

From Guidance to Practice: Early Insights from SEEA EA Valuation

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Abstract

The first iteration of the SEEA EA framework has, by design, a strong theoretical foundation in its prescribed approaches to valuing ecosystem services. Building on this foundation, a growing number of National Statistics Offices in countries, including Australia, along with academic researchers and the private sector, are actively testing and extending valuation techniques across a range of ecosystem accounts. These practical applications are generating valuable insights into how different techniques perform in operational settings, including which approaches have proven to be robust and well aligned with the exchange value concept used to represent ecosystem contributions.

Drawing on Australia's recent experience compiling the National Ecosystem Accounts, this paper highlights areas where further clarification and refinement of the valuation guidance would support more consistent application in practice. These include challenges such as volatile or unrepresentative estimates, distinctions between valuing ecosystem contributions versus benefits, the treatment of human and manufactured inputs, and the influence of physical standards on monetary outcomes. While many prescribed techniques align well with SNA principles, others may benefit from further development to ensure conceptual consistency and comparability across the ecosystem accounts.

An open exchange of practical valuation experiences will help practitioners focus effort on techniques that are productive, robust, and conceptually sound. In this spirit, the paper also presents two emerging approaches that show promise in better capturing ecosystem contributions in line with the exchange value concept: a rent revenue share approach for valuing wild-caught fisheries, and a market-based approach to valuing carbon retention services. The paper also explores the usefulness of an approach that was discussed during the development of the SEEA EA but not included in the valuation guidance.

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Questions to the London Group:

- How can the added value of a separate framework like the SEEA EA best be articulated from a valuation perspective, given that certain valuation techniques, such as the residual value method, draw almost exclusively on data and methodologies from the SNA?
- How can a standardised approach to valuing ecosystem services under SEEA EA be achieved when prescribed valuation methods vary widely and produce inconsistent results for similar ecosystems? Is consensus on valuation practicably achievable?
- Is the SEEA EA valuation hierarchy realistic in prioritising market-based approaches, given that markets for ecosystem services are often absent or underdeveloped? Does the hierarchy work? What alternative approaches are practitioners using?

1. Executive Summary

The SEEA EA (United Nations et al. 2024) is increasingly used to measure nature's contribution to the economy, with Australia leading through national ecosystem accounting initiatives. This paper examines ecosystem service valuation methods, focusing on exchange value concepts and Australian examples to improve the consistency and robustness of environmental-economic accounting compilation.

The experience to date has shown that valuation of ecosystem services can produce widely differing results depending on the methods and assumptions used, creating challenges for consistency within the SEEA EA framework. For instance, water and carbon values can vary significantly across techniques, with some estimates conflicting with observed market behaviour or diverging from the exchange value principles underpinning ecosystem accounting. The choice of carbon price—whether based on market prices, replacement costs, social cost of carbon, or policy targets—can substantially affect estimates, highlighting the need for careful methodological assessment, conceptual consistency, and reliance on observable market data where possible. Australia's National Ecosystem Accounts address these challenges by adopting a market-based carbon rental approach grounded in observable carbon prices.

Australia's experience with SEEA EA highlights several conceptual challenges in ecosystem service valuation, particularly around defining the correct accounting boundary and ensuring that estimates reflect ecosystem contributions rather than economic activity already captured within the System of National Accounts (SNA). Case studies of coastal protection, recreation, and climate regulation show that commonly used techniques such as replacement cost, avoided damage cost, consumption expenditure, and the social cost of carbon often value the benefits received by society or protected assets rather than the ecosystem service itself. Logic-chain analysis demonstrates that many valuation methods measure outcomes on the economy side of the ecosystem service pathway rather than the contribution of ecosystem assets, raising concerns about conceptual equivalence and consistency with SEEA EA exchange value principles.

Australian experimentation has also revealed limitations in widely used approaches such as the residual value (resource rent) method, which recent research suggests lacks a sound theoretical basis for isolating nature's contribution and can produce implausible results,

including negative ecosystem service values. In response, Australia's National Ecosystem Accounts have increasingly adopted market-based approaches where observable prices exist, including tradable water rights for freshwater provisioning and quota and licence values for fisheries. New valuation methods, such as the rent-revenue share approach for multispecies fisheries, have been developed to better reflect ecosystem contributions in complex production systems. These examples demonstrate the importance of refining valuation techniques to improve conceptual alignment, reliability, and consistency within accounting principles.

2. Introduction

Implementation of the internationally adopted System of Environmental-Economic Accounting (SEEA EA) (United Nations et al. 2024) has expanded globally, helping countries show how nature contributes to, and is affected by, the economy. Australia has been an early leader, with the Australian Bureau of Statistics (ABS) producing environmental-economic accounts across water, energy, waste, land, fisheries, and environmental taxes, along with experimental ecosystem accounts since the late 1990s. Keith et al. (2017) produced a seminal piece on ecosystem accounting showing that native forests in Victoria's Central Highlands provide substantial and interconnected ecosystem services including water supply, carbon storage, biodiversity habitat, timber production and recreation. From 2020 to 2024, a series of Australian regional ecosystem accounts were produced to inform the production of accounts at a national scale (DCCEE 2026). In 2025, the ABS released Australia's first National Ecosystem Accounts (NEA), including initial monetary estimates of selected ecosystem services, highlighting both progress and the still-experimental nature of valuation methods (ABS 2026b).

Valuing ecosystem services within SEEA EA remains complex and contested. The Statistical Commission recognised that the chapters on valuation describe internationally recognised statistical principles and recommendations for the valuation of ecosystem services and assets (United Nations et al. 2024). While the framework provides guidance based on System of National Accounts (SNA) principles, the hierarchy of environmental economic techniques produces a wide range of estimates. This requires practitioners to (a) assess results against conceptual, boundary and methodological underpinnings, (b) validate results against real-world experience and established knowledge and (c) check whether the estimates are conceptually equivalent. Estimates are often shaped by data availability, methodological familiarity, and policy context, raising concerns about consistency and alignment with the core exchange value principle (Pascoe et al. 2026).

A key source of contestability in valuing ecosystem services surrounds confusion on the conceptual foundation of ecosystem services and the production boundary. The SEEA EA measures the contribution of ecosystem assets to society. The SNA is a broad framework that captures the benefits derived from all goods and services and includes the contribution of other factors of production such as labour and capital. Specifically, the SNA does not (a) separately record the ecosystem contribution to production, or (b) does not capture the ecosystem contribution as it is outside of the SNA production boundary. This confusion has caused some practitioners mis-attributing economic activity from within the SNA to the environment because it may be closely associated with nature or is seen as an appropriate proxy. Valuation techniques such as the residual value method and avoided damages method predominantly

capture data from within the production boundary which may provide misleading estimates of ecosystem services and are unlikely to be conceptually consistent with the intent of the SEEA EA in measuring the ecosystem contribution.

Given the diversity of ecosystem services and limited market data, no single valuation technique is universally suitable. This requires ongoing experimentation and critical evaluation to ensure robust, stable, and conceptually sound estimates. In this context, this paper examines SEEA EA valuation guidance, explores the application of the exchange value concept and ecosystem service valuation, and reviews applicable techniques, drawing on Australian examples to inform further refinement of valuation practices and principles. The SNA records the goods and services produced and consumed within the economy. The ecosystem contribution is generally not recorded separately. Instead, what appears in the SNA is the benefit after it has been combined with labour, produced capital, and institutional arrangements.

3. Challenges with conflicting methods

Several academic papers provide direct comparison of the SEEA EA hierarchy of techniques for the same ecosystem service values resulting in very different estimates (e.g. Chen et al. 2025, Ferrini et al. 2025 and Zandebasiri et al. 2023). These experiences highlight risks in applying a mechanical approach to the valuation of ecosystem services which may be inconsistent and produce values that do not reflect real-world observations. While the exchange value conceptually represents the ecosystem contribution to economic activity, estimation techniques do not always adequately reflect this.

