

Flows from Environment to Economy

Compiles accounts for flows from the environment to the economy in the context of ocean accounting.

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OUTCOME

After completing this Circular, readers will be able to compile accounts for flows from the environment to the economy in the context of ocean accounting. These flows encompass ecosystem services (the contributions that marine and coastal ecosystems make to benefits used in economic and other human activity) as well as natural resource inputs extracted from the ocean environment. Understanding and measuring these flows is essential for three purposes: revealing the economic dependencies on ocean ecosystems, informing sustainable management of marine resources, and integrating environmental considerations into economic decision-making.

Section 3.3 includes a worked example tracing which supply-use and extent-account entries change under a spatial conversion scenario, of the kind evaluated in marine spatial planning.

For policy analysis, these accounts answer questions such as: What is the annual value of coastal protection provided by coral reefs and mangroves? How much fish biomass is being extracted relative to the ecosystem's capacity to supply it? What proportion of national tourism activity depends on marine ecosystem services? Which industries and communities are most dependent on flows from marine ecosystems, and therefore most exposed to ecosystem degradation? By compiling the accounts described in this Circular, countries can measure the flows that connect ocean ecosystems to economic production and human well-being. These accounts support indicators such as ecosystem dependency ratios (see [TG-2.3 Social and Livelihood Dependencies](#)) and environmental goods and services indicators (see [TG-2.4 Ecosystem Goods and Services](#)).

This Circular covers (1) the classification and measurement of provisioning, regulating, and cultural ecosystem services in marine contexts, (2) the treatment of natural resource inputs such as fish, water, and energy, (3) the compilation procedure for physical supply and use tables (PSUTs) for ecosystem services, (4) worked examples with synthetic data for coastal zones, and (5) approaches to the monetary valuation of flows from environment to economy. For the treatment of flows from economy to environment (residuals, emissions, waste), see [TG-3.4 Flows from Economy to Environment](#).

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ABOUT THIS CIRCULAR

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DRAFT

1. Outcome

¶1 After completing this Circular, readers will be able to compile accounts for flows from the environment to the economy in the context of ocean accounting. These flows encompass ecosystem services (the contributions that marine and coastal ecosystems make to benefits used in economic and other human activity) as well as natural resource inputs extracted from the ocean environment. Understanding and measuring these flows is essential for three purposes: revealing the economic dependencies on ocean ecosystems, informing sustainable management of marine resources, and integrating environmental considerations into economic decision-making¹.

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¶4 This Circular covers (1) the classification and measurement of provisioning, regulating, and cultural ecosystem services in marine contexts, (2) the treatment of natural resource inputs such as fish, water, and energy, (3) the compilation procedure for physical supply and use tables (PSUTs) for ecosystem services, (4) worked examples with synthetic data for coastal zones, and (5) approaches to the monetary valuation of flows from environment to economy. For the treatment of flows from economy to environment (residuals, emissions, waste), see **TG-3.4 Flows from Economy to Environment**.

2. Requirements

¶1 **Essential prerequisites:**

- ¶2 **TG-0.1 General Introduction to Ocean Accounts:** conceptual framework connecting ecosystems to economic activity
- ¶3 **TG-3.1 Asset Accounts:** relationship between ecosystem assets and the services they supply

¶4 **Helpful background:**

- ¶5 **TG-2.4 Environmental (including Ecosystem) Goods and Services** Section 3.10: valuation methods referenced throughout this Circular
- ¶6 **TG-0.7 Quality Assurance Principles:** quality assurance principles for the compiled accounts

¶7 ⓘ Framework Position

¶8 This Circular addresses the flows from marine and coastal ecosystems to human activities: ecosystem services flowing to the economy (E9), ecosystem services flowing to society beyond market transactions (E10), and intermediate ecological processes that maintain ecosystem functioning (E11). In the Ocean Accounts Framework (TG-0.1 Figure 0.1.2):

Edge	Direction	Description
E9	SG3 → FG1	Ecosystem services to economy (Applied)
E10	SG3 → FG2	Ecosystem services to society beyond the economy (Emerging)
E11	FG3 ↔ SG3	Intermediate ecosystem services and ecological processes (Applied)

¶9 **Scope.** TG-3.2 owns the supply and use tables for flows from the environment to the economy – the ecosystem services supply-use table and the natural resource inputs table – together with the ecosystem type change matrix that links them to extent. It cross-refers for the ecosystem-specific service method to Section 6 (**TG-6.1, TG-6.2, TG-6.3, TG-6.5**), for measurement of the service quantities to Section 4, for the valuation method applied to a service to **TG-2.4** Section 3.10, and for the asset the services are capitalised into to **TG-3.1**.

3. Guidance Material

¶1 Flows from the environment to the economy are the channel through which ocean ecosystems contribute to human well-being and economic production². The SEEA framework distinguishes two main categories of such flows: ecosystem services, which are the contributions of ecosystem assets to benefits, and natural resource inputs, which are physical materials extracted from the environment for use in economic processes³. Both categories are essential for ocean accounting. Marine ecosystem services include fish provisioning, coastal protection, carbon sequestration, and recreation, whilst natural resource inputs include harvested fish, abstracted seawater, and extracted seabed minerals.

¶2 This section examines ecosystem services in the marine context (Section 3.1), natural resource inputs (Section 3.2), the structure and compilation procedure for physical supply and use tables (Section 3.3), worked examples for coastal zone accounts (Section 3.4), and approaches to monetary valuation of flows from environment to economy (Section 3.5). The methodology presented here provides the basis for measuring the contributions that ocean ecosystems make to the economy and society. It supports the compilation of accounts for indicators of ecosystem dependency (**TG-2.3 Ecosystem Dependency Indicators**) and analysis of ecosystem goods and services (**TG-2.4 Ecosystem Goods and Services**). Measuring these flows draws on the spatial data sources described in **TG-4.1 Remote Sensing and Geospatial Data** and the survey methodologies presented in **TG-4.2 Survey Methods for Ocean Economic Activity**.

