

Environmental (including Ecosystem) Goods and Services

Provides guidance on compiling indicators of environmental goods and services, including ecosystem services, within the context of ocean accounting.

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OUTCOME

This Circular provides guidance on compiling indicators of environmental goods and services, including ecosystem services, within the context of ocean accounting. Ecosystem services represent the contributions that marine and coastal ecosystems make to benefits enjoyed by people and the economy. These contributions fall into three categories: provisioning services such as fish and other harvested biomass, regulating services such as coastal protection and carbon sequestration, and cultural services such as recreation and amenity values.

This Circular establishes an indicator framework aligned with the SEEA Ecosystem Accounting (SEEA EA) reference list of ecosystem services, providing guidance on measurement approaches for provisioning, regulating, and cultural service indicators in both physical and monetary terms. The guidance covers the derivation of indicators from ecosystem service flow accounts, the selection of appropriate measurement units, and the interpretation of physical versus monetary indicators for different policy applications.

Section 3.10 is normative for the publication on monetary valuation method. It sets out the value concepts the accounts use, the SEEA EA five-level preference order, the methods at each level, the methods that are not admissible as account entries, and a worked application across four marine ecosystem services. Compilers valuing any ecosystem service, in any circular, apply that section. Whether and when to value at all, and how the resulting figures should be communicated and caveated, remain with [TG-1.9 Safe Usage of Monetary Valuation](#), which should be read first; asset-level net present value is in [TG-3.1 Asset Accounts](#) Sections 3.3 and 3.5.3.

The methodology supports ocean-related EGSS measurement (identifying industries engaged in environmental protection and resource management under CEPA and CReMA), green and blue economy monitoring, environmental protection expenditure tracking, and marine spatial planning by quantifying ecosystem service flows associated with different ocean uses (see [TG-1.2 Marine Spatial Planning](#)).

This Circular is distinct from [TG-3.2 Flows from Environment to Economy](#), which covers the underlying supply and use table methodology for ecosystem service accounts. The present Circular focuses on compiling summary indicators from those accounts. It builds on the asset-service linkages established in [TG-3.1 Asset Accounts](#).

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DRAFT

1. Outcome

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2. Requirements

¶1 This Circular requires familiarity with:

- ¶2 **TG-0.1 General Introduction to Ocean Accounts** – for the conceptual framework connecting ecosystems to economic activity
- ¶3 **TG-0.2 Overview of Relevant Statistical Standards** – for the international statistical standards underpinning ocean accounting, including the SEEA EA and SEEA CF frameworks referenced throughout this Circular
- ¶4 **TG-3.1 Asset Accounts** – for understanding ecosystem assets and their relationship to service supply
- ¶5 **TG-3.2 Flows from Environment to Economy** – for the accounting structure underlying ecosystem service indicators, including physical supply and use tables

¶6 For the monetary valuation methods referenced throughout this Circular, see Section 3.10 below and **TG-1.9 Safe Usage of Monetary Valuation**.

3. Guidance Material

¶1 Indicators derived from ecosystem service accounts provide summary measures that can be used to track changes over time, compare across ecosystem types and regions, and inform policy decisions concerning ocean management and conservation.⁴

¶2 This section establishes the indicator framework (Section 3.1), addresses the relationship between ecosystem services and the environmental goods and services sector (Section 3.2), then examines indicators for each major category of ecosystem services: provisioning (Section 3.3), regulating (Section 3.4), and cultural services (Section 3.5). Section 3.6 addresses the distinction between physical and monetary indicators and their appropriate applications. Section 3.7 presents the compilation procedure for deriving indicators from accounts, and Section 3.8 provides a worked example with synthetic data.

3.1 Ecosystem Services Indicator Framework

¶1 The SEEA EA provides a framework for deriving indicators from ecosystem service accounts.⁵ Ecosystem service indicators can be derived from both the supply and use perspectives of the ecosystem services supply and use tables (SUTs), and can be expressed in physical or monetary terms. Figure 2.4.1 illustrates how ecosystem assets supply the three service categories, how those flows are recorded in the supply and use tables, and how physical indicators – with an optional valuation step – are derived from them.

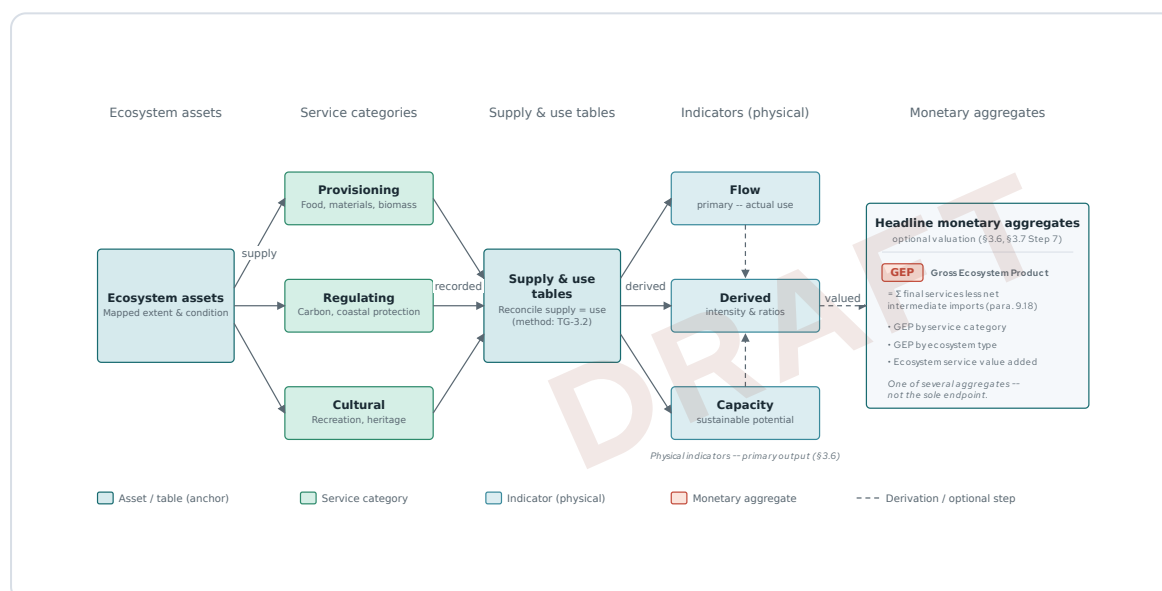


Figure 2.4.1 Ecosystem-service supply and use tables yield physical flow, capacity, and ratio indicators, with optional monetary aggregates. Dashed boxes mark capacity and derived ratios; solid marks primary flow indicators.

Source: TG-2.4 draft v7, §3.1 (indicator typology), §3.6 (physical vs monetary), §3.7 Steps 5--7 (compilation sequence); SEEA EA Tables 5.3--5.4 (supply-use of ecosystem services), Chapter 6 & para. 9.18 (monetary aggregates).

Adapted from: Ouyang et al. (2020), "Using gross ecosystem product (GEP) to value nature in decision making", PNAS 117(25); SEEA EA Figure 6.1 (ecosystem service capacity and flow).

3.1.1 Classification structure

¶1 The reference list of ecosystem services in SEEA EA organises services into three broad categories, summarised in Table 3.1.1 below.⁶

Category	Description
Provisioning services	Ecosystem contributions to the growth of biomass and other materials that are extracted or harvested from ecosystems for use in economic activity.

Category	Description
Regulating and maintenance services	Ecosystem contributions that regulate biological processes and influence climate, hydrological, and biochemical cycles, thereby maintaining environmental conditions beneficial to individuals and society.
Cultural services	The experiential and intangible contributions of ecosystems, related to the perceived or actual qualities of ecosystems, that support a range of cultural benefits.

¶12 For ocean accounting, each category encompasses distinct marine ecosystem services with specific measurement requirements and indicator possibilities. Table 1 summarises the key marine ecosystem services within each category and their indicative measurement units. The selection in Table 1 reflects the ecosystem services most commonly relevant to marine and coastal contexts and is not exhaustive. The SEEA EA reference list (Table 6.3) includes additional services such as wild animals and plants provisioning (covering non-fish marine species and marine bioprospecting for genetic material), storm mitigation services (where these are analytically distinct from coastal protection), and soil and sediment retention services.⁷ Compilers should consult the full SEEA EA reference list and include additional services where they are material for their national ocean accounting context.

Service Category	Ecosystem Service	Key Marine Ecosystem Types	Physical Units	Monetary Approach
Provisioning	Fish provisioning	Marine shelf, pelagic, demersal	tonnes biomass	Resource rent
	Aquaculture provisioning	Coastal, marine shelf	tonnes biomass	Residual value
	Seaweed/algae provisioning	Coastal, rocky shores	tonnes biomass	Market prices
	Water supply	Coastal, estuarine	cubic metres	Replacement cost
Regulating	Global climate regulation	Blue carbon ecosystems	tonnes carbon	Carbon prices
	Coastal protection	Coral reefs, mangroves, seagrass	avoided damages	Avoided damage cost
	Water purification	Coastal wetlands, seagrass	volumes filtered	Replacement cost
	Nursery habitat	Mangroves, seagrass, estuaries	hectares habitat	Productivity change
Cultural	Recreation	Coral reefs, beaches, MPAs	visitor-days	Travel cost
	Visual amenity	Coastal seascapes	hedonic index	Hedonic pricing
	Scientific/education	MPAs, research sites	research outputs	Cost-based

¶13 *Table 1: Marine ecosystem services indicator framework (adapted from SEEA EA Table 6.3)*⁸

3.1.2 Indicator types

¶11 Three main types of indicators can be derived from ecosystem service accounts:⁹

¶12 **Flow indicators** measure the quantity of ecosystem services supplied or used during an accounting period. These are the primary indicators derived from ecosystem service SUTs and represent the most direct measure of ecosystem contributions to benefits. Examples include tonnes of fish harvested (provisioning), tonnes of carbon sequestered (regulating), and visitor-days (cultural services).

¶3 **Capacity indicators** measure the potential or sustainable level of ecosystem service supply. The SEEA EA defines ecosystem capacity as “the ability of an ecosystem to generate an ecosystem service under current ecosystem condition, management and uses, at the highest yield or use level that does not negatively affect the future supply of the same or other ecosystem services.”¹⁰ Capacity indicators are particularly important for sustainability assessment, as they allow comparison of actual flows against sustainable thresholds. The relationship between ecosystem condition and service capacity is addressed in **TG-3.1 Asset Accounts**.

Compiling capacity indicators when formal assessments are unavailable

Formal capacity assessments are available for some marine ecosystem services (notably fisheries stock assessments), but for most regulating and cultural services there is no equivalent assessment in most developing-country contexts. Compilers should adopt a tiered approach:

- ¶4 **Tier 1 – Formal assessments.** *Where stock assessments or capacity models exist (e.g., fisheries B/BMSY data, peer-reviewed coastal protection capacity models), use these directly. For fisheries, FAO (2022) The State of World Fisheries and Aquaculture provides B/BMSY data for global and regional stocks.¹¹*
- ¶5 **Tier 2 – Condition-index proxies.** *Where no formal capacity assessment exists, derive a proxy using ecosystem condition indices from **TG-3.1 Asset Accounts** applied to a benchmark service capacity. Document the proxy method and benchmark assumptions transparently.*
- ¶6 **Tier 3 – Unknown, with documentation.** *Where no defensible proxy basis exists, leave the capacity entry blank and document the data gap. Blank entries are preferable to uninformed estimates.*

Sustainability ratios (actual flow / capacity) should only be computed for Tier 1 and Tier 2 entries, with the tier explicitly disclosed in metadata.

¶7 **Derived indicators** combine ecosystem service data with other information to produce policy-relevant ratios and indices. Examples include ecosystem service intensity indicators (ecosystem services per hectare or per unit of ecosystem asset value), sustainability ratios (actual flow divided by sustainable capacity), and dependency ratios (share of industry output dependent on ecosystem services).

¶8 For practical compilation purposes, compilers may find it useful to distinguish **headline indicators** from **supporting indicators**. Headline indicators are a small number of high-level summary measures intended for national reporting and policy communication—for example, Gross Ecosystem Product, total fish provisioning services, and aggregate coastal protection value. Supporting indicators provide the disaggregated detail needed for analytical work and are typically reported in supplementary tables. The SEEA EA notes that headline indicators “provide a summary of key features of ecosystems that can be monitored over time” whilst detailed indicators “provide more comprehensive information for use by researchers and policy analysts.”¹²

3.1.3 Spatial allocation

¶11 Many ecosystem services, particularly regulating services, are generated at landscape or seascape scale involving multiple ecosystem types.¹³ For indicator purposes, allocation of service flows to specific ecosystem types may be required. The SEEA EA notes that “a number of ecosystem services, particularly regulating and maintenance services but also some cultural services, are generated at landscape scale in the sense that this involves a range of ecosystem assets of different types.”¹⁴

¶12 For ocean accounting, spatial allocation is particularly relevant for:

- ¶3 Coastal protection services supplied by combinations of coral reefs, mangroves, and seagrass (see **TG-6.1 Coral Reef Accounts**, **TG-6.2 Mangrove and Coastal Wetland Accounting**, and **TG-6.3 Seagrass Accounts**)
- ¶4 Water purification services involving multiple coastal ecosystem types within estuaries
- ¶5 Nursery habitat services that span mangroves, seagrass meadows, and nearshore waters

3.2 Environmental Goods and Services Sector (EGSS)

¶1 The Environmental Goods and Services Sector (EGSS) framework complements the ecosystem services accounting framework by identifying the industries and activities engaged in producing goods and services for environmental protection and resource management purposes.¹⁵ Whilst ecosystem services flow from ecosystems to economic units, EGSS represents the economic response—the industries and activities that produce goods and services aimed at environmental protection (following CEPA) or resource management (following CReMA).