The availability of multiple values based on the wide choice of valuation techniques that are available in the SEEA EA guidelines may open the door for interested parties to explore different values that may align more closely with their perspectives or policy priorities. The range of ecosystem service values brings into question the conceptual equivalence of the techniques and choice of price mechanisms. They may represent different aspects of the relationship between ecosystems and society (Oras et al. 2025).

Some examples where different methodological approaches result in substantially different estimates of exchange values are provided in the following sections regarding water and carbon valuation.

3.1 Different water ecosystem service values

Ferrini et al. (2025) reviewed empirical studies estimating exchange value for water ecosystem services and found that the practice contrasted substantially with the valuation hierarchy of techniques as set out in the SEEA EA. They found that market-based methods, while conceptually aligned with the SNA, were rarely feasible for valuing water ecosystem services. Instead, approaches lower in the hierarchy, such as cost-based approaches and replacement cost approaches dominated. Value transfer approaches also were prolific.

Other studies have found that values are sensitive to the approach adopted. Chen et al. (2025) showed that estimates of water-related ecosystem service values in the Australian Capital

Territory can vary substantially depending on the valuation technique, the accounting treatment (i.e. the SEEA Central Framework or the SEEA EA) and water availability (see Figure1).¹

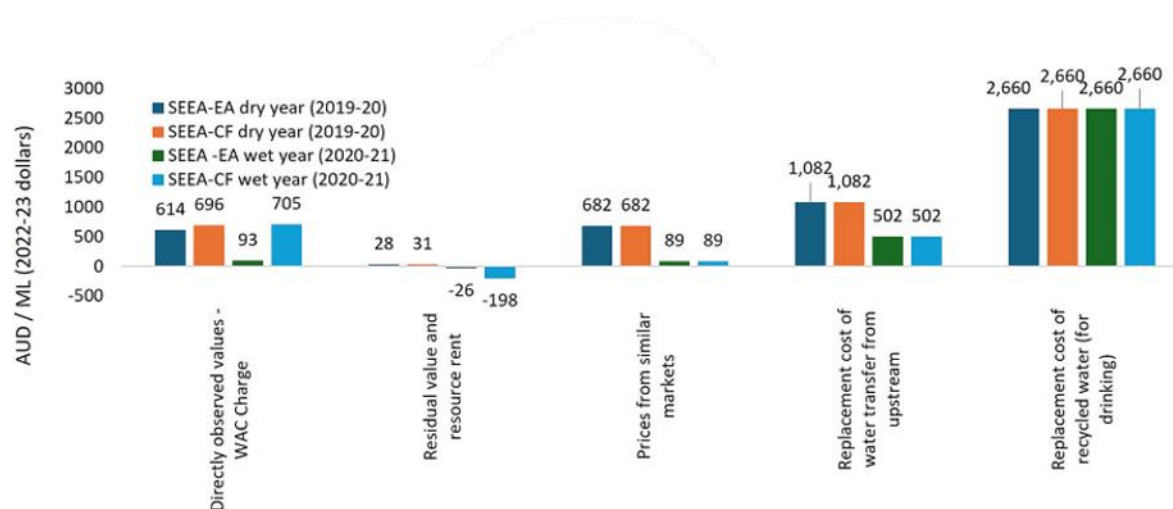


Figure 1 Ecosystem Service (ES) price by valuation method

Source: Chen et al. (2025)

In some cases, applying the residual value method to estimate the resource rent yielded negative estimates of water-related ecosystem services which from an accounting perspective is problematic (Chen et al. 2025). The technique also produced low values during dry periods of AUD\$28-\$31 per megalitre in 2019-20. This estimate conflicts with the well-documented increase in water scarcity values in Australia under drought-like or dry conditions as evidenced by water prices from similar markets (Hughes 2019, Jasper 2019 and Commonwealth of Australia 2021). The median price of water allocations in the Murrumbidgee Regulated River was AUD\$682 per megalitre in 2019-20 which was preceded by three years (2017-19) of intense drought conditions for large parts of Australia.

The replacement cost method of recycled water for drinking generates a much higher estimate at AUD\$2,660 per megalitre (Chen et al. 2025). This estimate largely comprises costs arising from duplicate pipework. Incorporating replacement costs estimates of build infrastructure as a substitute for natural capital is likely to generate estimates that are distinct from the exchange value concept envisaged under the SEEA EA because these types of costs primarily reflect economic or industrial activity rather than the underlying contribution of ecosystem services themselves.

3.2 Are carbon prices equivalent?

The valuation of global climate regulation services includes a measure of carbon retention – the safeguarding of stored carbon and the prevention of its release into the atmosphere, itself the subject of uncertainty. Global climate regulation values are heavily influenced by the choice of valuation technique and the choice of ‘carbon price’. Carbon prices may be sourced from

¹ Under the SEEA-EA treatment, the water provisioning ecosystem service may be recognised when water enters and is stored within the reservoir ecosystem, whereas the SEEA-CF treatment records water when it is supplied to users. SEEA-CF does not value ecosystem services.

domestic or overseas markets or institutional arrangements such as carbon taxes or emission permits.

The State of Victoria (2023) compared three different approaches to derive monetary values for global climate regulation services for the city of Melbourne: the social cost of carbon (SCC), replacement cost and market prices. The estimates comprise sequestration and carbon retention. The report incorporates global SCC estimates of between AUD\$75 to AUD\$178 per tonne of CO₂-e, market prices of AUD\$16 per tonne of CO₂-e and a replacement cost approach based on the marginal cost of the GHG abatement or offset measures, estimated at AUD\$74 per tonne of CO₂-e. Social cost of carbon estimates can vary substantially across studies due to differences in model specification, discount rates, climate sensitivity, damage functions, and other key assumptions. The resulting carbon retention value for the city of Melbourne in 2019 ranges from AUD\$35 million per year (using the market price/replacement cost) to AUD\$106 million per year (using the SCC) based on an annuity with a 4% discount rate for 100 years (State of Victoria 2023). The equivalent numbers for sequestration are estimated at between AUD\$6 to AUD\$19 million.

Social Cost of Carbon (SCC) estimates the economic value of carbon sequestration based on the avoided global damages from climate change. It represents the present value of future social and economic costs avoided by preventing the emission of one additional tonne of CO₂-e. Market prices value carbon sequestration using observed market prices for carbon credits or emissions permits. Replacement Cost Approach values carbon sequestration based on the cost of alternative greenhouse gas abatement measures required to achieve a specified emissions reduction target. Under this approach, the value of carbon sequestration provided by vegetation is measured by the cost savings arising from a reduced need for other abatement activities or projects required for Australia to meet its emissions reduction commitments

3.2.1 The social cost of carbon

Estimates that rely on a SCC can be subject to substantive revisions. United States based estimates of the SCC have often been relied on in worldwide applications (see Hutley 2021 and Government of Canada 2022). Hutley (2021) used US SCC estimates as they are generally derived using similar modelling approaches. Furthermore, many of these estimates draw on the sophisticated and widely recognised modelling framework developed by the US Interagency Working Group (IWG). Estimates of the SCC have evolved significantly across different US administrations, reflecting changing policy priorities in the valuation of carbon emissions, improvements in methodology and data. The US Government (2021) estimate of the SCC was updated to US\$51 per ton of CO₂. Rennert et al. (2022) provided updated estimates of the SCC of US\$185 per ton of CO₂ using a 3% discount rate.

SCC estimates are also sensitive to the value of the discount rate. For instance, the US Government (2016) central estimate of the SCC for 2020 was US\$42 per ton of CO₂-e using a discount rate of 3% and US\$62 per ton of CO₂-e using a discount rate of 2.5%.