3.1 Ecosystem Services

¶1 Ecosystem services are the contributions of ecosystems to the benefits that are used in economic and other human activity⁴. The SEEA Ecosystem Accounting framework defines ecosystem services as flows between ecosystem assets and economic units, where economic units encompass businesses, governments, and households⁵. In the marine context, ecosystem services include the provision of fish and other harvested biomass, the regulation of climate through carbon sequestration, the protection of coastlines from storms and erosion, the filtration and purification of water, and the provision of recreational and cultural experiences.

Classification of ecosystem services

¶1 The SEEA EA presents a reference list of ecosystem services organised into three main sections⁶, summarised in Table 3.1.1 below.

Service category	Description
Provisioning services	Ecosystem contributions to the growth of biomass and other materials that can be harvested or extracted for use in economic activity.
Regulating and maintenance services	Ecosystem contributions that regulate or maintain environmental conditions that benefit people.
Cultural services	The experiential and intangible contributions of ecosystems that support physical, intellectual, and spiritual well-being.

¶2 This classification builds upon and is compatible with the Common International Classification of Ecosystem Services (CICES)⁷, which provides a hierarchical structure for ecosystem service classification. For ocean accounting, each category has particular relevance. A summary of key marine ecosystem services and their classification is presented in Table 1.

Service Category	Ecosystem Service	Key Marine Ecosystem Types	Typical Units
Provisioning	Fish provisioning	Marine shelf, pelagic	tonnes biomass
	Aquaculture provisioning	Coastal, marine shelf	tonnes biomass
	Seaweed/algae provisioning	Coastal, rocky shores	tonnes biomass
Regulating and maintenance	Global climate regulation	All marine, esp. blue carbon	tonnes carbon
	Coastal protection	Coral reefs, mangroves, seagrass	hectares protected
	Water purification	Coastal wetlands, seagrass	volumes filtered
	Nursery habitat*	Mangroves, seagrass, estuaries	hectares habitat
Cultural	Recreation	Coral reefs, beaches, MPAs	visitor-days
	Visual amenity	Coastal seascapes	hedonic value

¶3 Table 1: Selected marine ecosystem services by category (adapted from SEEA EA Table 6.3)⁸.

*Nursery habitat is a potentially intermediate service (see Section 3.1 on nursery services); compilers should take care to avoid double counting with provisioning services.

¶4 For the full list of marine-relevant ecosystem services, compilers should consult SEEA EA Table 6.3. Table 1b below provides an expanded reference mapping all SEEA EA services to ocean relevance.

Ecosystem services by ecosystem type: a worked example

¶1 To illustrate how ecosystem services vary across marine and coastal ecosystem types, Table 1a presents a worked example mapping selected ecosystem services to four representative ecosystem types. Compilers are encouraged to develop similar mappings for their accounting area, following the SEEA EA Technical Recommendations guidance to “create a table showing which ecosystem services are likely to be supplied from different ecosystem types for their country or target ecosystem accounting area”⁹. The services listed below follow the three categories defined in SEEA EA Table 6.3: provisioning services, regulating and maintenance services, and cultural services¹⁰.

¶2 **Table 1a: Illustrative ecosystem services by marine ecosystem type**

Ecosystem Service	Mangroves	Coral Reefs	Seagrass Meadows	Open Marine Pelagic
Provisioning services				
Biomass provisioning (wood)	Timber and fuel-wood harvest	—	—	—

Ecosystem Service	Mangroves	Coral Reefs	Seagrass Meadows	Open Marine Pelagic
Wild fish and other aquatic biomass provisioning	Inshore fish, crabs, shellfish	Reef fish, lobster, sea cucumber	Fish, shellfish associated with seagrass beds	Pelagic fish (tuna, mackerel, sardines)
Aquaculture provisioning	Shrimp ponds in mangrove areas	—	—	Offshore cage aquaculture
Genetic material services	Bioactive compounds from mangrove species	Genetic resources from coral reef organisms	—	Marine genetic resources from open-ocean species
Regulating and maintenance services				
Global climate regulation	High carbon sequestration and long-term storage in soils	Limited direct sequestration; reef calcification affects CO ₂	Carbon sequestration and storage in sediments	Ocean CO ₂ uptake by phytoplankton
Coastal protection (flood control)	Wave and storm surge attenuation	Wave breaking and energy dissipation	Wave attenuation and sediment stabilisation	—
Water purification	Nutrient filtration and sediment trapping	—	Nutrient uptake and sediment trapping	—
Nursery population and habitat maintenance	Critical nursery habitat for fish and crustaceans	Shelter and feeding habitat for juvenile reef species	Nursery and feeding grounds for fish and invertebrates	Spawning and migration habitat for pelagic species
Soil erosion control	Shoreline stabilisation through root systems	Breakwater function reducing shoreline erosion	Sediment binding by root systems	—
Storm mitigation (non-water-related storms only)	Windbreak and buffering of windstorms and sandstorms	—	—	—
Cultural services				
Recreation-related services	Kayaking, bird-watching, ecotourism	Diving, snorkelling, glass-bottom boat tours	Snorkelling, paddle boarding	Whale watching, sport fishing, sailing
Education, scientific and research services	Mangrove ecology research and education	Coral reef monitoring and marine research	Seagrass ecology and blue carbon research	Oceanographic and marine biology research
Spiritual, artistic and symbolic services	Sacred mangrove forests, cultural heritage sites	Cultural significance of reefs for island communities	—	Spiritual significance of the open ocean

¶3 Table 1a: Illustrative ecosystem services by marine ecosystem type, following SEEA EA Table 6.3 categories. A dash (—) indicates the service is not typically supplied by that ecosystem type.

¶4 Abiotic flows from the marine environment (seawater abstraction for desalination and cooling, extraction of seabed minerals and aggregates, and capture of offshore wind, wave, and tidal energy) are recorded separately as contributions from the environment following the SEEA EA framing in Table 6.1¹¹. These abiotic flows are distinct from ecosystem services: they arise through abstraction and extraction of resources from geophysical or geological sources rather than being un-

derpinned by ecological characteristics and processes. Compilers are encouraged to record abiotic flows alongside ecosystem services to enable joint analysis of environmental trends, but they should not be classified within the three ecosystem service categories.

