation of complex social goods and their impacts.
Address: CSIRO, James Cook University, Building 145, James Cook Drive, Townsville, QLD 4811, Australia.
e-mail: daniel.grainger@csiro.au

Glenn Finau is a Senior Lecturer in Accounting and Information Systems in the Tasmanian School of Business and Economics at the University of Tasmania. His research interests examines the clashes/tensions between Western-based systems of environmental recording/management and Indigenous-based systems of environmental management.
Address: College of Business and Economics, University of Tasmania, Centenary Building, Hobart, Australia.
e-mail: glenn.finau@utas.edu.au

Natalie Stoeckl is a Professor of Economics in the Tasmanian School of Business and Economics at the University of Tasmania. Her research is motivated by a desire to find ways of helping people, businesses, communities and regions capitalise on opportunities to promote genuinely sustainable development.
Address: College of Business and Economics, University of Tasmania, Centenary Building, Hobart, Australia.
e-mail: natalie.stoeckl@utas.edu.au

Michael Douglas is a professor of environmental science at The University of Western Australia. As hub leader for the Commonwealth Environment Research Facilities (CERF), National Environmental Research Programme (NERP) and National Environmental Science Program (NESP), he has led some of the largest and most successful interdisciplinary and transdisciplinary research initiatives ever undertaken in northern Australia. Under his leadership, these hubs have delivered applied outcomes for major environmental issues across northern Australia and have set new standards in Indigenous collaboration. His research on catchment management has directly influenced policy and planning across the region and globally.
Address: University of Western Australia, Perth, WA, Australia.
e-mail: michael.douglas@uwa.edu.au