Regardless, the SCC typically includes welfare values that examine the impact of damages on consumption, health, and productivity (see Rennert et al. 2025 and Adler et al. 2017).² The SCC is an economic estimate that can be useful in quantifying a range of climate related flow on impacts, but at its core it does not link to any one ecosystem or ecosystem service flow, which is the focus of the SEEA EA framework. That is, there is a distinction between estimating the contribution from ecosystem assets and the flow-on impact of those services.

3.2.2 Target based carbon pricing

The ABS considered several carbon prices to estimate the retention value of global climate regulation services in Australia's NEA. A target-based approach was one such approach considered as an alternative to the government's auction scheme. Infrastructure Australia (2024) estimated that a carbon price of AUD\$66 per tonne of CO₂-e would be required for Australia to meet its national net zero emission target by 2050. The target-based approach was ultimately not adopted for Australia's NEA because the SEEA EA framework is a positive framework, providing information on what is, as opposed to what might or should be. Furthermore, a target-based approach need not represent a market clearing (exchange) price.

This distinction is important because basing accounts on a normative framework is problematic in several ways. Firstly, a target-based approach requires estimates on what a carbon price could be into the future such as might be the case for a net zero target. Such estimates are highly susceptible to uncertainty and revisions both in terms of (a) the level of the emission reduction target, (b) potential changes in government mandated trajectories on how to transition to a target and (c) advances in technological innovations that enable firms to abate their emissions in a cost-effective manner. These estimates typically require agreement on the discount rate that may also have an outsized effect on the estimated ecosystem service value.

This poses challenges for practitioners as to which models to rely on and implicitly, the assumptions underpinning those models. Different models and assumptions are likely to result in different values, with a risk that the final models accepted may be driven by the values they produce rather than their actual appropriateness (Iftekhhar and Pannell, 2015). This may also affect the confidence in the consistency of global climate regulation values.

3.2.3 Market based carbon prices

Australia's NEA applies a carbon-rental approach, based on the annuity technique described in Edens (2021), as an estimate of the rental value that ecosystem owners, such as forest managers, could accrue for maintaining a stock of carbon. This technique links the value of global climate regulation services to a market price for carbon sequestration.

The retention value of global climate regulation services is calculated by multiplying the carbon stock by the relevant carbon price. To express this stock value as an annual flow, it is converted to an annuity using an appropriate rate of return. Conceptually, the ecosystem service associated with retaining carbon can be represented through the annualization of an asset value, similar to the interest earned on a savings account or the return generated by an

² See section 4.1.3 - Logic Chain for more detail.

investment. The rate of return reflects the expected yield on this asset and is estimated as the sum of a 4% real discount rate and the relevant rate of price inflation (the Consumer Price Index). The choice of discount rate is consistent with the rate used in the World Bank's *Changing Wealth of Nations* framework. The 4% approximated the long-run (100 years or more) global real return on financial assets and provided international comparability of wealth estimates. This facilitates comparison with other natural capital accounts and previous estimates. The selected rate is also considered appropriate for public ecosystem assets such as national parks and Crown land.

The institutional settings in Australia provide the principal source for carbon prices, reflected through (a) a fixed carbon price in 2013 and 2014 and auction prices undertaken by the Clean Energy Regulator (CER) between 2015 and 2023. The CER ran Emissions Reduction Fund auctions under the Australian Carbon Credit Unit (ACCU) Scheme in which registered ACCU projects bid to sell carbon abatement to the Australian Government. As the ACCU market continues to develop, a key concern has been whether the depth of the market is sufficient to provide a representative price. Notwithstanding, ACCUs offer the advantage of being grounded in observable auction prices. The auctions used a pay-as-bid reverse auction mechanism, and the contracted projects generated abatement by either avoiding greenhouse gas emissions or sequestering carbon (removing and storing carbon from the atmosphere).

As the fixed carbon price and ACCUs are reported in dollars per tonne of carbon dioxide equivalent (\$/t CO₂-e), a conversion to carbon (C) is required when valuing carbon stocks. This is achieved using the 44/12 conversion factor, which accounts for the difference in molecular weight between carbon dioxide and carbon.

Using this approach, Australia's NEA 2026 estimated climate regulation services at \$218.2 billion in 2021–22, based on 34.6 million kilotonnes of carbon stored in selected ecosystems (ABS 2026b).

4. Conceptual issues identified through the application of SEEA EA principles: Australian experiences

The experience to date has revealed that different valuation techniques prescribed under the SEEA EA produce inconsistent results. The SEEA EA applies the SNA concept of exchange values to ensure that ecosystem service values and ecosystem asset values are comparable with the values of products and assets recorded in the national accounts. This has contributed to a problem in identifying the correct boundary as some valuation techniques, or their application, reflect economic activity in the SNA production boundary. This is in direct contrast to the intent of the SEEA EA that is meant to capture the contribution of ecosystems from the extended production boundary (United Nations et al. 2024, para 1.39).

Furthermore, it is no longer clear that certain conceptual foundations are adequate or fit for purpose in the context of the SEEA EA. There is a spectrum of values ranging from ecosystem functions to the flow-on benefits that society receives, which reflects direct ecosystem contributions, societal benefits and economic values (Oras et al. 2025). For instance, the monetary value of a fish may be captured through quota licenses (the right to capture wild fish),

a landed price incorporates additional value that accounts for the fisher's labour and capital inputs, whereas the retail price also incorporates processing, storage and distribution costs.

Consequently, the desire to match concepts such as resource rent in SEEA EA with the SNA construct of resource rent may not only be counter-productive but be counter to the intent of measuring ecosystem and natural resource contributions to the economy because the derivation of resource rent is typically captured within the production boundary. The *raison d'être* for creating the SEEA EA as a separate framework is the acknowledgment of shortcomings in the SNA, but contrasts with the desire for the SEEA EA to conform to the SNA to maintain consistency.

4.1 Boundary issues

4.1.1 Coastal protection

Australia has experimented with monetary valuation of coastal protection using both a replacement and avoided damage cost, two of the most commonly used techniques to estimate coastal protection services (Cannard et al. 2025). The techniques can be applied at both the ecosystem level, such as may be drawn from the restoration of ecosystems, and the economy in terms of construction of built capital, such as seawalls.

Australia first published experimental physical and monetary estimates of coastal protection services in the [National Ocean Account, 2022](#) (ABS 2022). Monetary values were derived using a replacement-cost method, estimating the cost of maintaining built infrastructure (such as seawalls) that would provide an equivalent level of protection. In the National Ocean Accounts the annual service value of mangroves and saltmarsh was estimated through the capital depreciation of seawall infrastructure (i.e. the replacement cost method). The monetary value of coastal protection services ranged from \$1.96 to \$7.84 billion per year for mangroves protecting 88,100 dwellings and from \$416 to \$1,664 million per year for saltmarsh protecting 85,600 dwellings, based on expected infrastructure lifespans of 25 to 100 years. The physical scope of the coastal protection included all saltmarsh and mangroves within 200 metres of the coastline that had a minimum belt width of 40 metres for saltmarsh and 90 metres for mangroves. These ecosystems were assumed to provide protection to areas up to 1 kilometre inland.

However, seawalls (a) are often not cost-effective in areas with limited dwellings (b) may cause ecological impacts and (c) may be designed to meet engineering standards that do not reflect the coastal protection from existing marine ecosystems such as mangroves and saltmarshes. More concerning is that the application of replacement cost may adopt a weak substitutability framing between natural and built capital, one of the drivers that has contributed to a decline in the condition and extent of ecosystems.