Expanded reference: SEEA EA ecosystem services and ocean relevance

¶1 Table 1b provides an expanded reference mapping the ecosystem services from SEEA EA Table 6.3 to their relevance for ocean and coastal accounting. This table is intended to assist compilers in identifying which services from the reference list are most pertinent to their marine accounting area and in selecting appropriate measurement priorities¹².

¶2 **Table 1b: SEEA EA ecosystem services and their ocean relevance**

Ecosystem Service	Relevance to Ocean Accounts
Provisioning services	
Biomass provisioning services (crop provisioning, wood provisioning, wild animals and plants)	Includes timber from mangroves (wood provisioning) and non-fish harvesting in intertidal and coastal areas (wild animals, plants and other biomass provisioning). Crop provisioning is less directly relevant but may apply to cultivated seaweed and coastal salt production.
Wild fish and other natural aquatic biomass provisioning services	Central to ocean accounting. Covers capture fisheries, marine harvesting of shellfish and other aquatic organisms, and all wild-harvest marine biomass in uncultivated production contexts.
Aquaculture provisioning services	Ecosystem contributions to the growth of fish, shellfish, and seaweed in marine and coastal aquaculture facilities. The ecosystem provides water quality maintenance, nutrient cycling, and waste assimilation services that support cultivated production.
Genetic material services	Genetic materials sourced from coastal and marine ecosystems, including bioactive compounds from mangroves, corals, sponges, and deep-sea organisms used in pharmaceutical and biotechnology research.
Water supply	The combined ecosystem contributions of water flow regulation, water purification, and other services to the supply of water of appropriate quality. In coastal contexts, this relates to purification functions of mangroves, tidal flats, estuaries, and coastal vegetation that support freshwater quality in adjacent areas.
Regulating and maintenance services	
Global climate regulation services	Carbon sequestration and storage by phytoplankton in the open ocean, and by mangroves, seagrasses, and salt marshes in coastal zones (blue carbon). The ocean absorbs approximately 25–30% of anthropogenic CO ₂ emissions, making this one of the most significant marine regulating services.
Local (micro and meso) climate regulation services	Applicable to coastal ecosystems, especially mangroves and coastal vegetation that provide evaporative cooling and shade in tropical coastal settlements. Urban coastal water bodies (blue space) also contribute to local climate regulation.
Air filtration services	Ocean uptake of atmospheric pollutants, including particulate matter deposition on coastal vegetation. Primarily relevant in coastal areas where mangroves and other vegetation filter airborne pollutants affecting nearby communities.
Soil erosion control services	Coastal erosion control and flood protection provided by mangroves, coral reefs, seagrasses, and other coastal vegetation through root stabilisation and wave energy reduction. Includes protection of shorelines, coastal infrastructure, and adjacent agricultural land.
Water purification services (retention and breakdown of nutrients; retention and breakdown of other pollutants)	Retention and breakdown of organic pollutants, excess nutrients, and other contaminants by coastal wetlands, mangroves, and seagrass beds. These services maintain water quality in coastal and nearshore areas, supporting both marine ecosystem health and human uses such as aquaculture and recreation.

Ecosystem Service	Relevance to Ocean Accounts
Water flow regulation services (baseline flow maintenance; peak flow mitigation)	In the marine context, wave regulation and tidal flow moderation by mangroves, coral reefs, and seagrass meadows. Includes baseline flow maintenance in estuarine and lagoon systems and peak flow mitigation during storm and tidal surge events.
Flood control services (coastal protection)	Tidal surge mitigation and coastal protection by linear seascape elements including coral reefs, sand banks, dunes, and mangrove ecosystems along the shore. One of the most economically significant marine regulating services.
Storm mitigation services	Buffering of windstorms, sandstorms and other storms other than water-related events (SEEA EA Table 6.3), for example windbreak functions of mangrove and coastal forest canopy. Wave and tidal surge attenuation is <i>not</i> recorded here: it is a coastal protection service under flood control, in the row above. Storm mitigation is rarely the material entry in a marine account, and compilers should confirm it is analytically distinct from coastal protection before populating it.
Nursery population and habitat maintenance services	Coastal and marine ecosystems—including mangroves, seagrass meadows, estuaries, and coral reefs—provide critical nursery habitat for commercially important fish species and support the maintenance of marine biodiversity. These are intermediate services that underpin biomass provisioning and recreation-related services.
Solid waste remediation services	Coastal and marine ecosystem contributions to the transformation of organic or inorganic waste substances through microbial, algal, and biological processes. Includes breakdown of organic matter in coastal sediments and remediation functions of mangrove and wetland ecosystems.
Cultural services	
Recreation-related services	Coastal and marine tourism, recreational fishing, diving, snorkelling, surfing, whale watching, and beach recreation. Coral reefs, beaches, and marine protected areas are among the most significant ecosystem types for recreation-related services globally.
Education, scientific and research services	Marine research, oceanographic monitoring, environmental education at coastal and marine sites. Marine ecosystems support scientific discovery and serve as sites for ecological monitoring and education programmes.
Spiritual, artistic and symbolic services	Sacred marine and coastal sites, cultural heritage associated with the ocean, and the spiritual significance of the sea for coastal and island communities. Includes artistic inspiration derived from marine landscapes and seascapes.
Ecosystem and species appreciation	Whale watching, diving with marine megafauna, marine wildlife viewing, and the well-being that people derive from the existence and preservation of marine species and ecosystems. While not classified as an ecosystem service per se, these flows related to non-use values may be recorded alongside ecosystem services.

¶3 *Table 1b: SEEA EA ecosystem services mapped to ocean accounting relevance, based on the reference list in SEEA EA Table 6.3.*

Provisioning services in marine ecosystems

¶1 Marine provisioning services encompass the ecosystem contributions to the growth of biomass and water supply that can be harvested for human use¹³. Key provisioning services in the ocean domain include:

¶2 **Fish provisioning services** represent the ecosystem contributions to the growth of wild fish and other aquatic organisms that are harvested¹⁴. This service reflects the role of marine ecosystems in supporting fish populations through provision of habitat, food, and suitable environmental conditions. The SEEA EA notes that “provisioning services are recorded in contexts both of cultivation and of non-cultivation”¹⁵. For wild-capture fisheries the ecosystem provides the service, whilst for aquaculture the ecosystem contribution is distinguished from cultivated inputs. For detailed

guidance on fisheries stock assessment and the relationship between ecosystem services and fish harvests, see **TG-6.7 Fisheries Accounting: Integrating Stock Assessment**.