3.2.1 Relationship to ecosystem services

¶1 The SEEA Central Framework describes EGSS as comprising “the producers of environmental protection and resource management goods and services” and notes that “the output of the EGSS equals the sum of the supply of environmental protection services and resource management services.”¹⁶ For ocean accounting, the relevant EGSS activities include:

EGSS Category	Ocean-related activities	Related ecosystem services
Environmental protection (CEPA)	Marine pollution monitoring and control (CEPA 1, 2, 3)	Water purification, waste assimilation
	Coastal and marine biodiversity protection (CEPA 6) ¹⁷	Nursery habitat, biodiversity maintenance
	Marine protected area management (CEPA 6, 9)	Multiple regulating and cultural services
Resource management (CReMA)	Protection of biodiversity and landscapes (CEPA 6) ¹⁷	Fish provisioning services
	Coastal forest management (mangroves) (CReMA 11)	Coastal protection, carbon sequestration
	Marine renewable energy production (CReMA 13A)	Energy from renewable sources (abiotic flow)

¶2 *Table 2: Ocean-related EGSS activities and their connections to ecosystem services*

¶3 EGSS output represents economic expenditure on activities that maintain, enhance, or restore the capacity of ecosystems to supply services. For example, expenditure on marine protected area management (CEPA 6) maintains ecosystem condition that sustains the capacity of coral reef, mangrove, and seagrass ecosystems to supply services. Fisheries management expenditure (classified under CEPA 6)¹⁷ aims to maintain fish stocks within sustainable limits, thereby protecting ongoing provisioning capacity.

3.2.2 Compilation approach for ocean EGSS indicators

¶1 EGSS indicators are derived from supply-use tables extended to incorporate environmental protection and resource management activities. The SEEA CF describes the compilation approach as involving three steps: (i) identifying relevant industries and activities using CEPA and CReMA classifications, (ii) measuring the output of environmental goods and services by those industries, and (iii) measuring the use of those goods and services by final demand categories and intermediate consumption.¹⁸

¶2 For ocean accounting, key data sources include:

- ¶3 **Government budget data** on expenditure by environment and fisheries ministries, classified according to CEPA (e.g., marine protected area management, coastal pollution control) and CReMA (e.g., fisheries stock assessment, aquaculture extension services)
- ¶4 **Industry surveys** of businesses engaged in environmental consulting, marine monitoring, coastal restoration, and other ocean-related environmental services
- ¶5 **Specialised ocean accounts** for fisheries management (**TG-6.7 Fisheries Accounting: Integrating Stock Assessment**), aquaculture (**TG-3.9 Aquaculture Accounts**), and offshore energy (**TG-3.10 Offshore Energy Accounts**) that provide detail on resource management activities

¶6 Compilers should distinguish between the producer types summarised in Table 3.2.2 below.

Producer Type	Description
Primary EGSS producers	Units whose principal activity is environmental protection or resource management (e.g., marine consulting firms, government environmental agencies).
Secondary EGSS producers	Units whose principal activity is not environmental, but which produce environmental goods and services as a secondary output (e.g., aquaculture facilities providing fish nursery habitat management as ancillary environmental activity).
Ancillary EGSS producers	Units producing environmental goods or services as an ancillary activity, that is, as an input to their own principal production activity, not for sale or transfer to other units (e.g., manufacturing plants operating in-house wastewater treatment for coastal discharges, where the treated effluent supports the plant's own production process).

¶7 The distinction matters for indicator interpretation: primary and secondary producers contribute to measured EGSS output and value added, whilst ancillary production is not separately recorded as EGSS output – it is embedded in the intermediate consumption of the producing industry, following SEEA CF paras. 4.100–4.105.¹⁹

3.3 Provisioning Service Indicators

¶1 Ecosystem service categories and the mapping of marine services to the SEEA EA Table 6.3 framework are described in **TG-3.2 Flows from Environment to Economy** Section 3.1. The sections below present the indicator derivation procedure for each service category applicable to ocean accounting.

3.3.1 Fish provisioning indicators

¶1 Fish provisioning services represent the ecosystem contributions to the growth of wild fish and other aquatic organisms that are harvested by capture fisheries.²⁰ Key indicators include:

¶2 **Physical flow indicators:**

- ¶3 **Gross catch** (tonnes): The SEEA CF defines gross catch as “the total live weight of fish or other aquatic organisms taken (captured, caught, harvested or removed) for all purposes (commercial, industrial, recreational and subsistence) by all types and classes of fishing units (including fishermen, vessels, gear, etc.) operating in inland, fresh and brackish water areas, and in in-shore, offshore and high-seas fishing areas.”²¹ Gross catch therefore includes retained catch and discarded catch. In practice, NSO compilers should estimate gross catch as landings plus estimated discards, drawing on FAO FishStatJ landings data and FAO/regional fisheries management organisation discard estimates where direct discard surveys are unavailable.²²
- ¶4 **Landings** (tonnes): Live weight equivalent of fish brought to port, commonly available from fisheries statistics
- ¶5 **Catch by species group** (tonnes): Disaggregated catch data by major species categories (pelagic, demersal, crustaceans, molluscs)

- ¶6 **Catch by ecosystem type** (tonnes): Allocation of catch to supplying marine ecosystem types (e.g., continental shelf, pelagic, coral reef associated)

¶7 **Capacity and sustainability indicators:**

- ¶8 **Sustainable yield** (tonnes): Maximum catch that can be taken without reducing long-term stock productivity
- ¶9 **Exploitation rate**: Ratio of actual catch to sustainable yield, where values above 1.0 indicate depletion
- ¶10 **Stock status index**: Proportion of stocks within biologically sustainable limits

¶11 Fish provisioning services and asset accounts are tightly coupled: extraction recorded in the ecosystem service SUT should correspond to extraction entries in the aquatic resource asset account as described in **TG-3.1 Asset Accounts**.²³ This correspondence provides a consistency check for ocean accounts.

¶12 IUU fishing must be included in provisioning service flow estimates where estimable, because omission overstates sustainability. For the SEEA CF accounting treatment and estimation methods, see **TG-4.10 Extending Fisheries Statistics** Section 3.8.4.

3.3.2 Water and other provisioning indicators

¶1 While provisioning of water from marine sources is typically treated as an abiotic flow rather than an ecosystem service, ecosystem contributions to water quality and regulation may be relevant.²⁴

¶2 **Water-related indicators:**

- ¶3 **Freshwater provision from coastal ecosystems** (cubic metres): Where coastal wetlands contribute to freshwater supply
- ¶4 **Desalination intake volume** (cubic metres): Seawater abstraction for desalination (treated as abiotic flow)

¶5 **Other biomass provisioning indicators:**

- ¶6 **Seaweed and algae harvest** (tonnes): Ecosystem contribution to growth of harvested seaweed
- ¶7 **Shellfish harvest** (tonnes): Wild shellfish collection
- ¶8 **Mangrove timber provisioning** (cubic metres): Wood harvested from mangrove ecosystems

3.4 Regulating Service Indicators

Decision rule: Intermediate vs final ecosystem services for regulating services used by industries
 SEEA EA paras. 6.11–6.17 distinguish **intermediate ecosystem services** (services supplied by one ecosystem to another ecosystem, supporting the supply of a further final service) from **final ecosystem services** (services flowing directly to economic units as beneficiaries).²⁵ For regulating services consumed by industries (e.g., water purification benefiting an aquaculture operation, coastal protection benefiting tourism infrastructure), the SEEA EA convention is to record them as **final services** flowing to the industry as beneficiary, not as intermediate inputs to the industry's production process. The industry appears as a user column in the ecosystem service use table. Intermediate ecosystem service flows are recorded separately (e.g., in supplementary tables) when the analytical purpose requires tracing the ecosystem-to-ecosystem contributions that support a final service. Compilers should not collapse intermediate and final flows into a single column without indicating which row represents which type, as this conflates analytically distinct relationships and risks double-counting.

3.4.1 Global climate regulation indicators

¶1 Global climate regulation services represent ecosystem contributions to reducing concentrations of greenhouse gases in the atmosphere through carbon sequestration and storage.²⁶ Marine ecosystems form part of the global carbon cycle, and “blue carbon” ecosystems such as mangroves, seagrass meadows, and salt marshes are recognised for their climate mitigation potential.

¶2 The SEEA EA identifies two components of global climate regulation services:²⁷

¶3 **Carbon retention** reflects the ability of ecosystems to accumulate and retain carbon stocks, supplying a service through the avoided emission of carbon to the atmosphere. The indicator for carbon retention is the stock of carbon held by ecosystem assets at the beginning of the accounting period. Operationally:

$$\text{Carbon Retention Service Flow (period } t) = \text{Opening carbon stock (asset account, period } t)$$

¶4 This identity links the service supply directly to the opening balance of the carbon component of the relevant ecosystem asset account in **TG-3.1 Asset Accounts**. Compilers should record carbon retention service supply values that equal the corresponding opening stock values in the asset account, providing an automatic consistency check. Where formal asset accounts are not yet compiled, the opening stock can be derived from the most recent national blue carbon inventory or default IPCC Wetlands Supplement (2014) values, with documentation of the source.

Service-account row (Table 4-style)	Corresponding TG-3.1 asset-account entry
Carbon retention – mangroves (tC)	Mangrove ecosystem asset: opening C stock
Carbon retention – seagrass (tC)	Seagrass ecosystem asset: opening C stock
Carbon retention – salt marsh (tC)	Salt marsh ecosystem asset: opening C stock
Carbon sequestration – by ecosystem (tC/yr)	Net change in C stock over period (additions less reductions)

¶5 Compilers should distinguish between **soil organic carbon** (slow-cycling, long-residence-time stock dominant in mangrove and seagrass sediments and most relevant to carbon retention indicators) and **above-ground biomass carbon** (faster-cycling, more dynamic, more relevant to short-period sequestration flux estimates). The two pools have different measurement methods and uncertainty profiles, and disaggregation supports interpretation of the retention versus sequestration distinction.

¶6 **Carbon sequestration** reflects the ability of ecosystems to remove carbon from the atmosphere for long-term storage. The indicator is net carbon uptake over the accounting period, typically measured as net ecosystem carbon balance.

¶7 **Key indicators:**

- ¶8 **Carbon stock** (tonnes C): Total carbon stored in blue carbon ecosystems (mangroves, seagrass, salt marshes), including above-ground biomass, below-ground biomass, and soil carbon
- ¶9 **Carbon sequestration rate** (tonnes C/year): Net annual carbon uptake by marine and coastal ecosystems
- ¶10 **Carbon stock by ecosystem type** (tonnes C): Disaggregated carbon storage by ecosystem type (mangroves, seagrass, tidal marshes, marine shelf sediments)
- ¶11 **Carbon retention service** (tonnes C): Opening stock of carbon, serving as proxy for the flow of retention services

¶12 For blue carbon ecosystems, the SEEA EA recommends that measurement scope include carbon stored to a maximum of two metres below the surface in the case of organic carbon-rich soils such as those found in mangroves and seagrass meadows.²⁸ Related asset information is recorded in **TG-3.1 Asset Accounts**.

¶13 The treatment of global climate regulation services raises questions about user attribution. The SEEA EA notes that the user of global climate regulation services is “the global community or, where the focus is on a national ecosystem accounting area, the rest of the world.”²⁹ For national ocean accounts, this implies that the bulk of carbon sequestration services should be attributed to the rest of the world as the beneficiary. This attribution reflects the global public good nature of climate regulation, whilst a country may also derive domestic benefits from its own contribution to global climate stability. In practice, compilers should record the full physical flow of carbon sequestration in the supply table (attributed to domestic ecosystem types) and allocate the use to “rest of the world” in the use table. For monetary valuation, the exchange value approach would value the service at the price that would be agreed between a willing buyer and seller, which in practice is typically approximated using observed carbon market prices or abatement cost methods. The indicator implications are that physical indicators of carbon sequestration represent domestic ecosystem contributions, whilst monetary indicators should be interpreted carefully given that the beneficiaries are predominantly global rather than domestic.

3.4.2 Coastal protection indicators

¶1 For the full biophysical basis of coastal protection services, SPA/SBA delineation, and tiered method selection, see **TG-3.2 Flows from Environment to Economy** Section 3.3.^{30, 31}

Operational definition: “kilometres of coastline protected”

“Kilometres of coastline protected” is defined as **the length of beneficiary shoreline landward of protective ecosystems with population or assets at risk under a defined reference hazard scenario, following SEEA EA para. 9.72 (no flow recorded where there are no potential damages to avoid).**³² Compilers must:

1. ¶2 **Choose the hazard reference scenario** using the nationally adopted return period for coastal flood and storm risk assessment (commonly 1-in-50 or 1-in-100 year for coastal engineering applications). The choice must be documented in compilation metadata and held constant across reporting periods.
2. ¶3 **Choose the attenuation threshold** (the minimum wave-energy or wave-height reduction required for a shoreline segment to qualify as “protected”) drawing on national coastal risk assessments, InVEST coastal vulnerability or coastal protection model parameters, or peer-reviewed studies appropriate to the ecosystem types present (e.g., Beck et al. 2018 for coral reefs).³³
3. ¶4 **Apply a tiered approach** where data are limited:
 - ¶5 Tier 1. Modelled beneficiary shoreline with explicit attenuation and exposure analysis.
 - ¶6 Tier 2. Kilometres of protective ecosystem frontage multiplied by an effectiveness factor derived from peer-reviewed or national-standard sources.
 - ¶7 Tier 3. Kilometres of protective ecosystem frontage as a minimum proxy, flagged as an unadjusted upper bound.