For the [National Ecosystem Account 2025](#) (ABS 2025), the method was reviewed and an avoided-damage-cost approach was applied, based on average dwelling damage costs from a 1-in-15-year flood event. The annualised value of avoided damages was estimated at \$57 million per year for mangroves protecting 69,400 thousand dwellings and \$8 million per year for saltmarsh protecting 44,300 thousand dwellings, based on the highest-risk dwellings (up to

1 m above the Highest Astronomical Tide). The physical scope of the coastal protection was defined by identifying areas protected by mangroves and saltmarsh that met specific criteria within the coastal inundation (coastal connectivity) layer, itself a highly uncertain measure. Eligible vegetation required a minimum belt width of at least 100 metres for mangroves and 40 metres for saltmarsh and had to meet a connectivity threshold approximating a 1-in-100-year coastal inundation event.

A counterfactual example serves to illustrate concerns in the application of the technique to built capital. Imagine that a beach-side property builds a second story. The estimate of the coastal protection service would increase under the avoided damage cost method as the house is now worth more. Yet, the ecosystem condition and extent of an ecosystem asset such as mangroves may not have changed. The benefit of the service has increased, but the level of service itself has not. In this case the improved value (or part thereof) of built capital is misattributed to ecosystems.

It may also be noted that the SNA does not generally infer changes in the value of non-market services from changes in the number or value of beneficiaries. For example, the value of services provided by national parks and public galleries is measured primarily using production costs. This suggests caution in adopting valuation approaches that allow changes in the value of beneficiaries to drive estimates of ecosystem contributions where ecosystem condition and service supply remain unchanged.

A key insight from this experimentation is that these techniques are inconsistent with the SEEA EA valuation guidelines (Chapters 8–10). Avoided damages value the benefits to the protected asset rather than the contribution from the ecosystem service itself, contrary to paragraph 8.24 of the SEEA EA (United Nations et al. 2024). The application of replacement cost using industrial based activities (i.e. economic activity within the SNA boundary) makes strong assumptions about substitutability. Both methods draw on monetary values from built capital as a proxy but do not necessarily produce a SEEA EA-consistent exchange value. Rather they reflect an economic cost of an engineered, purpose-built infrastructure asset that may differ considerably from the level of protection that ecosystems provide raising questions as to its equivalence. The ABS is currently reviewing methods to value coastal protection ecosystem services. Possible candidates for consideration include costs arising from repairing or maintaining marine ecosystem such as mangroves.

4.1.2 Valuation of recreation-related services

Another area where the production boundary matters is the valuation of recreation-related services. The two most applied valuation methods, Consumption Expenditure and Simulated Exchange Value leave room for alternative interpretations of the accounting treatment and require substantial assumption about market structures. This provides challenges with account consistency more generally. These are explained in more detail below.

4.1.2.1 Consumption Expenditure

The SEEA EA does not explicitly justify its recommendation to use Consumption Expenditure (CE) as a proxy for the exchange value of recreation-related services. However, the SEEA EA

interim technical report on monetary valuation (NCAVES and MAIA 2022) suggests that CE represents a minimum willingness to pay for the ecosystem service. The report recognises that CE is already recorded within the SNA but argues that there is no need to reallocate it within the sequence of accounts given it is used as a proxy to value complementary ecosystem services outside the SNA production boundary.

This reasoning leaves room for alternative interpretations. One interpretation is that the estimated exchange value of recreation-related services constitutes an addition to the CE already recorded in the SNA. However, this would raise a double-counting concern unless CE is reallocated. It would also imply that visitors are effectively willing to pay for the recreation-related services (perhaps via an imposed access fee) in addition to the observed CE. Such doubling of the implicit “price” of a recreational trip would, in most cases, reduce visitation, unless demand was perfectly inelastic, which is unlikely.

A related justification for using CE as a proxy has been advanced by Pelletier et al. (2021), who argue that CE would not occur in the absence of recreation-related services. While appealing, this argument appears at odds with a core SEEA EA principle of isolating the ecosystem service from human and produced capital, which are used jointly to enable recreational trips. Beyond this conceptual tension, a more substantive concern is that reliance on CE based exchange values risks generating misleading signals for decision-making. For example, an increase in estimated exchange value may simply reflect higher CE unrelated to the ecosystem service, such as a shift from camping to hotel use for multiday trips rather than any improvement in the underlying ecosystem asset).

4.1.2.2 Simulated Exchange Value

The Simulated Exchange Value (SEV) method infers a ‘market’ price and quantity by simulating what visitors would be willing to pay for recreation-related services under a hypothetical exchange (Caparrós et al. 2003; Caparrós et al. 2017; Donnelly and Melstrom 2026; Scheufele and Pascoe 2023 and Scheufele et al. 2026). It relies on observed or estimated willingness-to-pay (e.g. via non-market valuation) and cost (e.g. government management cost records) to match demand with supply. The SEV method relies on strong assumptions about supply behaviour, cost structures, and pricing mechanisms. Under the assumption of monopolistic competition (which are likely to characterise many recreational contexts), the resulting price includes monopoly rents. This creates a fundamental identification problem: the SEV of recreation-related services may inadvertently capture monopoly rents in addition to resource rents. Whether and how these two sources of value can be disentangled warrants further investigation. Addressing this issue would help strengthen the theoretical foundations of the SEV method. Finally, because manufactured and human inputs must be deducted, the SEV method effectively combines a market simulation approach with the Residual Value Method (RVM). This raises the question of whether the concerns associated with the RVM, discussed in Section 4.2, also apply to the SEV method.

An alternative method worth reconsidering is adapting the Marginal Value Pricing (MVP), which was discussed during the SEEA EA development for valuing open access green space supplied to households (Barton et al. 2019).

Rather than estimating exchange value of recreational trips, this method would estimate exchange value of ecosystem characteristics that contribute to recreational experiences, such as forest condition, wildlife presence, or landscape amenity. The required marginal value functions would be derived using a random utility model of recreation site choice, in which recreationists are assumed to derive utility from the ecosystem characteristics of the sites they visit. The estimated functions would identify the marginal values corresponding to the observed level of each relevant ecosystem characteristic recorded during the accounting period. These values would then be summed across all trips to derive the total exchange value. In essence, the exchange value of the recreation-related service would reflect the value generated by the ecosystem characteristics experienced by visitors during recreational trips.

The approach would produce revealed-preference shadow prices for ecosystem characteristics that are consistent with observed recreational behaviour and substitution patterns. Since the marginal value functions of the ecosystem characteristics would be estimated from a multi-site choice model, they reflect the equilibrium value of that attribute in the presence of all substitute recreation opportunities available during the accounting period.

To align this approach with ecosystem accounting concepts, the utility function could be specified such that ecosystem, human, and produced capital represent the production inputs required to generate the recreational experience. For example, a composite ecosystem-specific condition index may represent the ecosystem contribution and iconic status, a composite access index may represent enabling capital that facilitates the use of ecosystem services, and a composite infrastructure index may represent produced capital. The recreational value generated for a trip would therefore be modelled as a function of ecosystem condition and iconic status, access, and infrastructure, with only the ecosystem component attributed to the recreation-related service. This approach would provide a transparent basis for distinguishing the contributions of ecosystems from those of enabling and produced capital when estimating exchange values for recreation-related ecosystem services.

This approach bypasses the need to simulate a market equilibrium and avoids explicit assumptions about supply functions, cost structures, and pricing rules. Importantly, the level of ecosystem provision at which MWTP is evaluated is not arbitrary but reflects the existing (or policy-determined) level of supply, which is itself constrained by government expenditure, management costs, and competing land uses. In this sense, supply-side considerations are implicitly embedded in the observed quantity of recreation-related services. If ecosystem provision is understood to reflect decisions informed (at least indirectly) by both costs and benefits (as estimated via a random utility model of recreation choice), then evaluating MWTP at this level yields an exchange value of recreation-related service that is anchored in a real-world allocation outcome.