¶3 **Aquaculture provisioning services** represent ecosystem contributions to the growth of cultivated aquatic organisms¹⁶. Marine aquaculture depends on ecosystem services including water quality maintenance, nutrient cycling, and waste assimilation. The distinction between wild-capture and aquaculture is important: for aquaculture, part of the biomass growth results from cultivated inputs (feed, seed stock) whilst the ecosystem provides supporting services. The SEEA EA describes this as distinguishing “the contributions made by cultivated inputs from the contributions made by ecosystem assets”¹⁷. Detailed treatment of aquaculture accounts is provided in **TG-3.9 Aquaculture Accounts**.

¶4 **Other biomass provisioning services** include contributions to the growth of seaweed, shellfish, and other harvestable marine organisms¹⁸. Seaweed harvesting, for example, depends on ecosystem services that support algal growth, including nutrient availability and suitable water temperature and light conditions.

¶5 **Water supply services** in the marine context relate primarily to the abstraction of seawater for desalination, cooling, and other industrial uses¹⁹. Whilst seawater itself is typically treated as an abiotic flow rather than an ecosystem service (see Section 3.2), the quality of seawater (its temperature, salinity, and freedom from pollutants) may be influenced by ecosystem processes.

Regulating and maintenance services in marine ecosystems

¶1 Marine regulating and maintenance services matter for ocean accounting, as they encompass many of the non-market contributions that ecosystems make to human well-being²⁰. Key categories include:

¶2 **Global climate regulation services** represent ecosystem contributions to the regulation of the global climate through carbon sequestration and storage²¹. Marine ecosystems contribute substantially to the global carbon cycle: the ocean absorbs approximately 25–30% of anthropogenic CO₂ emissions, whilst coastal ecosystems such as mangroves, seagrass meadows, and salt marshes sequester carbon at rates far exceeding terrestrial forests²². This ‘blue carbon’ function is increasingly recognised as an ecosystem service. The SEEA EA states that “global climate regulation services represent a final ecosystem service with the user typically recorded as the global community or, where the focus is on a national ecosystem accounting area, the rest of the world”²³.

¶3 The treatment of global climate regulation services raises questions about national attribution. Following SEEA EA para 6.60, when compiling national accounts the service is recorded as supplied by domestic ecosystems and used by the rest of the world (RoW), with the entry in the use table appearing in the RoW column. Countries may additionally record domestic benefits from climate regulation where quantifiable, but should avoid double counting between global and local climate regulation services.

¶4 **Coastal protection services** are the ecosystem contributions to reducing the impacts of coastal hazards including storms, waves, and erosion²⁴. Coral reefs, mangroves, seagrass beds, salt marshes, and coastal dunes all provide natural flood and storm protection. The SEEA EA notes that “ecosystem services encompass services that are both predominantly biotic (e.g. air filtration services provided by forests) and predominantly abiotic (e.g. coastal protection services provided by sand dunes)”²⁵. For ocean accounting, coastal protection represents one of the most economically significant regulating services, with global estimates suggesting that coral reefs alone provide flood protection benefits exceeding USD 4 billion annually²⁶. Thematic guidance on coral reef ecosystem services is provided in **TG-6.1 Coral Reef Ecosystem Accounting**, on mangroves in **TG-6.2 Mangrove and Coastal Wetland Accounting**, and on seagrass in **TG-6.3 Seagrass Ecosystem Accounting**.

¶5 **Water purification services** represent ecosystem contributions to the removal or breakdown of pollutants and other substances from water²⁷. Coastal wetlands, mangroves, and seagrass beds filter nutrients, sediments, and pollutants from water flowing from land to sea, maintaining water quality that benefits both marine ecosystems and human uses such as recreation and aquaculture.

¶6 **Nursery population and habitat services** are the ecosystem contributions to the maintenance of populations of species through provision of critical habitat²⁸. Many commercially important fish species depend on coastal ecosystems such as mangroves, seagrass meadows, and estuaries as nursery habitat. 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”²⁹. Treating nursery services as intermediate makes the case for recording both final and intermediate ecosystem services, so that the contributions of coastal ecosystems to commercial fisheries are fully captured.

¶7 **Pollination and seed dispersal services** in marine contexts include the dispersal of marine plant propagules and the maintenance of genetic connectivity among populations³⁰. Whilst less prominent than in terrestrial ecosystems, these services contribute to the resilience and productivity of marine ecosystems.

¶8 **Soil and sediment retention services** represent ecosystem contributions to preventing erosion and maintaining sediment stability³¹. In coastal areas, vegetation such as mangroves and seagrasses stabilise sediments, reducing erosion and maintaining the physical integrity of coastal ecosystems.

Cultural services in marine ecosystems

¶1 Marine cultural services reflect the experiential, spiritual, and intellectual contributions of ocean ecosystems to human well-being³². Many of these contributions (cultural and spiritual values, non-market recreational benefits, subsistence provisioning) are not mediated through market transactions. In the Ocean Accounts Framework (TG-0.1), these non-market ecosystem contributions correspond to Edge E10 (ecosystem services to society beyond the economy), complementing the market-mediated services captured by Edge E9. These include:

¶2 **Recreation-related services** encompass the ecosystem contributions to recreational activities such as swimming, diving, snorkelling, fishing, and wildlife watching³³. Coral reefs, beaches, and marine protected areas attract tourists and recreational users, and that use generates economic activity. The SEEA EA notes that “recreation-related services are considered final ecosystem services since they are directly enjoyed by people”³⁴. For guidance on marine tourism and recreation accounts, see **TG-6.14 Marine and Coastal Tourism Accounting**.

¶3 **Visual amenity services** represent the contribution of ecosystems to aesthetic enjoyment through scenic views and landscapes³⁵. Coastal seascapes and marine environments contribute to the amenity value of coastal properties and destinations.