SEEA EA does not prescribe a single numeric attenuation threshold or return period for coastal protection service measurement. Both are localisation decisions to be made by the compiling agency drawing on national coastal risk assessment standards. Cross-country comparability requires that the chosen return period and attenuation threshold are disclosed in compilation metadata and held constant across reporting periods. Cross-references: **TG-6.1 Coral Reef Accounts**, **TG-6.2 Mangrove and Coastal Wetland Accounting**.

¶8 **Physical indicators:**

- ¶9 **Coastline protected** (kilometres): Length of beneficiary coastline as defined in the operational definition box above
- ¶10 **Area protected** (hectares): Coastal land area with reduced flood risk due to ecosystem services
- ¶11 **Wave attenuation** (%): Percentage reduction in wave energy provided by coral reefs, mangroves, or seagrass
- ¶12 **Population protected** (number): Coastal population within areas benefiting from ecosystem-based protection

¶13 **Capacity indicators:**

- ¶14 **Protection capacity index:** Measure of ecosystem condition relative to optimal protective function
- ¶15 **Vulnerability reduction:** Change in coastal vulnerability attributable to ecosystem services

¶16 The measurement of coastal protection services depends on the likelihood of hazard events and the presence of assets or population at risk.³² Even where hazard probability is high, no ecosystem service flow is recorded if there are no potential damages to be avoided.

3.4.3 Other regulating service indicators

¶1 **Water purification indicators:**

- ¶2 **Nutrient retention** (tonnes N, P): Quantity of nutrients removed or retained by coastal ecosystems
- ¶3 **Sediment retention** (tonnes): Sediment captured by coastal vegetation before reaching marine waters
- ¶4 **Water quality improvement index:** Composite measure of ecosystem contribution to water quality

¶5 **Nursery and habitat maintenance indicators:**

- ¶6 **Nursery habitat extent** (hectares): Area of mangroves, seagrass, and other ecosystems providing nursery functions
- ¶7 **Recruitment contribution** (%): Estimated proportion of commercial fish recruitment dependent on coastal nursery habitat
- ¶8 **Habitat connectivity index:** Measure of connectivity among nursery, juvenile, and adult habitats

¶9 The SEEA EA treats nursery services as potentially intermediate services: "the nursery population services supplied by seagrass meadows are an input to the supply of fish biomass provisioning services, which in turn contribute to the benefit of marketed fish."³⁴ Recording both final and intermediate ecosystem services is therefore necessary to fully capture the contributions of coastal ecosystems to commercial fisheries.

¶10 **Erosion control indicators:**

- ¶11 **Sediment stabilisation** (hectares): Coastal area with reduced erosion due to ecosystem services
- ¶12 **Erosion rate reduction** (%): Percentage reduction in erosion attributable to vegetation

3.5 Cultural Service Indicators

3.5.1 Recreation indicators

¶1 Recreation-related services are the ecosystem contributions to recreational activities through the biophysical characteristics and qualities of ecosystems that enable people to use and enjoy the marine environment.³⁵

¶12 **Physical indicators:**

- ¶13 **Visitor-days** (number): Total person-days of recreational visits to marine and coastal ecosystems
- ¶14 **Recreational fishing trips** (number): Fishing trips undertaken for recreation rather than commercial purposes
- ¶15 **Diving/snorkelling visits** (number): Visits to coral reefs and other underwater attractions
- ¶16 **Beach visits** (number): Recreational visits to coastal beaches and shores

¶17 **Activity-specific indicators:**

- ¶18 **Recreational catch** (tonnes): Fish caught during recreational fishing activities (also recorded as a separate row in the provisioning service supply and use tables – see decision rule below)
- ¶19 **Whale/dolphin watching trips** (number): Marine wildlife tourism activities
- ¶10 **Marine protected area visits** (number): Recreational visits to MPAs

Decision rule: Recording recreational catch in supply and use tables³⁶

Where recreational catch is **material** (as a rule of thumb, where it represents 5% or more of commercial catch by weight, or where it is policy-relevant regardless of share), compilers should record it as a **dedicated row** in the physical supply and use tables for fish provisioning, with users allocated to “Households” (subsistence/recreational consumption) or “Tourism” (where the catch supports a tourism enterprise). The recreation cultural service is recorded separately on its visitor-day row. The two rows capture distinct phenomena – biomass extracted vs. experiential service – and must not be aggregated into a single headline “fish provisioning” figure without disclosure.

Where recreational catch is **not material** and is omitted from the supply table, compilers should add a footnote to the provisioning row explicitly stating the omission and the rationale.

¶11 In practice, the physical indicator for the cultural service should be expressed in units that capture the recreational experience (visitor-days or trips), whilst the physical indicator for the provisioning service should be expressed in harvest units (tonnes). Monetary indicators require particular attention: the cultural service value (willingness to pay for the recreational experience) and the provisioning service value (resource rent on the harvested biomass) capture distinct economic contributions and should be presented separately rather than summed without explanation.

3.5.2 **Amenity indicators**

¶1 Visual amenity services represent ecosystem contributions to local living conditions through sensory benefits, especially visual appreciation of seascapes.³⁷

¶12 **Physical indicators:**

- ¶13 **Coastal access points** (number per km of coastline): Publicly accessible coastal entry points enabling visual and sensory access to seascapes
- ¶14 **Seascape quality index**: Composite measure of visual amenity characteristics
- ¶15 **Blue space accessibility** (population within distance): Population with access to coastal recreational areas

¶16 **Monetary indicators (see Section 3.6.2):**

- ¶17 **Coastal property premium index**: Hedonic-pricing-derived measure of property value differentials attributable to marine views and coastal proximity. This is a monetary-economic indicator (not a physical indicator) and is compiled using hedonic pricing methods. See Section 3.10.3 below for the hedonic pricing method and its place in the preference order.

3.5.3 **Spiritual, scientific, and educational indicators**

¶1 Scientific and educational indicators:

- ¶2 **Research publications** (number): Scientific outputs associated with marine ecosystem research
- ¶3 **Educational visits** (number): School and university visits to marine educational sites
- ¶4 **Traditional knowledge documentation**: Records of indigenous and local knowledge associated with marine ecosystems

¶5 Spiritual and symbolic indicators:

- ¶6 **Sacred site extent** (hectares): Marine and coastal areas of spiritual significance
- ¶7 **Cultural heritage sites** (number): Marine and coastal sites of cultural and historical significance

¶8 Indigenous and local communities often hold deep cultural and spiritual connections to marine ecosystems that conventional indicators may not adequately capture. The governing principle is that measurement of these values rests on the free, prior, and informed consent (FPIC) of the communities concerned: indicators are co-designed with those communities, complex cultural relationships are not reduced to simplistic quantitative measures, and qualitative supplementary information accompanies any quantitative figures. Where traditional ecological knowledge contributes to the understanding of ecosystem condition or service flows, compilers should acknowledge and appropriately attribute it.³⁸

3.6 Physical vs Monetary Indicators

¶1 The trade-offs between physical and monetary ecosystem service indicators – including advantages, limitations, and appropriate applications – are analysed in **TG-1.9 Safe Usage of Monetary Valuation**, which should be read in conjunction with this circular. The methods themselves, and the preference order governing their selection, are set out in Section 3.10 below.³⁹ Physical accounts should always be compiled as the primary output, with monetary valuation undertaken as a complement where appropriate and feasible.⁴⁰

3.6.1 Valuation approaches by service type

¶1 Valuation approach selection by service type follows the criteria in Table 1.⁴¹ For global climate regulation services, the preferred valuation approach uses observed carbon market prices or abatement cost methods, which align with the exchange value concept used in national accounts. The “social cost of carbon” (SCC) estimates the marginal damage from an additional tonne of carbon emissions. It represents a welfare-based measure rather than an exchange value and is therefore not the preferred approach under SEEA EA guidance.⁴² Where carbon market prices are unavailable, or where the policy context specifically requires a damage-cost perspective, the SCC may be used as an alternative. Where the SCC is used, compilers should clearly document that it represents a welfare value rather than an exchange value and note the divergence from standard accounting practice.

3.6.2 Presentation and interpretation

¶1 When presenting ecosystem service indicators, compilers should follow the principles set out in Table 3.6.4 below.⁴³

Principle	Description
Present physical and monetary indicators together	Physical accounts provide the foundation and should always accompany monetary values.
Document methods and assumptions	Clearly state the valuation methods used and key assumptions.
Acknowledge uncertainties	Communicate the confidence level and key sources of uncertainty.

Principle	Description
Avoid over-interpretation	Monetary values represent exchange values, not the full importance of ecosystems.
Provide contextual information	Include data on ecosystem extent, condition, and trends to support interpretation.

3.7 Compilation Procedure for Ecosystem Service Indicators

Step 1: Identify priority ecosystem services and users

¶1 Identify which ecosystem services are most relevant to the national or subnational ocean accounting area, and which economic units and communities use those services. This step should involve:

- ¶2 Reviewing the SEEA EA reference list (Table 6.3) and selecting services relevant to the ecosystem types present (see **TG-3.2 Flows from Environment to Economy**, Table 1a for marine ecosystem services by type)
- ¶3 Consulting with policy users to identify which services are priorities for management and monitoring ⁴⁴
- ¶4 Mapping ecosystem service users by institutional sector (industries, households, government, rest of world)

¶5 For ocean accounting, priority services typically include fish provisioning (used by fisheries industries), coastal protection (used by coastal property owners and government), carbon sequestration (used by the global community), and recreation (used by households).

Step 2: Assemble data sources

¶1 Primary data sources include:

- ¶2 **Fisheries statistics** from national fisheries agencies and FAO FishStatJ, providing catch data by species, gear type, and fishing zone
- ¶3 **Ecological monitoring data** from field surveys measuring carbon stocks, water quality, and condition variables (see **TG-4.2 Survey Methods**)
- ¶4 **Remote sensing data** for extent and condition of blue carbon ecosystems (see **TG-4.1 Remote Sensing Data**)
- ¶5 **Tourism statistics** from visitor surveys at marine protected areas, coastal recreation sites, and diving operators
- ¶6 **Geospatial data** on coastal population and assets at risk from flooding and erosion

¶7 Data quality should be assessed following **TG-0.7 Quality Assurance**, with particular attention to temporal consistency and spatial coverage.

Steps 3–4: Compile the physical supply and use tables

¶1 The supply and use tables are the input to every indicator below, and their compilation is specified in **TG-3.2 Flows from Environment to Economy** Section 3.3 – the structure of PSUTs, the procedure, the supply and use sub-procedures, physical units, the supply = use identity, and the treatment of beneficiaries who fall outside survey frames. It is not restated here.

¶2 Two properties of the compiled tables determine what the indicators in Step 5 can carry, and are worth confirming before proceeding:

- ¶3 **Supply is attributed by ecosystem type.** Without that attribution the disaggregated and intensity indicators below cannot be produced, only the headline totals.
- ¶4 **The supply = use identity holds for every service.** An indicator derived from tables that do not balance will not reconcile with any other national figure, and the imbalance usually means a

beneficiary group is missing rather than that a number is wrong.

Step 5: Derive physical flow indicators

¶1 From the compiled supply and use tables, derive flow indicators for reporting and analysis:

- ¶2 **Headline flow indicators:** Total supply of each priority service, aggregated across all ecosystem types
- ¶3 **Disaggregated flow indicators:** Supply by ecosystem type, use by sector
- ¶4 **Intensity indicators:** Flow per hectare of ecosystem extent (requires linking to extent accounts from **TG-3.1 Asset Accounts**)
- ¶5 **Sustainability indicators:** Actual flow compared to capacity or sustainable yield

Step 6: Apply monetary valuation (optional)

¶1 Where monetary indicators are required, apply valuation methods following the preference order in Section 3.10.2 below:

- ¶2 For services with observable market prices (e.g., fish quota values, carbon credits), apply observed prices
- ¶3 For services embedded in market transactions (e.g., fish provisioning), apply resource rent method
- ¶4 For services without markets (e.g., coastal protection, water purification), apply replacement cost or avoided damage cost methods
- ¶5 For recreation, apply travel cost or consumer expenditure methods

¶6 For each valuation, document the method, data sources, key assumptions, and uncertainty.