Under this attribute-based approach, there is no need to subtract supply costs ex post, as the valuation targets the ecosystem input directly rather than a residual of production. The resulting estimate reflects the value of ecosystem attributes as perceived by users at the prevailing level of supply. While this implies a departure from a strictly production-based definition of exchange

value, it offers a transparent and empirically tractable alternative to the original SEV method. It avoids the need to disentangle exchange value of the ecosystem service from monopoly rents and other artefacts of market structure, thereby reducing reliance on strong and often unverifiable assumptions. The key remaining assumption is that the observed level of the recreation-related service provides a meaningful anchor that reflects underlying cost constraints. Where this holds, the approach can be interpreted as yielding a demand-consistent valuation of ecosystem contributions that is grounded in actual behaviour and policy-relevant supply conditions, without requiring explicit modelling of supply-side processes.

However, this approach entails substantial data and analytical requirements and may be challenging due to high levels of complexity introduced via heterogeneity across space, ecosystems, activity and visitors. This may represent a challenge to its implementation. Nevertheless, this approach should be revisited by exploring its application across a range of spatial scales, recreational activities, and ecosystem attributes.

It is acknowledged that this approach entails substantial data and analytical requirements and may be challenging due to high levels of complexity introduced via heterogeneity across space, ecosystems, activity and recreationists. Nevertheless, it is recommended that the MVP be revisited by exploring its application across a range of spatial scales, recreational activities, and ecosystem attributes.

4.1.3 Logic chains

Logic chains can be useful in clarifying boundary issues and explaining how the application of valuation techniques can measure different aspects of an ecosystem service. Logic chains explain how ecosystems contribute to human well-being and economic activity. Furthermore, they help structure the causal relationships between ecological assets, the services they provide, and the flow-on benefits that people derive (ABS 2026a).

For climate regulation services, the logic chain identifies ecosystem assets such as forests, woodlands, shrublands, grasslands, wetlands, and marine ecosystems which support ecological functions that absorb carbon (Figure 2). These functions generate valuable global climate regulation services comprising carbon sequestration and retention. Valuation in the SEEA EA framework focusses on the left-hand side of Figure 2, the ecosystem assets and the services, whilst the right-hand side can also be valued, but these values focus on the benefit or outcome of ecosystem services.

Intermediate benefits, while not present in the SEEA EA framework, link the ecosystem service with the other benefits. In this case, an intermediate benefit is the reduction in atmospheric greenhouse gas (GHG) concentrations, which helps mitigate climate change and its associated risks. The final benefits include reduced exposure to climate-related hazards, leading to improved public health and decreased economic disruption. In the SEEA EA framework these benefits are collectively consumed by governments on behalf of society while individuals, households, and businesses may benefit directly as well.

The logic chain underscores why some valuation techniques may not reflect the exchange value as envisaged in the SEEA EA framework. For example, the SCC measures the economic value of damage caused by carbon emissions. Typically, this measure focusses solely on outcomes, such as avoided impacts on infrastructure, production or health impacts (the right-hand side of Figure 2), rather than on the contribution from ecosystems (the left-hand side of Figure 2). This raises the question of whether the SCC is conceptually equivalent to other techniques that measure the exchange value of the climate service ecosystem service.

A key insight from the logic chain is understanding how different practitioners approach the valuation challenge. Estimates of the global climate regulation service will differ on whether practitioners approach the valuation problem from the economy (as measured in the SNA) or the ecosystem side of the logic chain, which in turn influences the choice of valuation technique.

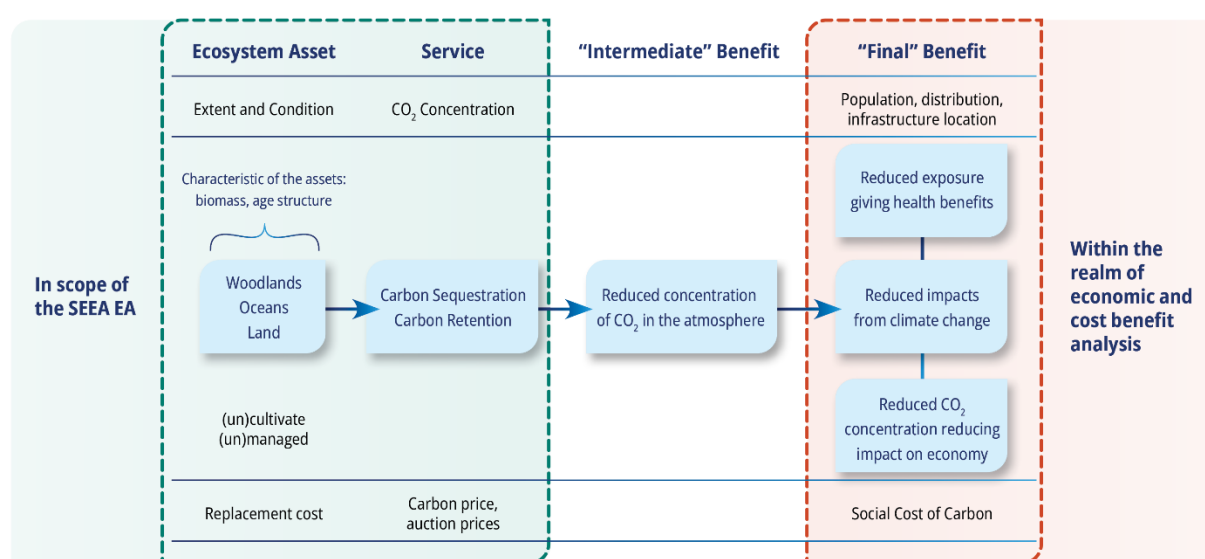


Figure 2 Logic chain for global climate regulation services
Adapted from Hein et al. (2019)

4.2 Recent evidence on the use of the Residual Value Method

One of the most commonly applied methods for valuing ecosystem services is the “residual value method”, often also referred to as the resource rent approach (Atkinson and Obst 2017). The residual/resource rent method derives the value of the ecosystem service as the residual after all costs, including normal returns to produced capital, are deducted from revenue, on the assumption that what remains reflects the ecosystem contribution (United Nations et al. 2024).

Concerns regarding the use of residual method have been raised previously for a range of reasons. For example, Obst et al. (2016) suggested that residual approaches are inappropriate where market structures prevent observed prices from reflecting a meaningful exchange value for ecosystem services. For example, in the case of water provisioning services, water prices are often regulated with the aim of cost recovery rather than rent generation, resulting in negligible or zero residual. Horlings et al. (2020) found that variation in estimated resource rents is often

driven by factors unrelated to ecosystem service provision, resulting in unreliable valuation outcomes. More serious, however, is the potential for the method to result in negative estimates of the exchange values (Edens and Graveland 2014). For example, based on the residual value approach, the Office for National Statistics (2025) estimated the value of water related ecosystem services in the UK to be GBP£-2.5 billion.

Pascoe et al. (2026) reviewed the approach and concluded that it is not fit for purpose due both to conceptual and practical reasons, with shortcomings of the residual method extending beyond issues of measurement, data availability, or market imperfection. Using relatively simple economic models, Pascoe et al. (2026) demonstrated that no theoretical relationship exists between average residual returns and the contribution of the ecosystem input to production. While the method can, in some cases, generate estimates that appear reasonable, Pascoe et al. (2026) show that this occurs by coincidence rather than design. As typically applied, the approach potentially misattributes the value of the ecosystem contribution to produced capital and captures elements of economic activity that already lie within the production boundary rather than isolating nature's contribution.

The widespread application of the technique and its reliance on SNA data bring into question the value add of a separate framework, at least in terms of monetary estimates.