¶4 **Education, scientific, and knowledge services** encompass ecosystem contributions to research, education, and the generation of knowledge³⁶. Marine ecosystems are sites of scientific discovery and environmental education, and they are associated with traditional knowledge and cultural significance for coastal communities.

¶5 **Spiritual, artistic, and symbolic services** represent contributions to cultural identity, spiritual practices, and artistic inspiration³⁷. For many coastal and island communities, the ocean has profound cultural and spiritual significance. The SEEA EA notes that recording these services may involve “indicators of the physical characteristics associated with the supply of the service” rather than direct measurement of service flows³⁸.

¶6 Figure 3.2.1 illustrates the structure of flows between the environment and the economy as presented in the 2025 SNA (Figure 35.4). Natural inputs flow from the environment to the economy, whilst residuals flow from the economy back to the environment. Economic units within the econ-

omy produce and consume products. Recording both directions of this flow structure is necessary for ocean accounts that close the environment-economy circuit³⁹.

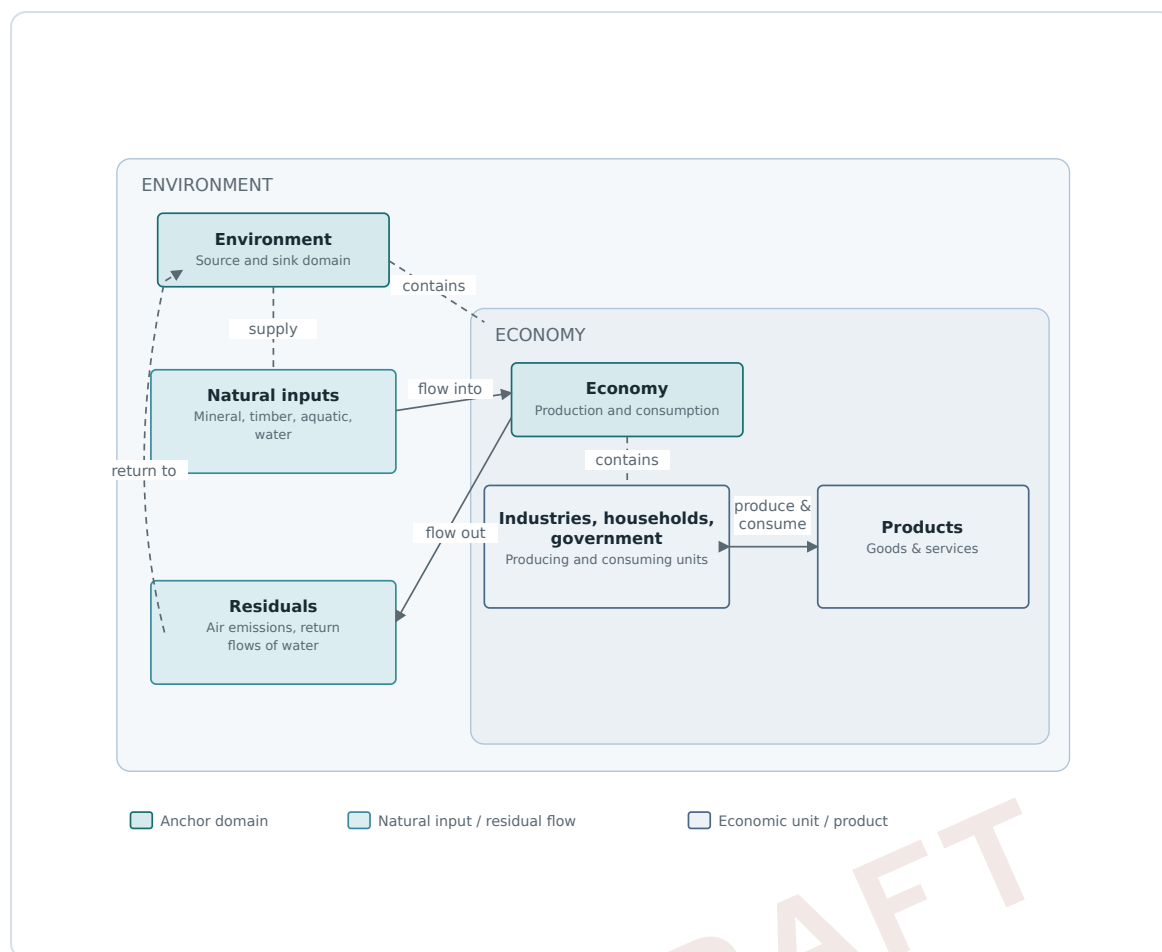


Figure 3.2.1 Natural inputs flow from the environment into the nested economy; residuals return the other way.

Source: System of National Accounts 2025, Figure 35.4; environment-economy flow concepts per SEEA Central Framework.

Adapted from: SNA 2025 Figure 35.4 (Flows between the economy and the environment), with GOAP-palette rendering and node-role colouring.

3.2 Natural Resource Inputs

¶1 Natural resource inputs are physical flows from the environment that are moved from their location in the environment as part of economic production processes⁴⁰. The SEEA Central Framework describes natural inputs as encompassing “all physical inputs that are moved from their location in the environment as a part of economic production processes or are directly used in production”⁴¹. For ocean accounting, key natural resource inputs include:

¶2 **Aquatic resources** extracted through capture fisheries represent the primary natural resource input from marine ecosystems⁴². The SEEA CF recommends measuring extraction as gross catch (the total live weight of fish caught, including discarded catch but excluding pre-catch losses) to capture the full impact on marine resources⁴³. The relationship between natural resource inputs (recorded in physical flow accounts) and changes in aquatic resource stocks (recorded in asset accounts as described in **TG-3.1 Asset Accounts**) provides an important consistency check. Specifically, extraction flows recorded in the PSUT should equal extraction entries in the asset account.

¶3 **Water abstraction** includes the removal of seawater and coastal water for use in economic processes⁴⁴. Whilst seawater stocks are not recorded in asset accounts due to their scale, abstraction flows are relevant for understanding industrial use of marine resources, particularly

for desalination and cooling. The SEEA CF notes that “the focus of the SEEA is the inland water system, with provision for the inclusion of sea or ocean water abstracted for production and consumption”⁴⁵.