Step 7: Calculate aggregate monetary indicators

¶1 From the monetary valuations, derive aggregate indicators:

- ¶2 **Gross Ecosystem Product (GEP):** Sum of monetary values of all final ecosystem services, less net imports of intermediate ecosystem services from outside the accounting area (SEEA EA para. 9.18). In practice the deduction is often zero where the accounting area is hydrologically and ecologically self-contained, but compilers must explicitly check for cross-boundary intermediate service flows – for example, freshwater purification capacity supplied by inland watersheds to coastal estuaries – and deduct the net import where material. Where the deduction is assumed zero, this assumption must be stated in metadata.
- ¶3 **GEP by service category:** Provisioning, regulating, cultural
- ¶4 **GEP by ecosystem type:** Marine shelf, pelagic, coastal wetlands, etc.
- ¶5 **Ecosystem service value added:** GEP attributed to domestic ecosystem assets (excluding imports of services)

Step 8: Integration with other accounts and policy applications

- ¶1 **Cross-check with asset accounts:** Ensure that extraction flows (e.g., fish harvest) recorded in service accounts match extraction entries in asset accounts
- ¶2 **Link to EGSS accounts:** Compare ecosystem service values with expenditure on environmental protection and resource management
- ¶3 **Support SDG 14 monitoring:** Derive indicators for SDG 14.4.1 (proportion of fish stocks within sustainable limits), 14.5.1 (marine protected area coverage, linked to service supply), and 14.7.1 (economic benefits from sustainable ocean resources)
- ¶4 **Inform budget processes:** Provide evidence for natural capital budgeting (see **TG-1.1 National Ocean Budgets**)

3.8 Worked Example: Coastal Ecosystem Service Indicators

¶1 The example uses synthetic data for three marine ecosystem types (mangroves, seagrass meadows, and coral reefs) to illustrate the compilation procedure described in Section 3.7. The supply = use identity (total supply in Table 4 equals total use in Table 5 for each service row) is verified at Step 4 below. Compilers revising either table independently must re-verify this identity.

Scenario description

¶1 The accounting area is a coastal province encompassing 500 km² of mangrove forest, 200 km² of seagrass meadows, and 150 km² of coral reef systems. The area supports commercial fisheries, coastal aquaculture, and marine tourism. The accounting period is calendar year 2025.

Step 1-2: Priority services and data sources

¶1 Through consultation with the provincial environment ministry and fisheries agency, five priority ecosystem services were identified:

Ecosystem Service	Data Source	Measurement Unit
Fish provisioning	Fisheries agency catch statistics	tonnes (live weight)
Coastal protection	Coastal engineering study + population census	kilometres beneficiary coastline (see Section 3.4.2 operational definition)
Carbon sequestration	Field survey + remote sensing	tonnes C/year
Water purification	Estuary water quality monitoring + nutrient budget model	tonnes N removed/year
Recreation	Marine park visitor survey	visitor-days/year

Steps 3–4: The compiled supply and use tables

¶1 The tables below are the **input** to this example, compiled under **TG-3.2 Flows from Environment to Economy** Section 3.3 from field surveys, remote sensing, modelling, fisheries registration data, the property cadastre and tourism statistics. They are reproduced here because the indicator arithmetic that follows cannot be checked without them, not to restate how they were built.

Service	Mangroves	Seagrass	Coral Reef	Total Supply
Fish provisioning – commercial (tonnes)	1,200	800	1,500	3,500
Fish provisioning – recreational (tonnes)	20	10	70	100
Coastal protection (km beneficiary coastline)	45	30	25	100
Carbon sequestration (tC/yr)	4,000	1,600	150	5,750
Water purification (tN/yr)	120	80	0	200
Recreation (visitor-days)	5,000	2,000	45,000	52,000

¶2 *Table 4: Physical ecosystem service supply by ecosystem type, 2025. Supply totals in this table must equal use totals in Table 5 for each row; the identity is verified at Step 4.*

¶3 **Reading the supply table:** coral reefs dominate commercial fish provisioning (1,500 t, 43%) and recreation (45,000 visitor-days, 87%); mangroves dominate carbon sequestration (4,000 tC/yr, ~70%) and coastal protection (45 km, 45%). These shares drive the disaggregated indicators at Step 5.

Service	Fisheries Industry	Aquaculture	Tourism	Coastal Households	Rest of World	Total Use
Fish provisioning – commercial (tonnes)	2,800	0	0	0	0	2,800

Service	Fisheries Industry	Aquaculture	Tourism	Coastal Households	Rest of World	Total Use
Wild seed extraction to aquaculture (tonnes) [intermediate flow to asset account]	0	700	0	0	0	700
Fish provisioning – recreational (tonnes)	0	0	30	70	0	100
Coastal protection (km beneficiary coastline)	0	20	0	80	0	100
Carbon sequestration (tC/yr)	0	0	0	0	5,750	5,750
Water purification – final regulating service to aquaculture industry (tN/yr)	0	150	0	0	0	150
Water purification – final regulating service to households (tN/yr)	0	0	0	50	0	50
Recreation (visitor-days)	0	0	8,000	44,000	0	52,000

¶4 *Table 5: Physical ecosystem service use by sector, 2025. Supply = use identity verified for all rows against Table 4 (commercial fish provisioning 2,800 + wild seed extraction 700 = 3,500; water purification 150 + 50 = 200; all other rows match by construction).*

¶5 **Reading the use table:** the supply = use identity holds for every row (commercial fish provisioning 2,800 + wild seed extraction 700 = 3,500; water purification 150 + 50 = 200). Carbon sequestration is attributed entirely to the rest of the world, reflecting its global public-good character. It still counts in GEP at Step 7, because it is supplied by ecosystems within the accounting area; its monetary value should be read with that user attribution in mind. Households take 80% of coastal protection and 85% of recreation, the two shares the dependency indicators in **TG-2.3** read.

Step 5: Physical flow indicators

¶1 From the supply and use tables, headline and derived indicators were calculated:

¶2 Headline flow indicators:

- ¶3 Total commercial fish provisioning: 3,500 tonnes
- ¶4 Total recreational fish provisioning: 100 tonnes
- ¶5 Total coastal protection: 100 km beneficiary coastline
- ¶6 Total carbon sequestration: 5,750 tC/yr
- ¶7 Total water purification: 200 tN/yr
- ¶8 Total recreation: 52,000 visitor-days

¶9 Intensity indicator matrix (per km² of ecosystem extent):

Service	Mangroves (500 km ²)	Seagrass (200 km ²)	Coral Reef (150 km ²)
Fish provisioning – commercial (t/km ²)	2.4	4.0	10.0
Carbon sequestration (tC/yr/km ²)	8.0	8.0	1.0
Coastal protection – linear (m coastline/km ² of ecosystem area) ⁴⁵	90	150	– (see note)
Recreation (visitor-days/km ²)	10	10	300

¶10 *Table 5a: Intensity indicators by ecosystem type and service, 2025.*

¶11 Notes on omitted/qualified cells:

- ¶12 **Coral reef coastal protection** is omitted from the linear-per-area row above because coral reef coastal protection in this example is more meaningfully expressed per kilometre of reef frontage facing the coast (a linear-on-linear metric) than per km² of reef area. Reporting an areal denominator would be misleading where the reef's protective function is determined by frontage geometry rather than total area.
- ¶13 **Water purification and recreational fish provisioning intensities** are not reported on a per-km² basis in this example because the supply attributions are dominated by a single ecosystem type for water purification (mangroves and seagrass only) and are small in absolute terms for recreational catch. Compilers facing different attributions should compute these intensities.

¶14 **Derived dependency indicators:**

- ¶15 Fisheries industry dependency on ecosystem services: 2,800 tonnes commercial fish harvest (80% of commercial provisioning supply attributed to the fisheries industry)
- ¶16 Aquaculture dependency: 700 tonnes wild seed extraction + 150 tN water purification (final regulating service)
- ¶17 Coastal household dependency: 80 km coastal protection + 50 tN water quality maintenance + 44,000 recreation visitor-days + 70 tonnes recreational catch

Step 6-7: Monetary indicators (illustrative)

¶1 For demonstration purposes, monetary values were estimated using the following approaches (see **TG-1.9 Safe Usage of Monetary Valuation** for method details):

Service	Physical Flow	Unit Value	Valuation Method	Monetary Value
Fish provisioning (commercial; wild seed is an intermediate flow and is excluded)	2,800 tonnes	USD 600/tonne	Resource rent	USD 1,680,000
Coastal protection	100 km	USD 500,000/km	Avoided damage cost	USD 50,000,000
Carbon sequestration	5,750 tC/yr	USD 50/tC	Carbon market price	USD 287,500
Water purification	200 tN/yr	USD 8,000/tN	Replacement cost	USD 1,600,000
Recreation	52,000 v-days	USD 25/v-day	Consumer expenditure	USD 1,300,000
Total (GEP, before net-import deduction)				USD 54,867,500

¶2 *Table 6: Monetary ecosystem service account, 2025. The GEP figure above is the sum of final ecosystem service values supplied by ecosystems within the accounting area. In this worked example, no imports of intermediate ecosystem services from outside the accounting area are assumed (the coastal province's water purification supply does not draw on inland watershed services for the modelled period). In practice, compilers must check for cross-boundary intermediate service flows – e.g., freshwater services from inland watersheds supporting coastal estuarine water purification – and deduct net imports per SEEA EA para. 9.18 to obtain the SEEA-EA-compliant GEP. See Step 7.*

¶3 **Interpretation:** The Gross Ecosystem Product (GEP) for the coastal province is approximately USD 54.9 million in 2025 (no intermediate-service net-import deduction applied – see Table 6 note), with coastal protection representing 91% of the total monetary value. This reflects the avoided damage approach, which captures the high value of infrastructure and population at risk in the densely populated coastal zone. Fish provisioning (USD 1.7 million) represents the resource rent accruing to the ecosystem (distinct from the gross value of fish landings, which includes labour and capital inputs). Carbon sequestration has relatively low monetary value (USD 287,500) due to low

carbon prices, though the physical quantity (5,750 tC/yr) is substantial. Recreation services (USD 1.3 million) reflect consumer expenditure on marine-based tourism.

Step 8: Policy applications

¶1 The compiled indicators supported several policy applications:

¶2 **Natural capital budgeting:** The provincial government incorporated the GEP estimate (USD 54.9 million) into supplementary budget documents, comparing ecosystem service values with the provincial environment budget (USD 3.2 million), yielding a 17:1 ratio of ecosystem service value to conservation expenditure. This ratio does not represent a benefit–cost analysis, as ecosystem services are sustained by factors beyond government expenditure alone.

¶3 **SDG 14 monitoring:** The fish provisioning indicator (3,500 tonnes commercial harvest) was compared to the sustainable yield estimate (3,200 tonnes from stock assessment). The resulting exploitation rate of 1.09 (9% overfishing) was reported under SDG 14.4.1.

¶4 **Marine spatial planning:** The ecosystem service supply data by ecosystem type were used to evaluate alternative coastal development scenarios, quantifying the trade-offs between converting mangrove areas to aquaculture (loss of carbon sequestration and coastal protection) versus maintaining natural ecosystems.

¶5 **EGSS compilation:** Government expenditure on marine protected area management (CEPA 6), fisheries monitoring (CEPA 6), and mangrove restoration (CEPA 4, CReMA 11) totaling USD 3.2 million was classified as ocean-related EGSS output, enabling comparison with the ecosystem service flows those expenditures aim to maintain. Government fisheries-management expenditure was classified under CEPA 6 in accordance with the Eurostat EGSS reclassification of former CReMA 12 activities (see Table 2 footnote).

3.9 Summary of Ecosystem Service Measurement Methods

¶1 Sections 3.3–3.5 present the full compilation guidance for provisioning, regulating, and cultural services indicators respectively. For a cross-cutting comparison of data requirements and feasibility, see Table 1.

3.10 Monetary Valuation Methods

¶1 Where monetary valuation is undertaken, this section is normative for the choice of method. **TG-1.9 Safe Usage of Monetary Valuation** remains the guidance on *whether and when* to value at all, and on how the resulting figures should be communicated; it should be read first. This section sets out *how*: the value concepts the accounts use, the SEEA EA preference order, the methods at each level, the methods that are not admissible in accounts, and a worked application across four marine ecosystem services.

¶2 Asset-level valuation – the net present value of ecosystem service flows, the discount rate, the horizon, and the treatment of degradation and enhancement – is set out in **TG-3.1 Asset Accounts** Sections 3.3 and 3.5.3, which applies the preference order below to the service flows it discounts.

3.10.1 Valuation in the SEEA framework

Exchange values versus welfare values

¶1 A key characteristic of ecosystem accounts is that they use exchange values, defined as “the values at which goods, services, labour or assets are in fact exchanged or else could be exchanged for cash.”⁴⁶ For the vast majority of entries in national accounts, exchange values are measured using data from observed transactions involving market prices. Market prices are amounts of money that willing buyers pay to acquire something from willing sellers.⁴⁷

¶2 Exchange values differ from welfare values, which are commonly used in environmental cost-benefit analysis and include consumer surplus.⁴⁸ Consumer surplus is the difference between what

is paid for a good or service and what a person is willing to pay. The accounts record the former (exchange value), not the latter (total willingness to pay including surplus).⁴⁹

¶3 This distinction has important implications for ocean accounting:

Concept	Exchange Values	Welfare Values
Definition	Values at which items are or could be exchanged for cash	Total benefit including consumer/producer surplus
Primary Use	National accounts, balance sheets, GDP	Cost-benefit analysis, impact assessment
Includes Surplus	No	Yes
Basis	Observed or imputed transactions	Willingness to pay/accept
Aggregation	Directly comparable with economic aggregates	Not comparable with national accounts

¶4 The SNA 2025 clarifies that the integrated framework does not attempt to determine the utility of flows and stocks within its scope. Rather, it measures the current exchange value of entries in the accounts in monetary terms.⁵⁰ Exchange values align with national accounting conventions and are the appropriate concept for entries in ecosystem accounts. Welfare values remain important for cost-benefit analysis, but they yield estimates that cannot be directly compared with GDP, national wealth, or other aggregates from the System of National Accounts. Practitioners should use this distinction as a first check when selecting or interpreting valuation studies for ocean accounting purposes.