4.3 Joint production – accounting for multispecies wild-caught fisheries

Experimentation to date has revealed the need to develop or adapt valuation techniques that better capture the concept of exchange value to the ecosystem contribution. One such example is the revenue rent share approach developed for Australia's NEA.

The SEEA EA essentially assumes that ecosystem services are separable, such that each service can be measured and valued discretely. For activities that involve joint production, developing appropriate exchange values is more complex. Fisheries biomass provisioning services is one such area that provides a challenge for estimating exchange values due to the joint nature of fisheries production. Most fisheries are characterised by joint production, with fishers catching several different species with each unit of fishing effort. These fisheries are generally referred to as "multispecies fisheries". Although fishers may target a particular species, they will also catch several other "byproduct" species that also contribute to their revenue. In many cases, fishers depend on this mix of species to supplement their revenue. Further, many fisheries straddle several ecosystems, and in the case of multispecies fisheries, the combination of these species (and subsequent catch) may change across these different ecosystems.

While the ecosystem service in quantity terms (i.e., the retained harvest) can be readily measured, identifying the exchange value of wild-caught catch is more complex. Under the SEEA EA valuation hierarchy, the closest applicable approaches to estimating exchange values are those that rely on observable market prices, residual based approaches and production function-based approaches. While market prices are observable for the final products, allocating costs to individual species within multispecies fisheries is infeasible, resulting in residual-based approaches to estimating exchange prices being unreliable (notwithstanding the

other criticisms associated with the residual approach noted above). For production function-based approaches, the marginal value product of individual species may be estimated provided biomass information is available for each. However, such data are generally not available for all species, especially at the ecosystem level, while the joint production nature further complicates the relationship.

In Australia, several fisheries are managed through licences and quotas: licences grant the right to fish under specified conditions, while quotas, often as transferable shares of the total allowable catch (TAC), limit how much can be harvested. These individual quota shares can be traded or leased, creating a market-based system that controls catch levels while supporting sustainability and economic efficiency across Commonwealth and State fisheries.

In individual transferable quota (ITQ) fisheries, the exchange price of the ecosystem service is (theoretically) directly observable via quota trading prices. In theory, quota lease prices reflect the annual resource rent generated by an additional unit of catch, while quota sale prices represent the discounted value of expected future rents and therefore the value of the underlying ecosystem asset (Newell et al. 2005; Pascoe et al. 2019 and Gunnlaugsson et al. 2020). For single species fisheries, this assumption is reasonable. However, for multispecies fisheries, several complications may distort this relationship. First, not all species are usually included in a quota system, and the value of associated byproduct can be captured in part in the quota price of the target species. Where quota is more limited for some species than others (i.e., providing a “choke” on total production), the marginal value of the quota may exceed its species-specific value as the quota price of the limited species may also capture the value of other quota species that it enables to be caught jointly. Conversely, the quota trading value of the other quota species may be reduced if they are not able to be caught without access to the “choke” species quota. For other non-quota species, and for all species in non-quota fisheries, the value of access to the resource is captured by the licence value, assuming limited entry management is in place. This is not species specific but reflects the value of access to the resources as a whole.

In non-quota, input-controlled fisheries, licence values similarly capture the discounted future rents associated with operating in the fishery (Flaaten et al. 1995). These techniques rely on situations where the price of the ecosystem service can be directly observed.

Pascoe and Scheufele (2025) devised a rent revenue share technique for estimating the exchange value from wild caught fisheries which can be applied to multispecies fisheries (Figure 3). This treats the value of access to the total resource as defined by the average (per vessel) annualised value of the combined licence and quota holdings, reflecting the total willingness to pay to access the multispecies resource. This is divided by the average revenue to derive the rent revenue share. This share can be applied to the price of each individual species to measure its contribution to the overall value. The distribution of catch of the species across ecosystems can then be used to assign the proportion each ecosystem contributes to the total exchange value. This technique was used to estimate the ecosystem service value of fisheries in Australia’s NEA (ABS 2026b).

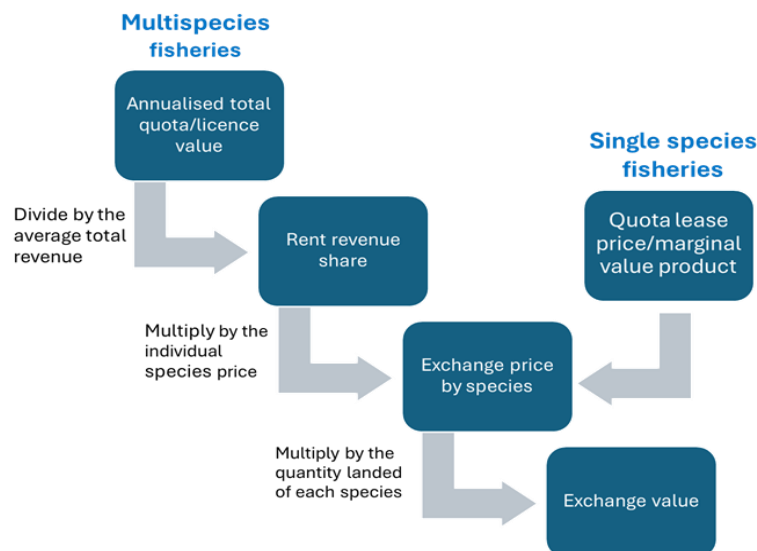


Figure 3: Summary of process for estimating exchange prices for individual species
Source: Pascoe et al. (2024)

In Australia's latest NEA, the estimated ecosystem service value of Commonwealth and State fisheries wild caught fish was [\\$463 million from 162 kilotonnes of catch in 2021-22](#) (Australian Bureau of Statistics 2026b). In the same year, the output of Commonwealth and State fisheries wild caught fish was valued at \$1.5 billion of Gross Value Product (GVP), which includes costs associated with harvesting fish (Tuynman et al. 2025). When those fish are processed, packaged, and sold in supermarkets the added value of this economic activity contributes to GDP, including the original ecosystem service value.

4.4 Water provisioning services

One example that highlights the potential for market-based estimates in estimating ecosystem services occurs when water access rights are traded. In Australia's NEA, water provisioning services are valued using market prices from tradable surface-water allocations, specifically the Murray-Darling Basin, home to one of the world's most mature water markets. Water supply services capture the ecosystem's contribution to providing usable water for households, businesses and government.

Under this approach, the value of ecosystem services is linked to prices paid for water extraction rights, where these rights can be separately identified from land values and are actively traded in established water markets. In theory, the value of water rights should be closely related to the marginal value of water estimated using productivity-based valuation methods (NCAVES and MAIA 2022). The value of water rights can be highly sensitive to changes in water availability. For example, during periods of drought, increased scarcity of water may significantly increase the market value of water rights. Consequently, fluctuations in water rights prices may reflect changes in water availability and market conditions, in addition to the underlying value of the ecosystem service.

In Australia, tradeable water rights manage access to water resources: a water access entitlement provides a perpetual right to a share of water from a specific catchment and can be

bought, sold or leased. These rights are recorded in the SNA as non-produced intangible assets. Because they reflect ownership and control rather than actual water use, they are excluded from GDP and other production measures and fall outside the SNA production boundary.

Around 1,750 GL of surface-water allocations are traded each year, about 15–20% of water used for drinking and material purposes. About 90% of trading occurs in the states of New South Wales and Victoria due to the maturity of Murray–Darling Basin markets. Prices respond to rainfall, storage levels, agricultural demand, institutional settings and broader climate conditions.

The monetary values in Australia’s NEA include only surface water supplied to the economy, excluding groundwater. Values are calculated by applying ecosystem service prices, which are derived from median system-level prices from the Bureau of Meteorology and aggregated to state and national levels using volume-weighted averages, to physical water use from the census of water utilities. The Australian total price is derived as a volume weighted median across states and territories.