¶4 **Mineral resource extraction** encompasses the removal of sand, gravel, and other seabed materials, as well as extraction of oil, gas, and deep-sea minerals⁴⁶. These extractions are recorded as natural resource inputs in physical flow accounts and correspond to reductions in mineral asset stocks. Detailed guidance on offshore energy accounting is provided in **TG-3.10 Offshore Energy Accounts**.

¶5 **Energy from natural inputs** includes energy captured from marine renewable sources such as tidal, wave, and offshore wind⁴⁷. The SEEA Energy framework describes energy from natural inputs as comprising “flows of energy from the removal and capture of energy from the environment by resident economic units”⁴⁸. These flows are recorded in the physical supply and use tables for energy and represent a growing component of ocean-based economic activity.

Relationship to ecosystem services

¶1 The relationship between natural resource inputs and ecosystem services requires careful treatment to avoid double counting⁴⁹. The SEEA EA clarifies this relationship:

- ¶2 **Natural inputs** in the SEEA CF include inputs of timber, aquatic resources (e.g. fish), and other biological resources “but only in cases where the production process does not entail cultivation or is unmanaged since cultivated biological resources are produced within the economy”⁵⁰.
- ¶3 **Provisioning services** in the SEEA EA are recorded in both cultivation and non-cultivation contexts, reflecting the ecosystem contribution to biomass growth⁵¹.

¶4 For fish, for example, the natural resource input is the harvested catch (a physical flow of biomass from environment to economy), whilst the ecosystem service is the contribution of the marine ecosystem to the growth of that fish population⁵². The two perspectives are complementary: the natural input approach focuses on extraction flows, whilst the ecosystem service approach focuses on the ecosystem’s productive contribution. The SEEA EA states that “natural resource residuals represent those flows of natural resources that are extracted or harvested and immediately returned to the environment. Examples include discarded catch in fishing”⁵³.

¶5 The distinction between gross catch and other catch measures matters for accounting consistency. Figure 3.2.2 illustrates the hierarchical relationships among catch concepts as defined in the SEEA CF, whereby gross removal is progressively refined at each stage to arrive at nominal catch⁵⁴.

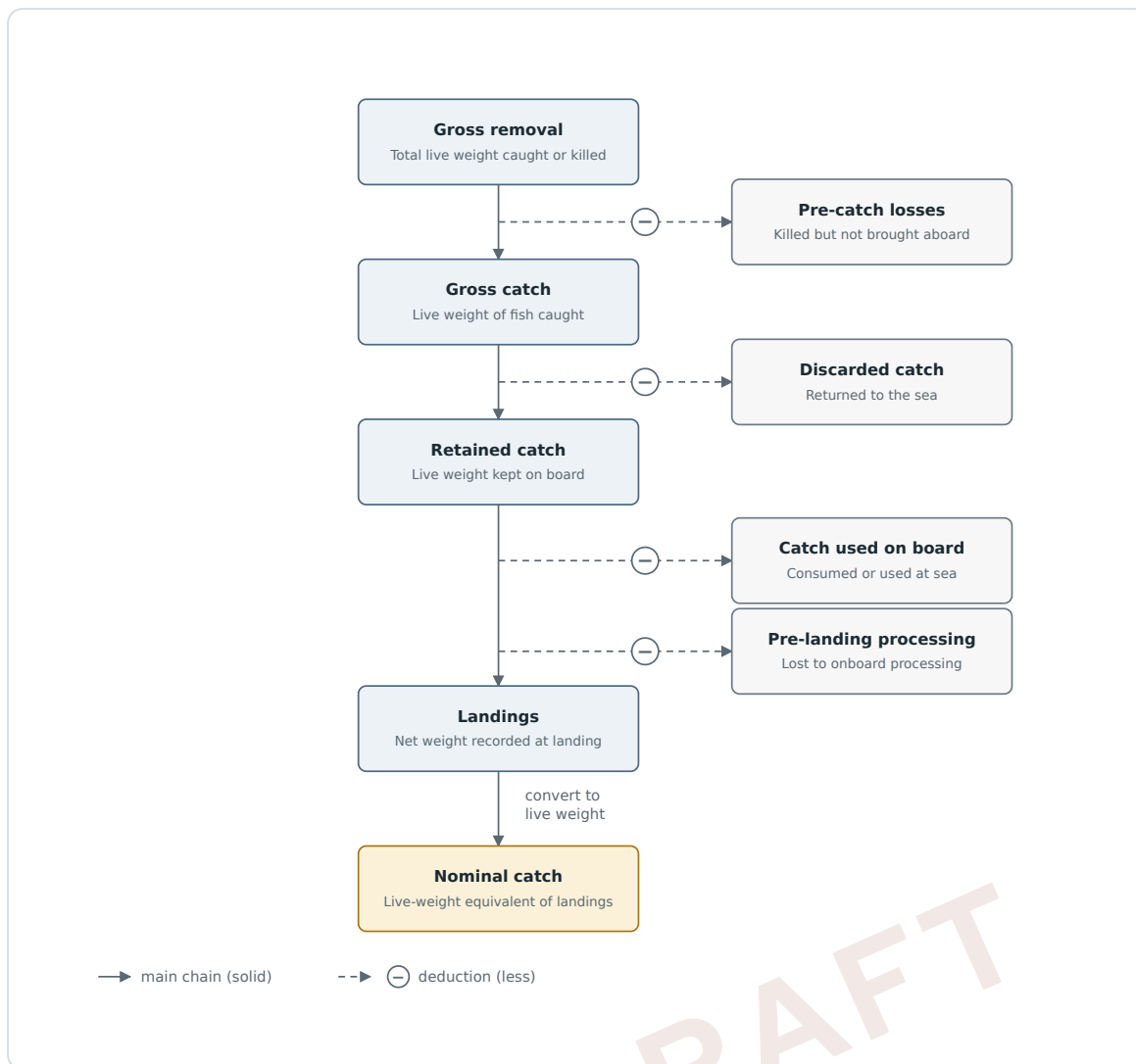


Figure 3.2.2 Catch concepts reconcile gross removal to FAO nominal catch through successive quantity deductions and a live-weight conversion. Each minus marks a subtracted quantity at that step.