The SNA production boundary

¶5 Ecosystem services as defined in SEEA EA fall outside the production boundary of the SNA. The SEEA EA extends this boundary by recording flows of ecosystem services.⁵¹ This extension creates a framework where:

- ¶6 **Provisioning services** (e.g., wild fish harvest, aquaculture inputs, coastal timber) contribute to SNA benefits: goods and services already within the SNA production boundary
- ¶7 **Regulating services** (e.g., coastal protection, carbon sequestration, water purification) typically contribute to non-SNA benefits that are outside the production boundary
- ¶8 **Cultural services** (e.g., marine recreation, coastal amenity) may contribute to both SNA and non-SNA benefits depending on institutional arrangements⁵²

¶9 For ocean accounting, this means that the value of many marine ecosystem services, such as coastal protection, carbon sequestration, and recreation, requires estimation using non-market valuation methods since direct market transactions are rarely observed.

¶10 **Classifying cultural services as SNA or non-SNA benefits:** Because the boundary for cultural services depends on national institutional arrangements, compilers should apply the following three-question checklist before classifying a specific cultural service (e.g., marine recreation by residents):⁵³

1. ¶11 Is a monetary transaction for this service already recorded in national accounts (e.g., tourism receipts, recreation-sector output)?
2. ¶12 Is the economic unit receiving the service a market producer whose output enters GDP?
3. ¶13 Is the benefit already captured in existing GDP aggregates through the expenditure or production approach?

¶14 If the answer to any question is yes, treat the service as contributing to SNA benefits. If the answer to all three questions is no, treat it as contributing to non-SNA benefits. This applies at the level of each specific service flow and beneficiary group. The same marine ecosystem may supply both SNA and non-SNA cultural services to different beneficiaries. See SEEA EA paras. 5.25–5.28 for classification of ecosystem service beneficiaries.

Status of the SEEA EA valuation chapters

¶15 The specific status of different components of SEEA EA affects the authority the valuation guidance below can carry.

¶16 The United Nations Statistical Commission at its fifty-second session in March 2021 (Decision 52/101):

- ¶17 **Adopted** SEEA EA chapters 1-7 (accounting framework and physical accounts) as an **international statistical standard**
- ¶18 **Recognized** that chapters 8-11 describe “**internationally recognized statistical principles and recommendations**” for valuation of ecosystem services and assets in a context coherent with the SNA for countries undertaking valuation
- ¶19 **Noted** chapters 12-14 as describing applications and extensions⁵⁴

¶20 **Implication for Ocean Accounting:** The physical accounting framework has full international statistical standard status. The valuation guidance represents best practice recommendations that countries may apply when undertaking valuation, rather than mandatory requirements. This circular follows these recommendations whilst acknowledging their status.

¶21 The characterisation above is drawn directly from the text of UNSC Decision 52/101. The Commission’s choice of the phrase “internationally recognized statistical principles and recommendations” rather than “international statistical standard” for chapters 8-11 was deliberate. At the time of adoption, monetary valuation methods had not reached the same level of methodological maturity as the physical accounting framework in chapters 1-7. In practical terms, this means that countries are encouraged but not required to implement monetary valuation, and where they do so they should follow the principles and recommendations set out in those chapters. Circulars carrying the **Core** badge draw only on adopted standards, so valuation guidance is presented throughout the Technical Guidance as authoritative best practice rather than as binding statistical standard.

¶22 The System of National Accounts 2025 (SNA 2025) was adopted by the United Nations Statistical Commission at its fifty-fifth session in 2024 as the updated international statistical standard for national accounts, replacing SNA 2008. The SEEA EA 2021 valuation recommendations remain the operative guidance for ecosystem accounting pending any future revision of SEEA EA, and SNA 2025 does not amend the SEEA EA valuation chapters. Where this circular cites both SNA 2008 and SNA 2025 paragraph numbers, the SNA 2025 reference is authoritative for current practice.⁵⁵

3.10.2 Valuation method preference order

¶1 The SEEA EA establishes a preference order for valuation methods based on their proximity to observed market prices and their alignment with exchange value concepts.⁵⁶

Five-level preference hierarchy

¶2 Table 3.10.1 summarises the SEEA EA preference order with examples relevant to ocean accounting.

¶3 *Table 3.10.1: SEEA EA valuation method preference order*

Preference level	Description	Ocean accounting examples
1. Directly observable prices	Prices observed in actual market transactions for the ecosystem service or asset	Fish quota (ITQ) trading prices; carbon credit prices from verified offset markets; water abstraction rights; aquaculture site lease fees
2. Prices from markets for similar goods/services	Prices observed in markets for goods/services sufficiently similar to the one being valued	Prices from comparable fisheries in other jurisdictions; rental values from comparable coastal sites; timber prices from comparable mangrove forests

Preference level	Description	Ocean accounting examples
3. Prices embodied in market transactions	Values estimated from market transactions where the ecosystem contribution is embedded	Resource rent from fisheries (gross output minus all non-ecosystem inputs); hedonic property prices reflecting coastal amenity; productivity change method for nursery services
4. Prices based on revealed expenditures (costs)	Values estimated from actual expenditures on related goods/services that have already been made	Averting behaviour (defensive expenditure actually incurred); travel expenditure (consumer expenditure method)
5. Prices based on expected expenditures or markets	Values estimated from modelled or hypothetical expenditures	Replacement cost (where the replacement has not actually been built); simulated market prices; avoided damage cost estimates based on modelled flood scenarios

***Note on replacement cost and preference level:** Replacement cost belongs at Preference Level 5 (expected/simulated expenditure) in the large majority of ocean accounting applications, because the replacement structure (e.g., a seawall, constructed wetland) is hypothetical: it has not been built and its cost has not been observed. Replacement cost may be classified at Level 4 only in the exceptional case where an equivalent replacement has actually been constructed and the observed construction costs are available from administrative records. See Section 3.10.4 for full guidance on applying these methods.*

¶4 Methods at lower preference levels introduce greater uncertainty and require stronger assumptions. Where feasible, compilers should aim for methods at preference levels 1–3, which rely on observed market data. Because methods at levels 4–5 rest on weaker assumptions, their application should be accompanied by explicit documentation of assumptions and sensitivity analysis.

Decision tree for method selection

¶5 The following decision tree provides a simplified guide to selecting a valuation method based on data availability, following the SEEA EA preference order from most to least preferred. Figure 2.4.2 traces this five-level preference order. Each data-availability gate routes compilers from directly observed prices at Level 1 to modelled expected costs at Level 5.

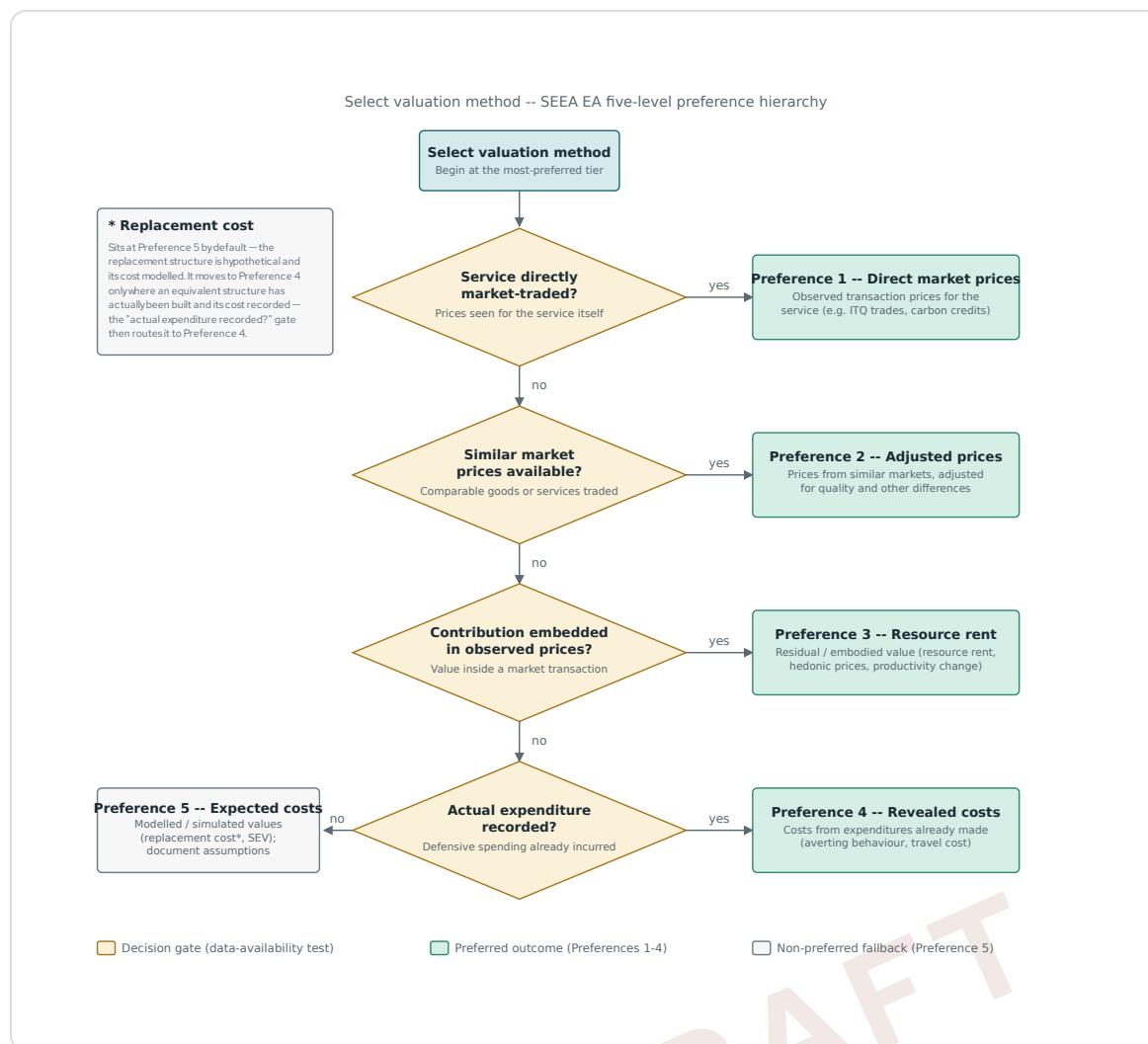


Figure 1.9.1 A five-level SEEA EA preference order routes compilers from direct market prices down to expected costs when higher-tier data are unavailable. [a] Yes at a gate selects that preference. [b] No passes to the next, less-preferred tier. Preference 5 is the non-preferred fallback.

Source: TG-1.9 Valuation Methods, Section 3.4 (five-level preference hierarchy) and Table 1.

Adapted from: SEEA EA 2024, Chapters 8-9 (monetary valuation); preference order per SEEA EA preference hierarchy for valuation methods.

¶6 Sections 3.10.3 and 3.10.4 set out methods for preference levels 1-3 and 4-5 respectively, each with specific ocean accounting examples and worked calculations.

3.10.3 Methods appropriate to accounts (preference levels 1-3)

Directly observable prices (first preference)

¶1 Where prices are directly observable in market transactions, these provide the most reliable basis for valuation. Examples relevant to ocean accounting include:

Ocean Context	Directly Observable Price
Commercial fisheries	Fish quota prices (where ITQ systems exist)
Aquaculture	Site lease/license fees reflecting ecosystem contribution
Coastal forestry	Stumpage values for mangrove timber
Blue carbon	Carbon credit prices from verified offset markets
Water abstraction	Water rights prices (coastal/estuarine contexts)

¶2 These directly observed values reflect the current institutional context and should be applied in accounts even when the resulting values might appear “low” relative to the perceived importance of the ecosystem. As the SEEA EA notes, resource rents for natural resources extracted in open-access contexts will tend toward zero, and this is a well-understood result that reflects institutional arrangements rather than low ecosystem importance.⁵⁷

¶3 Care should be taken to understand the size of markets and their maturity because the use of prices from small or immature markets may not be sufficiently representative for use in ecosystem accounting. To the extent that the recorded values are considered ‘low’, there may be an interest in estimating complementary values on the basis of alternative institutional contexts and market settings. These hypothetical values should not be recorded in ecosystem accounts but may be presented in complementary accounts.⁵⁸

Prices from similar markets (second preference)

¶4 When market prices for a specific ecosystem service are not observable, prices from markets for similar goods and services may provide an approximation. The SNA states that “if there is no appropriate market in which a particular good or service is currently traded, the valuation of a transaction involving that good or service may be derived from the market prices of similar goods and services by making adjustments for quality and other differences.”⁵⁹

¶5 For ocean accounting, this might include:

- ¶6 Using rental prices from comparable coastal land parcels for aquaculture sites
- ¶7 Applying fish prices from similar species/fisheries in other jurisdictions
- ¶8 Using carbon prices from comparable ecosystem types (e.g., terrestrial forest carbon prices for mangrove carbon)
- ¶9 Applying timber prices from comparable terrestrial forests to value mangrove timber provisioning

¶10 **Caution:** Value transfer across different institutional and ecological contexts requires careful adjustment for differences. Institutional mismatch (where source study contexts differ from accounting application contexts) is a risk.⁶⁰ The most widespread example of applying this approach in the national accounts is the estimation of the imputed rent for owner-occupied dwellings, where the observed rents paid by tenants are commonly used to apply a ‘similar markets’ method to estimate rents for owner-occupied dwellings (adjusting for variations in rents associated with the location and characteristics of the dwellings).⁶¹

Prices embodied in market transactions (third preference)