Freshwater provisioning was valued at AUD\$864 million in 2022–23, down from AUD\$1.85 billion in 2015–16 (Figure 4). The 52% decline in the value of surface water used as a material between 2015–16 and 2022–23 reflects improved water availability under wetter climatic conditions. Dry conditions in 2015–16 reduced water storages and increased the value of water, while sustained La Niña rainfall in 2022–23 replenished catchments and lifted dam storages to record levels, easing supply pressures and reducing the cost of water.

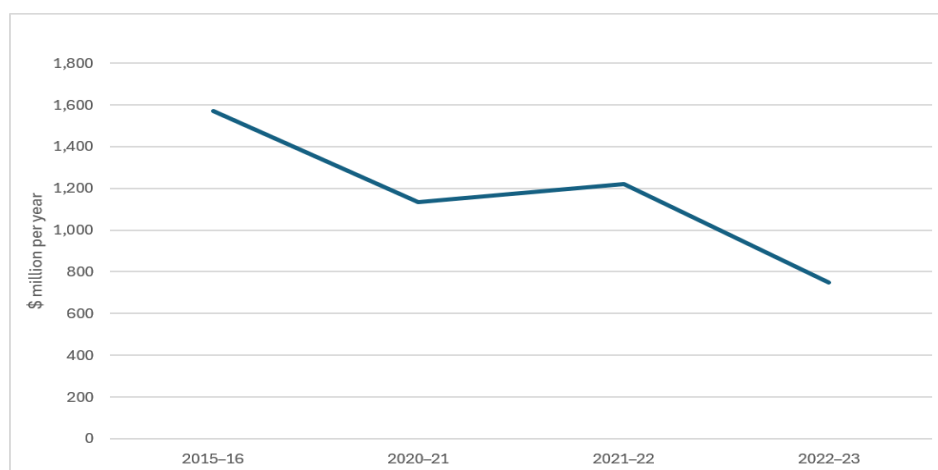


Figure 4: Value of surface water used as a material, Australia
Source: Australian Bureau of Statistics (2026b)

5. Conclusions

Early work on developing SEEA EA based monetary accounts reveals that, at times, there is a disconnect between the theory underpinning the valuation guidelines in the SEEA EA guidance material and practice. The framework offers flexibility by listing several approaches without prescribing specific techniques for different ecosystem services, allowing users to select approaches best suited to their context and objectives. This has contributed to variation in how

valuation techniques are applied, resulting in monetary estimates that are highly variable, are not always directly comparable, limiting coherence, and at times, reflect differing interpretations of ecosystem service value. The concern is that some techniques estimate downstream benefits that are conceptually distinct from the ecosystem service flows that are the focus of SEEA EA and so may not be fully consistent with the conceptual boundaries and objectives of ecosystem accounting. Therefore, careful consideration is required to determine precisely what is being measured and the extent of the ecosystem's contribution to the resulting flow-on benefits.

Statisticians around the world are grappling with these aspects, drawing on the experience of the national accounts and a large literature on environmental economics. In doing so practitioners are guided by the need for valuation techniques to be compatible with the national accounts framework as well as ensuring that the values are based on robust statistical measurement and conceptual underpinnings (Brown et al. 2021).

Three observations stand out:

- Not all valuation techniques are conceptually equivalent, nor do they produce an exchange value of ecosystem services. Their application across different accounting boundaries means they often measure different types of values.
- The choice of valuation technique and their application in the production boundary or the extended production boundary implies weak or strong substitutability, which in the former can contribute to a decline in natural capital. That is, the valuation techniques are not neutral in their application.
- It is important to establish not merely a physical link between the ecosystem and beneficiaries, there is also the need to establish a monetary link, which forms the foundation of the monetary supply use tables. Put another way, there needs to be a link between the value of the ecosystem service and its underlying biophysical characteristics (extent and condition). Not all prescribed valuation techniques in the SEEA EA (e.g. SCC) establish this link.

As ecosystem accounts are implemented more tailored techniques are needed that better reflect the exchange value of ecosystem services. This may require consensus on which techniques are appropriate for each type of ecosystem services, which can usefully be informed by the development of experimental ecosystem accounts worldwide. This would ensure that results are more consistent, representative and clearly demonstrate that the values reflect the ecosystem's contribution to the economy and to society. Consequently, valuation of ecosystem services may need a different approach to the SNA framework given that ecosystems are often outside the SNA production boundary. The challenge will be to ensure these approaches remain consistent with the broad principles underlying the concept of 'exchange value'.

References

Adler M, Anthoff D, Bosetti V, Garner G, Keller K and Treich N (2017) [Priority for the worse-off and the social cost of carbon](#). *Nature Clim Change* 7, 443–449.
<https://doi.org/10.1038/nclimate3298>

Atkinson G and Obst C (2017) [Prices for ecosystem accounting](#), *World Bank, Wealth Accounting and Valuation of Ecosystem Services*, World Bank Wealth Accounting and Valuation of Ecosystem Services global partnership (WAVES).

Australian Bureau of Statistics (ABS) (2022) *National Ocean Account, Experimental Estimates, Experimental estimates to measure changes in ocean ecosystems*, ABS, Canberra.

Australian Bureau of Statistics (ABS) (2025), [National Ecosystem Accounts, experimental estimate, Estimates of the extent, condition and services provided by Australia's ecosystems, including terrestrial, coastal, freshwater and marine realms 2020-21 financial year](#), ABS, Canberra.

Australian Bureau of Statistics (ABS) (2026a) *Valuing Nature's Contribution – A national ecosystem accounting perspective*, ABS, Canberra.

Australian Bureau of Statistics (ABS) (2026b) [National Ecosystem Accounts, experimental estimates, Estimates of the extent, condition and services provided by Australia's ecosystems, including Terrestrial, Freshwater, Coastal and Marine realms, 2022-23 financial year](#), ABS, Canberra.

Barton DN, Obst C, Day B, Caparrós A, Dadvand P, Fenichel E, Havinga I, Hein L, McPhearson T, Randrup T and Zulian G (2019) [Discussion paper 10: Recreation services from ecosystems. Paper submitted to the Expert Meeting on Advancing the Measurement of Ecosystem Services for Ecosystem Accounting](#), New York, 22-24 January 2019 and subsequently revised, Version of 25 March 2019.

Brown N, Femia A, Fixler D, Pedersen OG, Kaumanns SC, Oneto GP, Schurz S, Tubiello FN and Wentland S (2021) [Statistics: unify ecosystems valuation](#), *Nature*, Vol. 593, pp. 341.

Cannard T, Coggan A and Pascoe S (2025) *Developing a method to include coastal protection services from coastal ecosystems into national ecosystem accounts*, A report for the National Ecosystem Accounting Project, CSIRO, Australia,

Caparrós A, Campos P and Montero G (2003) [An operative framework for total Hicksian income measurement: application to a multiple use forest](#), *Environmental and Resource Economics*, Vol. 26, pp. 173-198.

Caparrós A, Oviedo JL, Alvarez A and Campos P (2017) [Simulated exchange values and ecosystem accounting: Theory and application to free access recreation](#), *Ecological Economics* Vol. 139, pp. 140-149.

Chen Y, Wyrwoll P, Burnett P, Grafton RQ and Vardon M (2025) [Valuing and accounting for water-related ecosystem services for water pricing and management: An Australian case study](#), *Ecosystem Services*, Vol. 75.

Commonwealth of Australia (2021) [Australian Water Markets Report 2019–20](#), Bureau of Meteorology.

Department of Climate Change, Energy, the Environment and Water (DCCEEW) (2026) [Past work on natural capital accounts](#), DCCEEW, Canberra, accessed on 13 July 2026.