Source: SEEA CF 2012, para. 5.428 and Annex A5.4 (fish catch concepts).

Adapted from: SEEA CF 2012 Annex A5.4.

¶6 Figure 3.2.3 illustrates the dual recording of a single harvest event: as a natural resource input under the SEEA CF and as a complementary provisioning service under the SEEA EA, with each reported in a distinct statistical product and no double-counting between them.

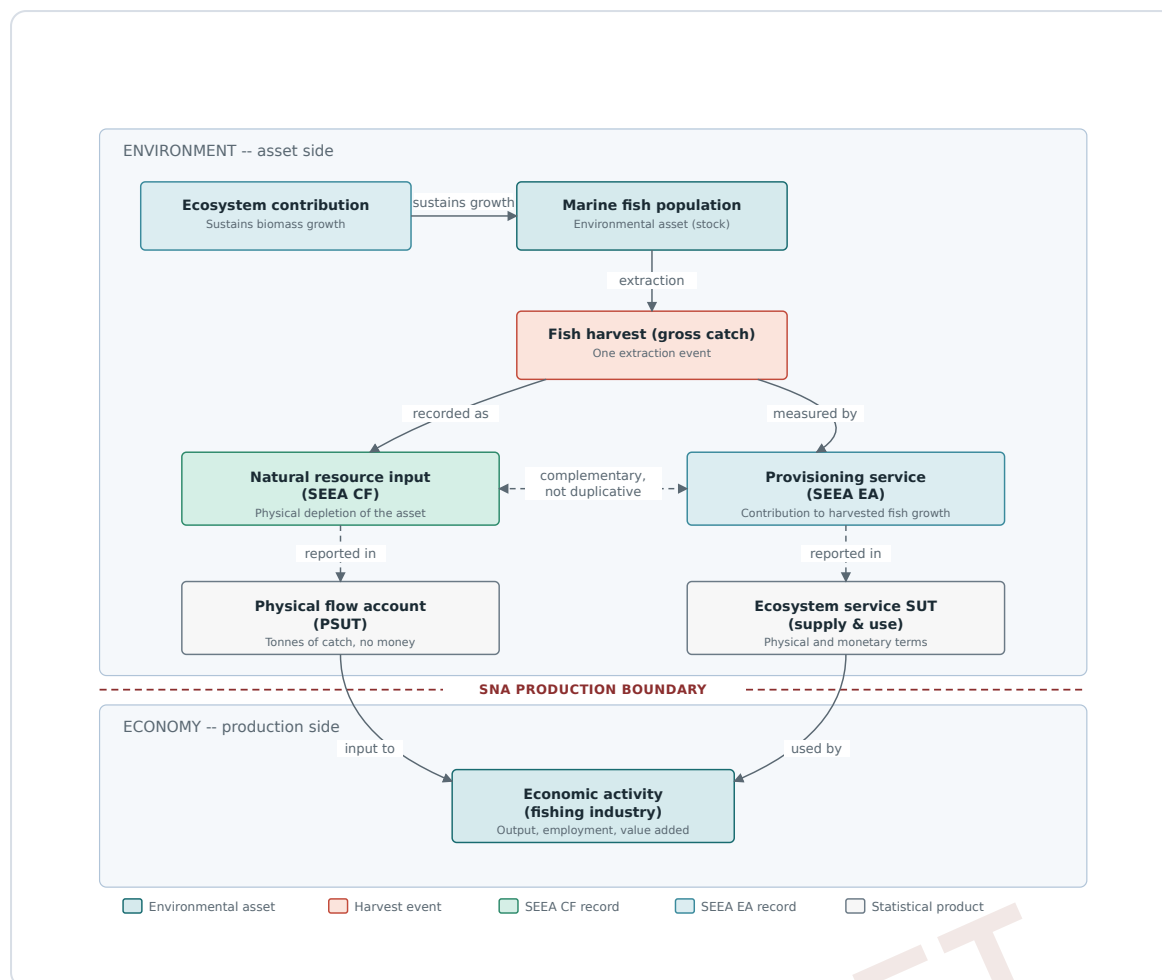


Figure 3.2.3 One harvest event is dual-recorded as a SEEA CF natural-resource input and a SEEA EA provisioning service without double-counting. Records sit in distinct statistical products (PSUT and ecosystem-service SUT), both feeding the fishing industry.

Source: TG-3.2, dual-recording of a transaction in physical and monetary accounts; SEEA CF natural-resource inputs and production boundary; SEEA EA 2024 provisioning ecosystem service flows.

Adapted from: TG-3.2 figure specification (fig-tg-3-2-dual-recording), with GOAP-palette rendering and node colouring by asset / framework / product / economic unit.

Linking extent change to flow categories: the extent-change matrix pattern

¶1 Flows from the environment to the economy depend on both the area and the type of ecosystem present in the accounting area. Where the ecosystem mix changes during the accounting period (for example, mangrove conversion to aquaculture pond, or seagrass loss with retreat to bare seabed), the supply of ecosystem services and natural resource inputs shifts correspondingly. The SEEA EA addresses this through the ecosystem type change matrix (SEEA EA Table 4.2), a square cross-classification of opening extent (rows) against closing extent (columns) by ecosystem type⁵⁵. Each off-diagonal cell records the area converted from one ecosystem type to another during the accounting period, whilst diagonal cells record areas that did not change type⁵⁶.

¶2 The matrix is constructed from the same input data as the extent account in **TG-3.1 Asset Accounts** but presented in a way that makes the *direction* of each conversion visible. For ocean accounting, this pattern can be extended as a cross-classifier between opening/closing extent and flow categories: each cell of the matrix can be paired with the change in supply of ecosystem services or natural resource inputs attributable to that conversion. For example, the cell at the intersection of [opening: mangrove] x [closing: aquaculture pond] is associated with reductions in coastal protection, carbon sequestration and nursery services, and a corresponding increase in aquaculture provisioning recorded in the SUT.