¶11 These methods estimate ecosystem service values from data on market transactions where the ecosystem contribution is embedded but not directly observable:

¶12 Residual Value and Resource Rent Methods

¶13 The resource rent method estimates value by taking gross output value and deducting costs of all other inputs including labour, produced assets, and intermediate inputs.⁶² For marine fisheries, this means:

```
Resource rent = Gross output value of catch
               - Intermediate consumption (fuel, ice, repairs)
               - Compensation of employees
               - Taxes on production net of subsidies (including resource access fees,
licence fees, royalties)
               - Consumption of fixed capital (vessel depreciation)
               - Return on produced assets (normal profit on vessel investment)
               - Imputed cost of self-employed labour
```

¶14 The residual represents the contribution of the marine ecosystem to the production value. This method is commonly applied for valuing wild fish provisioning services. This formulation follows the structure set out in SEEA CF Annex A5.1, which defines the resource rent as the residual after deducting all user costs of produced assets and labour from the gross value of output.⁶² In the fisheries context, the inclusion of an imputed cost of self-employed labour is essential, as owner-operators are common in many small-scale fisheries, and omitting this cost would inflate the residual. Similarly, the return on produced assets (i.e. normal profit on the capital invested in vessels and gear) must be deducted to isolate the ecosystem contribution from the return to produced capital. Taxes on production net of subsidies, including resource access fees, licence fees, and royalties payable to the resource owner (commonly government), must also be deducted explicitly. In jurisdictions where government retains resource ownership, access fees represent a transfer of the resource rent to the state. Omitting them causes the compiler-calculated residual to overstate the unappropriated rent and risks double-counting government revenue already recorded in national accounts.⁶³

¶15 The calculation is subject to variations in prices of outputs and inputs that can be considerable under market conditions, resulting in high annual volatility of estimates. For this reason, statistical offices tend to use 3–5 year moving averages when calculating residual value.⁶⁴

¶16 Hedonic Pricing

¶17 Estimates the differential premium on property values derived from proximity to marine and coastal environmental attributes such as beach quality, water clarity, or marine protected areas.⁶⁵ This method is particularly relevant for valuing coastal amenity and visual amenity services. Applications of hedonic pricing have grown substantially in recent years, with studies documenting property premiums for nature views, open spaces, beach access, and water quality.⁶⁶

¶18 Productivity Change Method

¶19 Estimates value based on the marginal contribution of ecosystem inputs to production functions. For ocean contexts, this includes estimating the productivity contribution of:

- ¶20 Nursery habitat services to fishery production
- ¶21 Water quality services to aquaculture productivity
- ¶22 Coastal vegetation services to agricultural productivity in adjacent lands⁶⁷

¶23 The productivity change method estimates an exchange value that is consistent with the SNA by estimating a production function directly, based on micro-level data on physical inputs and outputs at the site (e.g. farm) level. The econometric estimation of the equation provides a direct estimate of the marginal productivity of the input(s). Multiplying the marginal productivity by the price of the output gives the exchange value of the ecosystem service.⁶⁸ Such a method requires the availability of micro data to make the estimation, which can be data intensive.

3.10.4 Methods requiring caution (preference levels 4–5)

Revealed expenditure methods (fourth preference)

¶1 These methods derive prices from actual expenditures on related goods and services that have already been made and are observable in administrative or survey data.

¶2 **Boundary between averting behaviour and replacement cost:** This distinction applies before selecting a Level 4 method. Averting behaviour (defensive expenditure) requires that an actual expenditure has been made and recorded: it is a real cost that appears in national accounts or administrative data. Where the expenditure is hypothetical (the replacement or protective structure has not been built and its cost has not been observed), the correct method is replacement cost at Preference Level 5, not Level 4. Compilers must verify that an actual expenditure record exists before applying a Level 4 cost-based method. The mere plausibility of a future expenditure does not qualify. See Section 3.10.4 for replacement cost guidance.

¶3 Averting Behaviour (Defensive Expenditure)

¶4 Based on expenditures to mitigate or eliminate damages from adverse environmental impacts.⁶⁹ Ocean examples include:

- ¶5 Expenditure on desalination or treatment when natural water purification services decline
- ¶6 Health expenditure related to poor coastal water quality
- ¶7 Coastal engineering expenditure to protect against degraded natural defences: applicable at Level 4 only where the engineering work has actually been undertaken and costs are on record. Where the works are hypothetical or planned but not yet constructed, the correct method is replacement cost at Level 5

¶8 Travel Expenditure

¶9 Uses travel costs as a proxy for recreation service values.⁷⁰ The consumer expenditure method, which uses direct out-of-pocket expenditures (transport, fuel, accommodation, fees), provides exchange values appropriate for accounts. This differs from the traditional travel cost method that estimates total willingness to pay including consumer surplus.

¶10 For marine and coastal recreation, consumer expenditure data from tourism statistics can provide a basis for valuation, though care is needed to:

- ¶11 Isolate the marine/coastal component from total trip expenditure
- ¶12 Attribute expenditure to specific ecosystem assets
- ¶13 Avoid double-counting with coastal property amenity values

Expected or simulated expenditure methods (fifth preference)

¶14 Where observed prices and expenditures are not available, methods based on expected or simulated expenditures may be applied:

¶15 Replacement Cost

¶16 Estimates the cost of replacing a single ecosystem service using a process that provides equivalent benefits.⁷¹ For ocean accounting, common applications include:

Ecosystem Service	Replacement Cost Basis
Coastal protection (mangroves, reefs)	Engineered sea wall or breakwater
Water purification (wetlands)	Constructed treatment facility
Nursery services (seagrass)	Hatchery and stocking programs
Carbon sequestration	Direct air capture or alternative mitigation

¶17 **Validity conditions:** The replacement must (i) provide exactly the same function, (ii) be the least-cost alternative, and (iii) have evidence of actual demand.⁷²

¶18 Avoided Damage Cost

¶19 Estimates value based on the costs of damages that would occur due to loss of services.⁷³ This is particularly relevant for coastal protection services, where avoided damages from storm surge, flooding, and erosion can be estimated using flood risk models. The validity of the avoided damage cost method depends on conditions including that the damages avoided can be related to a specific service, and that people would be willing to pay an amount to actually avoid the damage.⁷⁴

¶20 Simulated Exchange Value (SEV)

¶21 Estimates the price and quantity that would prevail if the ecosystem service were traded in a hypothetical market.⁷⁵ The SEV method uses demand curves estimated from travel cost or stated preference studies to simulate what price would clear a hypothetical market for the service. Whilst

more complex, this method can provide exchange-value-consistent estimates where other methods are not feasible.

Case illustration: UK Marine Natural Capital Accounts (JNCC/Cefas)

The UK Joint Nature Conservation Committee (JNCC) and Centre for Environment, Fisheries and Aquaculture Science (Cefas) compiled an initial set of natural capital accounts for UK marine and coastal ecosystems. At the time of their study, an estimated 36% of UK marine habitats were classified as unmapped or unknown.⁷⁶ For those habitats where data were available, the study applied several valuation methods consistent with SEEA principles: replacement cost for waste mediation (phosphorus, nitrogen, BOD) by littoral sediments, coastal saltmarsh, shelf-sea, and deep-sea ecosystems; replacement cost for coastal protection based on the cost of constructing equivalent seawalls; abatement cost for carbon burial in marine sediments; and the resource rent approach for marine fish and shellfish, offshore renewable energy (wind), and abiotic products (marine aggregates). This study illustrates both the feasibility of applying the SEEA EA preference order to marine assets and the practical constraint that incomplete habitat data imposes on full valuation coverage.⁷⁷

3.10.5 Methods inappropriate for accounts

¶1 Certain valuation methods, whilst useful for other analytical purposes, do not yield exchange values appropriate for direct recording in ecosystem accounts.

Consumer surplus measures

¶2 Methods that estimate total willingness to pay including consumer surplus are not appropriate for direct entry in accounts. Consumer surplus cannot be transferred between transactors and represents value that is not exchanged.⁷⁸ However:

- ¶3 Demand curves from such studies can inform SEV calculations
- ¶4 Welfare values remain important for cost-benefit analysis and impact assessment
- ¶5 A “bridge table” between exchange and welfare values can be compiled as a complementary account⁷⁹

Stated preference methods (direct application)

¶6 Contingent valuation and choice experiment results that estimate total willingness to pay should not be directly entered in accounts. Stated preference data that have not been adjusted for exchange value consistency are not appropriate account entries regardless of data availability or the absence of alternative methods.⁸⁰

¶7 **Appropriate use of stated preference data:** If stated preference data are the only available source for a given service, they should be used only as inputs to SEV calculations, adjusting for consumer surplus to derive the simulated exchange value, and clearly flagged as Level 5 estimates requiring sensitivity analysis. They should not be entered as direct account values. Compilers using stated preference data in this way should cross-reference Section 3.10.4 on SEV methodology and document the adjustment procedure explicitly.⁸⁰

Other appropriate uses:

- ¶9 For complementary welfare analysis
- ¶10 In bridge tables linking exchange and welfare values (see Section 3.10.5)

Non-use values

¶11 Non-use values (existence values, bequest values, option values) are not within scope of ecosystem service values in accounts since there are no inherent transactions associated with these

values.⁸¹ This exclusion matters for ocean accounting given the high perceived non-use values associated with:

- ¶12 Iconic marine species (whales, dolphins, sea turtles)
- ¶13 Unique marine ecosystems (coral reefs, kelp forests)
- ¶14 Marine biodiversity in general

¶15 Whilst these values may be relevant for wider policy analysis and public communication, they represent a different measurement concept that should not be mixed with exchange-value-based accounts. Where non-use values are considered important for policy purposes, the SEEA EA framework accommodates their presentation through complementary accounts and thematic analyses. Chapter 12 of the SEEA EA describes how welfare values, including non-use values, can be reported in supplementary tables alongside exchange-value-based accounts, using a bridge-table approach that makes the relationship between the two measurement concepts explicit.⁷⁹ This approach allows policymakers to access information on non-use values without compromising the conceptual integrity of the core accounts. For ocean accounting, compilers may wish to consider producing such complementary analyses for ecosystem types or species where non-use values are known to be large relative to exchange values, such as iconic marine habitats and species.

Restoration costs for total asset valuation

¶16 The SEEA EA distinguishes between replacement costs (appropriate for individual services) and restoration costs (the cost of restoring an ecosystem as a whole). Restoration costs should not be used to value ecosystem assets, as this would make it impossible to separately assess the benefits of ecosystem restoration: they would by definition equal the costs.⁸² However, restoration costs can provide policy-relevant information in certain contexts and may be presented in complementary accounts.

3.10.6 Worked example: applying the preference order to marine ecosystem services

¶1 The following worked example covers a coastal marine ecosystem and illustrates step-by-step method selection for multiple ecosystem services supplied by a hypothetical coastal accounting area.

Scenario Description

¶2 **Accounting Area:** A coastal region encompasses 500 hectares of mangrove forest, 200 hectares of coral reef, and 5,000 hectares of continental shelf waters. The area supports commercial fisheries (targeting reef and pelagic fish), recreational diving, and provides coastal protection to 10 km of populated coastline. An ITQ system for fishing is not in place; catch is managed through annual total allowable catch (TAC) limits. Carbon markets operate at national level with verified blue carbon offsets for mangrove conservation.

¶3 **Objective:** Compile monetary values for four key ecosystem services (fish provisioning, coastal protection, carbon sequestration, and recreation) using the SEEA EA preference order.

Fish Provisioning Service

¶4 Step 1: Check for directly observable prices (Preference 1)

- ¶5 No ITQ market exists → No directly observable quota prices
- ¶6 Fish are sold at observed market prices, but these are product prices not ecosystem service prices

¶7 Step 2: Check for similar markets (Preference 2)

- ¶8 A neighboring jurisdiction with comparable species and fishing methods operates an ITQ market where quota prices average USD 800 per tonne
- ¶9 However, institutional differences (this jurisdiction has TAC but no ITQ) mean direct price transfer is not appropriate without adjustment

¶10 **Step 3: Apply prices embodied in transactions (Preference 3)**

- ¶11 **Method selected: Resource rent**
- ¶12 Data available: National fishery statistics provide gross output value, intermediate consumption, employment, and vessel capital stock data

¶13 **Calculation:**

Gross output value (landed value):	USD 5,200,000
Less: Intermediate consumption:	USD 1,800,000
Less: Compensation of employees:	USD 1,200,000
Less: Taxes on production net of subsidies (access fees, licence fees, royalties -- nil in this jurisdiction):	USD 0
Less: Consumption of fixed capital:	USD 400,000
Less: Return on produced assets (5%):	USD 300,000
Less: Imputed self-employed labour:	USD 500,000
= Resource rent:	USD 1,000,000
Annual catch: 2,000 tonnes	
Resource rent per tonne: USD 500	

Note: The taxes/access fees line is shown explicitly as nil here because the illustrative jurisdiction has no royalty or licence fee regime. In jurisdictions where government charges access fees or royalties, this line will carry a positive deduction. Omitting it where fees exist would overstate the resource rent.

¶14 **Result:** Fish provisioning service valued at USD 500 per tonne using resource rent method (Preference level 3). This represents the ecosystem contribution after deducting all other input costs. See also **TG-1.9** Section 3.2.4: because resource rent is used here, nursery habitat services from the reef should not be separately valued in this account.