Donnelly E and Melstrom RT (2026) The exchange value of ecosystem services from multi-site recreation. *Ecological Economics*, Vol. 245, 108994.

Edens B (2021) [The treatment of global climate regulation service in SEEA EA and its potential for informing climate policy](#), United Nations Statistics Division, New York.

Edens B and Graveland C (2014) [Experimental valuation of Dutch water resources according to SNA and SEEA](#), *Water Resources and Economics*, Vol. 7, pp 66-81.

Ferrini S, Reas V, Bartolini A, Ekins P and Grice J (2025), [Economic Methods for Water Ecosystem Services for SEEA EA](#), London Group on Environmental Accounting, 31st Meeting, 25th September 2025, Tallinn.

Flaaten O, Heen K and Salvanes KG (1995) [The Invisible Resource Rent in Limited Entry and Quota Managed Fisheries: The Case of Norwegian Purse Seine Fisheries](#), *Marine Resource Economics* 10, 341-356.

Government of Canada (2022) [Social Cost of Greenhouse Gas Estimates – Interim Updated Guidance for the Government of Canada](#), Environment and Climate Change Canada, Ottawa, Published by: Environment and Climate Change Canada (ECCC).

Gunnlaugsson SB, Saevaldsson H, Kristofersson DM and Agnarsson S (2020) [Resource Rent and its Distribution in Iceland's Fisheries](#), *Marine Resource Economics* 35, 113-135.

Hein L, La Notte A, Burkhard B, Dvarskas B, Rhodes C, Petersen J-E, Haines-Young R, and UNSD statistics (2019) [Towards defining ecosystem services for SEEA EEA – Position paper](#), 2019 Forum of Experts in SEEA Experimental Ecosystem Accounting, 26-27 June 2019, Glen Cove, NY, Background paper Session 3c: Ecosystem services.

Horlings E, Schenau S, Hein L, Lof M, de Jongh L and Polder M (2020) [Experimental monetary valuation of ecosystem services and assets in the Netherlands](#), Statistics Netherlands and Wageningen University and Research, The Hague.

Hughes N (2019) [Drought driving high water prices in the Murray-Darling Basin](#), Australian Water Association.

Hutley N (2021) [A Social Cost of Carbon for the ACT](#), DRAFT Prepared for the ACT Government, Rovingstone Advisory.

Iftekhar MS and Pannell DJ (2015) “Biases” in Adaptive Natural Resource Management. *Conservation Letters*, 8: 388-396. <https://doi.org/10.1111/conl.12189>

Infrastructure Australia (2024) [Guidance Note – Valuing emissions for economic analysis](#), Australian Government.

Jasper C (2019) [Water prices in southern Murray-Darling skyrocket as increased water demand collides with dry conditions](#), ABC Rural.

Keith H, Vardon M, Stein J, Stein J and Lindenmayer D (2017) [Experimental Ecosystem Accounts for the Central Highlands of Victoria](#), Final Report, Australian National University, Canberra.

NCAVES and MAIA (2022) [Monetary valuation of ecosystem services and ecosystem assets for ecosystem accounting: Interim Version 1st edition](#), United Nations Department of Economic and Social Affairs, Statistics Division, New York.

Newell RG, Sanchirico JN and Kerr S (2005) [Fishing quota markets](#), *Journal of Environmental Economics and Management* 49, 437-462.

Obst C, Hein L and Edens B (2016) [National Accounting and the Valuation of Ecosystem Assets and Their Services](#), *Environmental and Resource Economics*, Vol. 64, pp. 1-23.

Office for National Statistics (2025) [UK natural capital accounts: 2025: Estimates of the financial and societal value of natural resources to people in the UK](#), in Statistics, O.f.N. (ed.), Office for National Statistics, United Kingdom.

Oras K, Aun K, Luukas G, Schenau S, Femia A, Helm A, Veromann E, Kadulin A, Sepp K, Ehrlich U and Kosk A (2025) [Empirical insights into the multiple economic values of ecosystems: applications and reflections](#), United Nations (UN) London Group on Environmental Accounting, 31st Meeting, 25th September 2025, Talinn.

Pascoe S, Giles N and Coglan L (2019) [Extracting fishery economic performance information from quota trading data](#), *Marine Policy* 102, 61-67.

Pascoe S, Liu N, Scheufele G, Campbell ST and Schmidt B (2024) [Methods for developing a national dataset for Australia’s ecosystem services: fisheries biomass provisioning services \(2000-01 to 2020-21\)](#), A report for the National Ecosystem Accounting Project, CSIRO, Australia.

Pascoe S and Scheufele G (2025) [Monetising fisheries provisioning services from multispecies fisheries in ecosystem accounts: introducing rent revenue shares](#), *Ecosystem Services*, Vol. 76, 101785.

Pascoe S, Van Landeghem K, Scheufele G and Abrahams S (2026) [Rethinking the use of the residual value method for ecosystem services valuation](#), *Ecological Economics*, Vol. 248.

Pelletier MC, Heagney E and Kovac M (2021) [Valuing recreational services: A review of methods with application to New South Wales National Parks](#), *Ecosystem Services*, Vol. 50.

Rennert K, Errickson F, Prest BC, Rennels L, Newell RG, Pizer W, Kingdon C, Wingenroth J, Cooke R, Parthum B, Smith D, Cromar K, Diaz D, Moore FC, Müller UK, Plevin RJ, Raftery AE, Ševčíková H, Sheets H, Stock JH, Tan T and Watson M (2022) [Comprehensive evidence implies a higher social cost of CO₂](#), *Nature*, Vol. 610, pp. 687-692.

Rennert K, Kingdon C and Prest BC (2025) [Social Cost of Carbon 101 - A review of the social cost of carbon, from a basic definition to the history of its use in policy analysis](#), Resources for the Future, Washington DC.

Scheufele G and Pascoe S (2023) [Ecosystem accounting: reconciling consumer surplus and exchange values for free-access recreation](#), *Ecological Economics*, Vol. 212.

Scheufele G, Pascoe S, Nichols R, Smith G and Mcilgorm A (2026) [Monetary Accounting of Cultural Ecosystem Services: Recreational Fishing in the Murray–Darling Basin, Australia](#), *Australian Journal of Agricultural and Resource Economics*, Vol. 70, pp. 44-55.

The State of Victoria (2023) [Urban Melbourne Environmental-Economic Account](#), Department of Energy, Environment and Climate Action, Technical Report, May 2023, Melbourne.

Tuynman H, Curtotti R and Black S (2025) [Australian fisheries and aquaculture statistics 2024](#), Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), Canberra, September, DOI: <https://doi.org/10.25814/9xs4mw74>. CC BY 4.0.

United Nations, European Union, Food and Agriculture Organization of the United Nations (FAO), International Monetary Fund (IMF), Organisation for Economic Co-operation and Development (OECD), United Nations Environment Programme (UNEP) and The World Bank (2024) [System of Environmental-Economic Accounting: Ecosystem Accounting \(SEEA EA\)](#), Statistical papers Series F No. 124, UN Department of Economic and Social Affairs, New York.

US Government (2016) [Technical support document: Technical update of the social cost of carbon for regulatory impact analysis – Under Executive Order 12866](#), Interagency Working Group on Social Cost of Greenhouse Gases 2016, United States Government.

US Government (2021) [Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide: Interim Estimates under Executive Order 13990](#), Interagency Working Group on Social Cost of Greenhouse Gases, United States Government.

Zandebasiri M, Jahanbazi Goujani H and Iranmanesh Y (2023) [Ecosystem services valuation: a review of concepts, systems, new issues, and considerations about pollution in ecosystem services](#), *Environmental Science and Pollution Research*, Vol. 30, pp. 83051–83070.