Carbon Sequestration Service¶15 **Step 1: Check for directly observable prices (Preference 1)**

- ¶16 National blue carbon offset market exists for mangrove conservation
- ¶17 Verified carbon credits from mangroves trade at USD 15 per tonne CO₂-equivalent
- ¶18 **Method selected: Observed market prices (for credit valuation)**

¶19 **Step 2: Distinguish physical service flow from monetisable verified credits**

¶20 The physical service flow (gross CO₂ sequestration) is the quantity recorded in the physical account. The monetary value attaches to the verified offset credits that can be issued against that sequestration. The two quantities differ because verified carbon markets apply permanence buffers and leakage deductions to manage the risk that sequestered carbon is not permanently retained.

¶21 **Calculation:**

Physical service flow (gross sequestration):

Mangrove sequestration rate: 8 tonnes CO₂/ha/year
 Mangrove extent: 500 hectares
 Annual gross sequestration: 4,000 tonnes CO₂
 → Record 4,000 t CO₂/year in the physical supply account

Monetisable verified credits:

Less: Permanence buffer deduction (15%, illustrative --
 consistent with a moderate-risk Verra VM0033
 buffer contribution for credits specifically): 600 tonnes CO₂
 Net credits eligible for market price: 3,400 tonnes CO₂

Note: The 15% buffer is a requirement of the credit instrument, not a property of the sequestration service. It applies when valuing verified credits; do not apply it when recording the physical service flow in the physical account.

Monetary valuation:

Net credits: 3,400 tonnes CO₂
 Market price: USD 15 per tonne CO₂
 Annual service value: USD 51,000

***Where no verified credits exist:** If the jurisdiction has no operating verified carbon offset market, do not apply prices from other markets directly. Instead, use a Level 5 simulated exchange value method (Section 3.10.4), and document the method and assumptions explicitly.*

¶22 **Result:** Carbon sequestration service valued at USD 51,000 annually using observed carbon credit prices applied to net verified credit units (Preference level 1). The gross physical flow of 4,000 t CO₂/year is recorded separately in the physical account.

Coastal Protection Service¶23 **Step 1: Check for directly observable prices (Preference 1)**

- ¶24 No market for coastal protection services exists
- ¶25 Property owners do not pay for protection services provided by reefs and mangroves

¶26 **Step 2: Check for similar markets (Preference 2)**

- ¶27 No comparable markets for natural coastal protection

¶28 **Step 3: Check for prices embodied in transactions (Preference 3)**

- ¶29 Hedonic pricing study of coastal properties would require extensive data collection
- ¶30 Productivity change method not applicable (no direct production function)

¶31 **Step 4: Assess validity conditions for replacement cost (Preference 5)**

- ¶32 No equivalent seawall has been built in this area; the replacement is hypothetical → **Preference Level 5** applies (not Level 4)
- ¶33 Engineering studies for the region indicate that a seawall providing equivalent protection would cost USD 12,000 per km of coastline

¶34 **Validity conditions test:**

Condition	Evidence	Met?
(i) Equivalent function: the seawall provides the same flood and erosion protection as the reef/mangrove system for the 10 km coastline	Regional coastal engineering survey confirms a 1.2 m freeboard seawall at this location would replicate modelled protection levels under a 1-in-50-year storm event	Yes

Condition	Evidence	Met?
(ii) Least-cost alternative: no cheaper engineered option can provide the same protection	Comparative cost estimates for riprap revetment (USD 18,000/km) and hybrid living shoreline (USD 22,000/km) confirm the seawall at USD 12,000/km is the least-cost engineered substitute	Yes
(iii) Evidence of actual demand: beneficiaries would actually procure the replacement if natural protection were lost	Coastal development master plan for the region includes a contingency seawall provision; two recent development applications cite natural reef as justification for reduced setbacks, confirming revealed demand	Yes

If any condition cannot be demonstrated, the method should be applied at Level 5 with correspondingly stronger uncertainty documentation and sensitivity analysis, and the failed condition flagged in the disclosure statement.

¶35 Calculation:

Note: Cost figures in this example are purely illustrative and do not represent actual engineering costs.

Protected coastline: 10 km

Replacement cost: USD 12,000 per km

Annual service value (assuming 50-year asset life and 4% discount):

= USD 120,000 / 21.48 (annuity factor) = USD 5,586 per year

Alternatively, using direct annual equivalent:

= (USD 120,000 × 0.04) / (1 - (1.04)⁻⁵⁰) = USD 5,586 per year

¶36 **Result:** Coastal protection service valued at USD 5,586 annually using replacement cost method (Preference level 5). Sensitivity analysis should be conducted on asset life (30-70 years) and discount rate (3-5%).

Recreation Service

¶37 Step 1: Check for directly observable prices (Preference 1)

- ¶38 Dive operators charge fees, but these are for guide services not for the ecosystem service itself
- ¶39 Marine protected area has no entry fee

¶40 Step 2: Check for similar markets (Preference 2)

- ¶41 Nearby marine parks charge entry fees of USD 10 per visitor
- ¶42 However, institutional difference (this site is free-access) means fee cannot be directly applied

¶43 Step 3: Check for prices embodied in transactions (Preference 3)

- ¶44 No hedonic property study available for this specific area

¶45 Step 4: Apply revealed expenditure methods (Preference 4)

- ¶46 **Method selected: Consumer expenditure**
- ¶47 Tourism statistics record visitor numbers and expenditure on transport, accommodation, and dive operator fees

¶48 Calculation – raw expenditure:

Annual visitors: 15,000
 Average expenditure per visitor on marine recreation: USD 80
 (Transport USD 30, accommodation USD 35, dive fees USD 15)
 Total consumer expenditure: USD 1,200,000

¶49 Step 5: Isolate the marine ecosystem component

¶50 Not all trip expenditure is attributable to the marine ecosystem service. Accommodation costs (USD 35 of USD 80) serve the overnight stay regardless of the marine destination, and they should generally be excluded unless the marine attribute is demonstrably the primary trip driver. One accepted allocation approach uses visitor motivation data:

Visitor motivation survey: 65% of visitors cite marine recreation as their primary trip motivation (the remainder cite coastal amenity, cultural sites, or general relaxation)

Marine-attributable expenditure:

Transport + dive fees component = USD 45 per visitor

Marine motivation share applied to accommodation:

USD 35 × 65% = USD 22.75 per visitor

Total marine-attributable expenditure per visitor:

USD 45 + USD 22.75 = USD 67.75

Annual marine-attributable expenditure:

15,000 visitors × USD 67.75 = USD 1,016,250

¶51 Where motivation survey data are not available, a conservative approach is to include only purpose-specific fees (transport and dive fees) and exclude accommodation. Compilers should document the allocation method and reference tourism satellite account methodology for multi-purpose trips.⁸³

¶52 **Result:** Recreation service valued at approximately USD 1,016,250 annually using consumer expenditure method with marine motivation allocation (Preference level 4). Care must also be taken to avoid double-counting with coastal property amenity values already captured in any hedonic pricing estimate.

Summary Table

¶53 Table 3.10.2: Valuation method selection summary

Ecosystem Service	Method Selected	Preference Level	Annual Value	Rationale
Fish provisioning	Resource rent	3	USD 1,000,000	Observed market data for fish sales; resource rent isolates ecosystem contribution
Carbon sequestration	Market price (net credits)	1	USD 51,000	Blue carbon credit market provides directly observable prices; value applied to net verified credit units after permanence buffer
Coastal protection	Replacement cost	5	USD 5,586	No observed market; replacement hypothetical; validity conditions tested and met
Recreation	Consumer expenditure (marine-allocated)	4	USD 1,016,250	Visitor expenditure data available; marine motivation allocation applied

¶54 **Interpretation:** These four services were selected specifically to be non-overlapping for this illustrative example: they have distinct beneficiary populations (fishing industry, carbon market par-

ticipants, coastal residents, recreational visitors) and draw on distinct ecosystem processes (provisioning, carbon cycling, physical protection, amenity). Because of this non-overlap, the four values can be summed to an indicative total of approximately USD 2,072,836 for this accounting area. In real compilations, compilers must confirm non-overlap before summing service rows (see **TG-1.9** Section 3.2.4 for double-counting cautions, including the specific rule that nursery habitat services must not be separately valued when resource rent is used for fish provisioning). The corrected coastal protection value of USD 5,586 reflects the annuity factor of 21.48 at 4% over 50 years. All values should be presented alongside physical accounts showing mangrove extent, reef condition, fish stock biomass, and visitor numbers.

Ecosystem Asset Valuation – Simplified NPV Illustration

¶55 This section synthesises the four service values from Table 3.10.2 into a simplified ecosystem asset value using the net present value (NPV) approach. This is an introductory illustration only. TG-3.1 provides full guidance on ecosystem asset accounts.

¶56 Step 1: Annual service flow

Total annual service flow (sum of four services):	
Fish provisioning:	USD 1,000,000
Carbon sequestration:	USD 51,000
Coastal protection:	USD 5,586
Recreation:	USD 1,016,250
Total:	USD 2,072,836

¶57 Step 2: Projection assumption

¶58 For this simplified illustration, assume constant real service flows over the asset life (no growth or decline trend). In practice, compilers should assess whether a trend, positive (e.g., reef restoration) or negative (e.g., climate-related degradation), is observable and use that trend in the projection. TG-3.1 discusses projection methods in detail.

¶59 Step 3: Discount rate

¶60 Illustrative rate: **4%** social discount rate (reflecting a mix of collective-benefit services in this portfolio). See **TG-1.9** Section 3.1.2 for guidance on rate selection. Sensitivity analysis is mandatory.

¶61 Step 4: Time horizon

¶62 Illustrative horizon: **50 years** (broadly consistent with planning horizons for coastal ecosystems). This is a practical simplification. Ecosystem assets are long-lived, and a perpetuity formula may be more appropriate in some contexts.

¶63 Step 5: NPV calculation

$$\begin{aligned}
 \text{NPV} &= \text{Annual flow} \times \text{Annuity factor (4\%, 50 years)} \\
 &= \text{USD } 2,072,836 \times 21.48 \\
 &= \text{USD } 44,524,517
 \end{aligned}$$

$$\begin{aligned}
 \text{Annuity factor} &= [1 - (1 + r)^{-n}] / r \\
 &= [1 - (1.04)^{-50}] / 0.04 \\
 &= 21.48
 \end{aligned}$$

¶64 Table 3.10.3: Sensitivity analysis – ecosystem asset NPV

Discount rate	Time horizon	Annuity factor	NPV
3% (SIDS conservative benchmark)	50 years	25.73	USD 53,334,070
4% (primary illustration)	50 years	21.48	USD 44,524,517
4%	30 years	17.29	USD 35,839,334

Discount rate	Time horizon	Annuity factor	NPV
7%	50 years	13.80	USD 28,605,137
7%	30 years	12.41	USD 25,723,895

¶65 The sensitivity table demonstrates that the asset value is sensitive to both discount rate and time horizon assumptions. The spread between the 3%/50-year and 7%/30-year estimates is nearly twofold. Transparent disclosure of these assumptions is therefore essential. See TG-3.1 for full ecosystem asset account methodology, including how to handle multiple service types with different discount rates, depreciation of ecosystem assets, and time-series consistency.

4. Acknowledgements

¶1 **Authors:** [To be confirmed]

¶2 **Reviewers:** [To be confirmed]

5. References

- ¶1 SEEA Ecosystem Accounting (2021), para. 6.1, p. 134.
- ¶2 SEEA Ecosystem Accounting (2021), para. 6.51, Table 6.3, p. 144.
- ¶3 The Classification of Environmental Protection Activities (CEPA) and Classification of Resource Management Activities (CReMA) are statistical classifications maintained internationally for EGSS compilation. Recent updates – documented in Eurostat (2023) *Environmental Protection Expenditure Accounts – Compilation Guide* and Eurostat's EGSS compilation guide (most recent edition) – have integrated activities previously classified under CReMA 12 (Protection of biodiversity and landscapes) into CEPA 6. See footnote ¹⁷ for the consolidated classification note used throughout this Circular.
- ¶4 SEEA Ecosystem Accounting (2021), Chapter 14, provides guidance on deriving indicators from ecosystem accounts.
- ¶5 SEEA Ecosystem Accounting (2021), Chapter 14, provides guidance on deriving indicators from ecosystem accounts.
- ¶6 SEEA Ecosystem Accounting (2021), para. 6.51, pp. 144-145.
- ¶7 SEEA Ecosystem Accounting (2021), Table 6.3, pp. 144-148. The full reference list includes additional services such as biomass provisioning from wild animals and plants other than fish, genetic material services, and storm mitigation services.
- ¶8 Adapted from SEEA Ecosystem Accounting (2021), Table 6.3, pp. 144-148.
- ¶9 SEEA Ecosystem Accounting (2021), paras. 14.20-14.30, describe different types of indicators derivable from accounts.
- ¶10 SEEA Ecosystem Accounting (2021), para. 6.141, p. 165.
- ¶11 FAO (2022). *The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation*. Rome: FAO. The biennial SOFIA report provides global and regional fisheries stock-status data (including B/BMSY indicators where available) used as the Tier 1 capacity data source for fish provisioning indicators.
- ¶12 SEEA Ecosystem Accounting (2021), para. 14.8, p. 310. The distinction between headline and supporting indicators supports both high-level communication and detailed analytical use of ecosystem service accounts.
- ¶13 SEEA Ecosystem Accounting (2021), para. 7.58, p. 192.
- ¶14 SEEA Ecosystem Accounting (2021), para. 7.58, p. 192.
- ¶15 SEEA Central Framework (2012), Chapter 4, Section 4.3.3, describes the Environmental Goods and Services Sector (EGSS) and its relationship to environmental protection expenditure (EPE) and resource management expenditure (RME).
- ¶16 SEEA Central Framework (2012), paras. 4.92–4.95. The EGSS consists of producers of all environmental goods and services, encompassing environmental protection services (classified by CEPA) and resource management services (classified by CReMA).
- ¶17 **Consolidated note on the CReMA 12 reclassification.** The Eurostat EGSS compilation guide (most recent edition) and Eurostat (2023) *Environmental Protection Expenditure Accounts – Compilation Guide* reclassify activities previously coded under CReMA 12 ("Protection of biodiversity and landscapes") to CEPA 6. Two distinct activity groups are affected: (a) biodiversity and landscape protection activities (including coastal and marine biodiversity protection and marine protected area management), and (b) fisheries management activities (historically CReMA 12, now also CEPA 6). Compilers using the SEEA CF (2012) classifications, or national adaptations that have not yet adopted the Eurostat reclassification, should check their national adaptation and document the classification convention used. Cross-country comparability is preserved where the reclassification convention is stated in metadata.

8. ¶18 SEEA Central Framework (2012), paras. 4.140–4.152 describe the compilation approach for EGSS accounts using extended supply–use tables.
9. ¶19 SEEA Central Framework (2012), paras. 4.100–4.105; SNA 2025, para. 6.14 (ancillary activities); Eurostat EGSS compilation guide, Section 2.2. Ancillary production – environmental goods or services produced as an input to the producing unit’s own principal activity and consumed within the same unit – is embedded in the intermediate consumption of the producing industry and is not separately recorded as EGSS output.
10. ¶20 SEEA Ecosystem Accounting (2021), Table 6.3, p. 145, entry for “Wild fish and other natural aquatic biomass provisioning services.”
11. ¶21 SEEA Central Framework (2012), para. 5.399 (definition of gross catch within the aquatic resources extraction section, paras. 5.393–5.430).
12. ¶22 FAO FishStatJ database (<https://www.fao.org/fishery/en/statistics/software/fishstatj>) (<https://www.fao.org/fishery/en/statistics/software/fishstatj>) is the FAO’s primary annual capture–production data source, used in combination with FAO/RFMO discard estimates and the biennial *State of World Fisheries and Aquaculture* (SOFIA) report for compiling gross catch.
13. ¶23 The consistency between ecosystem service flows and asset account entries provides a fundamental quality check for ocean accounts. See **TG-3.1 Asset Accounts** for detailed guidance.
14. ¶24 SEEA Ecosystem Accounting (2021), paras. 6.98–6.101 discuss the boundary between ecosystem services and abiotic flows for water.
15. ¶25 SEEA Ecosystem Accounting (2021), paras. 6.11–6.17 (definition of and boundary between intermediate and final ecosystem services); para. 7.23 on use-table column structure.
16. ¶26 SEEA Ecosystem Accounting (2021), para. 6.107, p. 157.
17. ¶27 SEEA Ecosystem Accounting (2021), para. 6.110, p. 158.
18. ¶28 SEEA Ecosystem Accounting (2021), para. 6.112, p. 158.
19. ¶29 SEEA Ecosystem Accounting (2021), para. 6.115, p. 159, on user attribution for global climate regulation services.
20. ¶30 SEEA Ecosystem Accounting (2021), Table 6.3, p. 147.
21. ¶31 SEEA Ecosystem Accounting (2021), Table 6.3, p. 147, entry for “Coastal protection services.”
22. ¶32 SEEA Ecosystem Accounting (2021), para. 9.72, p. 230.
23. ¶33 Beck, M.W., Losada, I.J., Menendez, P., Reguero, B.G., Diaz-Simal, P., & Fernandez, F. (2018). The global flood protection savings provided by coral reefs. *Nature Communications*, 9: 2186. Documents wave–energy attenuation by coral reefs (typically in the range 70–97%) and provides parameters used in coastal protection effectiveness factors and tiered proxy methods.
24. ¶34 SEEA Ecosystem Accounting (2021), para. 6.15, p. 137.
25. ¶35 SEEA Ecosystem Accounting (2021), Table 6.3, p. 148, entry for “Recreation-related services.”
26. ¶36 SEEA Ecosystem Accounting (2021), para. 6.97, p. 156.
27. ¶37 SEEA Ecosystem Accounting (2021), Table 6.3, p. 148, entry for “Visual amenity services.”
28. ¶38 SEEA Ecosystem Accounting (2021), Table 6.3, p. 148, entry for “Spiritual, artistic and symbolic services.” See also United Nations (2007). *United Nations Declaration on the Rights of Indigenous Peoples*, Article 31 on the right to maintain, control, protect, and develop cultural heritage, traditional knowledge, and traditional cultural expressions.
29. ¶39 SEEA Ecosystem Accounting (2021), para. 1.34, p. 7.
30. ¶40 SEEA Ecosystem Accounting (2021), para. 1.33(c), p. 6, notes that the framework “enables coherent accounting in both physical terms (e.g. hectares or tons) and monetary terms.”
31. ¶41 SEEA Ecosystem Accounting (2021), paras. 9.21–9.27 establish the preference order for valuation methods.
32. ¶42 SEEA Ecosystem Accounting (2021), paras. 9.43–9.48, discuss the use of carbon prices for valuation of global climate regulation services. The social cost of carbon is a welfare-based concept that does not align directly with the exchange value framework of the SNA and SEEA.
33. ¶43 Based on SEEA Ecosystem Accounting (2021), Chapter 14 guidance on presentation and communication of indicators.
34. ¶44 Bradley, C., Clement, S., Vardon, M., Milligan, B., & Kagohashi, K. (2026). Operationalising the concept of critical natural capital to understand and manage nature dependency risk. *Ecosystem Services*, 77, 101799, §§6–7, Table 1, pp. 6–8. <https://doi.org/10.1016/j.ecoser.2025.101799> (<https://doi.org/10.1016/j.ecoser.2025.101799>). An importance hierarchy (basic needs; good health and safety; essential and non-essential wellbeing) for deciding which ecosystem services matter most, for whom and for what purpose, applied to the SEEA ecosystem service classes, with the split between levels 3 and 4 left for countries to set.
35. ¶45 **Note on linear vs areal intensity metrics for coastal protection.** Coastal protection intensity can be expressed as either (a) an *areal* metric – ecosystem area per unit of beneficiary shoreline protected (km²/km), useful where the protective function is distributed across the ecosystem’s full area such as in mangrove belts that absorb storm surge volumetrically, or (b) a *linear* metric – length of beneficiary shoreline per kilometre of ecosystem frontage, useful where the protective function is determined by the linear interface with the coast such as in coral reefs and dune systems. The choice should follow the dominant physical mechanism for the ecosystem in question and must be disclosed in metadata. Reporting an areal denominator for ecosystems whose protective function is essentially linear (or vice versa) will produce misleading intensity figures.
36. ¶46 SNA 2025, para. 4.131 (formerly SNA 2008, para. 3.118). Exchange values are defined as values at which goods, services, labour, or assets are exchanged or could be exchanged for cash.

7. ¶47 SNA 2025, para. 4.132 (formerly SNA 2008, para. 3.119). Market prices are amounts willing buyers pay to acquire something from willing sellers.
8. ¶48 SEEA EA 2021, para. 8.9. Exchange values differ from welfare values commonly used in environmental cost-benefit analysis, which include consumer surplus.
9. ¶49 NCAVES/MAIA 2022, Section 2.3.2. Consumer surplus is the difference between total willingness to pay and what is actually paid; accounts record the latter.
0. ¶50 SNA 2025, para. 4.130. The integrated framework measures current exchange value rather than attempting to determine utility of flows and stocks.
1. ¶51 NCAVES/MAIA 2022, Section 2.2. Ecosystem services are excluded from SNA production boundary; SEEA EA extends this boundary.
2. ¶52 NCAVES/MAIA 2022, Figure 1. Provisioning services contribute to SNA benefits; regulating and cultural services may contribute to SNA or non-SNA benefits.
3. ¶53 SEEA EA 2021, paras 5.25–5.28. Classification of ecosystem service beneficiaries by whether their benefits are within or outside the SNA production boundary.
4. ¶54 UNSC Decision 52/101, March 2021. Specifies different status for physical accounts (standard) versus valuation chapters (recognized recommendations).
5. ¶55 SNA 2025 was adopted by UNSC at its fifty-fifth session (2024), replacing SNA 2008. The SEEA EA 2021 is not amended by SNA 2025; its valuation recommendations remain operative pending future revision of SEEA EA.
6. ¶56 SEEA EA 2021, para. 9.27. Valuation methods should be applied in order of preference based on proximity to observed market prices.
7. ¶57 SEEA EA 2021, para. 9.29. Low values may reflect existing institutional arrangements; this is well understood in economics literature (open-access resources tend toward zero rent).
8. ¶58 SEEA EA 2021, para. 9.30. Care should be taken to understand market size and maturity; hypothetical values under alternative institutional contexts may be presented in complementary accounts.
9. ¶59 SNA 2025, para. 4.137 (formerly SNA 2008, para. 3.123). Similar markets approach adjusts for quality and other differences.
0. ¶60 NCAVES/MAIA 2022, Section 6.1. Value transfer requires consideration of institutional and ecological context differences between source and application sites.
1. ¶61 NCAVES/MAIA 2022, para. 3.3.2. The most widespread example of applying the similar markets approach in national accounts is the estimation of imputed rent for owner-occupied dwellings.
2. ¶62 SEEA CF 2012, Annex 5.1. Resource rent calculation deducts all factor payments from output value.
3. ¶63 SEEA CF 2012, Annex 5.1; SEEA EA 2021, para. 9.31. In jurisdictions where government retains resource ownership, access fees represent a transfer of the resource rent to the state and must be deducted to prevent double-counting government revenue already recorded in national accounts.
4. ¶64 NCAVES/MAIA 2022, Section 3.2.2.1. The calculation is subject to variations in prices of outputs and inputs that can be considerable under market conditions, resulting in high annual volatility of estimates. For this reason, statistical offices tend to use 3–5 year moving averages.
5. ¶65 NCAVES/MAIA 2022, Section 3.2.3.3. Hedonic pricing estimates differential premium on property value from environmental attributes.
6. ¶66 NCAVES/MAIA 2022, para. 3.2.3.3. Applications of hedonic pricing have grown substantially in recent years with studies documenting property premiums for nature views, open spaces, beach access, and water quality.
7. ¶67 SEEA EA 2021, para. 9.38–9.39. Productivity change method estimates marginal productivity of ecosystem inputs to production.
8. ¶68 NCAVES/MAIA 2022, Section 3.2.3.2. The productivity change method estimates an exchange value that is consistent with the SNA by estimating a production function directly based on micro-level data. The econometric estimation provides a direct estimate of the marginal productivity of the input(s).
9. ¶69 SEEA EA 2021, para. 9.45–9.46. Averting behaviour method based on expenditures to mitigate adverse environmental impacts.
0. ¶70 NCAVES/MAIA 2022, Section 3.2.4.2. Consumer expenditure method uses travel expenditures directly as exchange values.
1. ¶71 SEEA EA 2021, para. 9.50. Replacement cost estimates cost of replacing service using process providing same benefits.
2. ¶72 NCAVES/MAIA 2022, para. 3.2.5.1. The validity of the replacement cost method depends on three conditions: the substitute can provide exactly the same function; the substitute is the least-cost alternative; and evidence indicates an actual demand for the substitute.
3. ¶73 SEEA EA 2021, para. 9.52–9.53. Avoided damage cost based on damages that would occur from service loss.
4. ¶74 NCAVES/MAIA 2022, para. 3.2.5.2. The validity of the avoided damage cost method depends on conditions including that the damages avoided can be related to a specific service, and that people would be willing to pay an amount to actually avoid the damage.
5. ¶75 SEEA EA 2021, para. 9.55. Simulated exchange value estimates price and quantity from hypothetical market.
6. ¶76 JNCC and Cefas. Initial marine natural capital account for the UK. At the time of the study, approximately 36% of UK marine habitats were classified as unmapped or unknown.
7. ¶77 JNCC and Cefas. The study applied replacement cost methods (waste mediation, coastal protection), abatement cost (carbon burial), and resource rent (fish and shellfish, offshore wind, marine aggregates) consistent with

SEEA principles.

8. ¶78 NCAVES/MAIA 2022, Section 2.3.2. Consumer surplus cannot be transferred between transactors; accounts do not include it.
9. ¶79 SEEA EA 2021, Chapter 12 describes complementary accounts including bridge tables between exchange and welfare values.
0. ¶80 NCAVES/MAIA 2022, Section 3.2.5.4; SEEA EA 2021, para. 9.55. Stated preference data must be adjusted to derive a simulated exchange value before any use in accounts; they may not be entered as direct account values.
1. ¶81 SEEA EA 2021, Section 6.3.4. Non-use values are not within scope of ecosystem service values.
2. ¶82 SEEA EA 2021, Section 9.3.7 (para. 9.58) and Chapter 12 (Section 12.3.2). The restoration cost method is positioned for measuring ecosystem degradation rather than for total asset valuation.
3. ¶83 NCAVES/MAIA 2022, Section 3.2.4.2; tourism satellite account methodology for multi-purpose trips. Where visitor motivation data are unavailable, purpose-specific fees (transport, activity fees) provide a conservative lower-bound estimate that excludes accommodation costs.

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