¶3 **Structural template – ecosystem type change matrix linked to flow categories (after SEEA EA Table 4.2).** Table 1c presents a blank template. Rows are opening ecosystem types, and columns are closing ecosystem types. The total of each row equals the opening extent for that type, and the total of each column equals the closing extent (the accounting identity from SEEA EA para 4.34)⁵⁵. Where the EAA total area is unchanged between the two points in time, total row sums equal total column sums⁵⁶.

¶4 **Table 1c: Ecosystem type change matrix – structural template (after SEEA EA Table 4.2)**

Opening \ Closing	Type 1	Type 2	...	Type <i>n</i>	Opening extent (row total)
Type 1	[unchanged area]	[conversion 1->2]	...	[conversion 1-> <i>n</i>]	[Σ row]
Type 2	[conversion 2->1]	[unchanged area]	...	[conversion 2-> <i>n</i>]	[Σ row]
...	...	...	[unchanged area]	...	[Σ row]
Type <i>n</i>	[conversion <i>n</i> ->1]	[conversion <i>n</i> ->2]	...	[unchanged area]	[Σ row]
Closing extent (column total)	[Σ col]	[Σ col]	...	[Σ col]	[total EAA]

¶5 *Table 1c: Structural template of the ecosystem type change matrix; off-diagonal cells record area converted between ecosystem types; diagonal cells record unchanged area. Cells are blank for compiler population. Structure follows SEEA EA paras 4.34–4.35 and Table 4.2.*^{55, 56}

¶6 **Worked instance, from the conversions in the Section 3.4 coastal zone.** The extent account there records mangrove losing 4.0 km² to aquaculture conversion and 2.5 km² to storm erosion, and seagrass losing 0.5 km² to conversion and 1.8 km² to erosion, against managed and natural expansion of 3.3 km² and 1.5 km² respectively. Populating the matrix (km², opening rows against closing columns):

Opening \ Closing	Mangrove	Seagrass	Aquaculture pond	Bare seabed / eroded	Opening extent
Mangrove	493.5	–	4.0	2.5	500.0
Seagrass	–	197.7	0.5	1.8	200.0
Aquaculture pond	2.5	1.2	[n/a]	–	3.7
Bare seabed / eroded	0.8	0.3	–	[n/a]	1.1
Closing extent	496.8	199.2	4.5	4.3	704.8

¶7 *Table 1f: Ecosystem type change matrix, worked (hypothetical coastal zone, 2025, km²)*

¶8 Read the rows and columns against the extent account and the two agree: mangrove closing extent 493.5 unchanged + 2.5 gained from restored pond area + 0.8 gained by natural expansion = 496.8, which is the closing figure in Table 5 of **TG-3.1**. The matrix adds what the extent account cannot show – that the 6.5 km² of mangrove reduction went to two different places, 4.0 to aquaculture and 2.5 to bare seabed, and that these have different service consequences and different reversibility.

¶9 Paired with the flow change:

Conversion cell	Area (km ²)	Service flows lost	Service flows gained
Mangrove → aquaculture pond	4.0	Coastal protection, carbon sequestration, nursery habitat	Aquaculture provisioning

Conversion cell	Area (km ²)	Service flows lost	Service flows gained
Mangrove → bare seabed	2.5	Coastal protection, carbon sequestration, nursery habitat	None
Seagrass → aquaculture pond	0.5	Carbon sequestration, nursery habitat	Aquaculture provisioning
Seagrass → bare seabed	1.8	Carbon sequestration, nursery habitat	None

¶10 *Table 1g: Flow-category change paired to the conversion cells of Table 1f*

¶11 The pairing separates the two kinds of loss a planner should treat differently. Conversion to aquaculture trades one set of services for another and the trade can be appraised. Conversion to bare seabed is loss without compensation, and in this zone it accounts for 4.3 km² of the 8.8 km² reduction – nearly half.

¶12 **Pairing extent-change cells with flow-category change.** For each populated off-diagonal cell in the matrix above, compilers should record (in a parallel table or metadata layer) the associated change in flows attributable to the conversion, classified by SEEA EA service category (provisioning, regulating and maintenance, cultural) and by SEEA CF natural resource input category where relevant. SEEA EA para 4.23 notes that conversions imply “the supply of a different set of ecosystem services”⁵⁷. The extent-change matrix therefore bridges the asset (extent) account and the ecosystem services supply table compiled in Section 3.3 below.

¶13 This pattern supports three analytical uses: (a) decomposing observed changes in ecosystem service supply into an *area effect* (extent change) and an *intensity effect* (per-area service flow change driven by condition), (b) identifying the conversions that are responsible for the largest shifts in total service supply across the accounting area, and (c) attributing changes in flows to managed versus unmanaged conversions for policy interpretation. SEEA EA para 4.31 notes that the change matrix may be extended to classify conversions by reasons for change (e.g., urban expansion, salinisation, afforestation), and the same extension applies when pairing the matrix with flow categories⁵⁸.

3.3 Physical Supply and Use Tables: Structure and Compilation Procedure

¶1 Two distinct accounts are compiled under this heading and should not be confused. The **SEEA CF physical supply and use table** (CF Table 3.1) records natural inputs entering the economy, products moving within it, and residuals returning to the environment, in one structure. The **SEEA EA ecosystem services supply and use table** records the contributions of ecosystem assets to economic units. They answer different questions about the same harvest: the CF table records the tonnes of fish removed, the EA table records the ecosystem’s contribution to those fish having grown.

¶2 This Circular carries the natural-inputs block of the CF table (Section 3.3.1 below) and the whole of the EA table (from Section 3.3.2). **TG-3.4 Flows from the Economy to the Environment** Section 3.4 carries the residuals block. Together the two circulars hold the two halves of CF Table 3.1.

3.3.1 Natural resource inputs supply and use table

¶1 Section 3.2 named the categories of natural input. This is the table they are recorded in. Supply is by the environment, disaggregated by the asset the input is drawn from; use is by the extracting industry. Because natural inputs come from the environment rather than from a producing industry, the supply side has a single origin column, and the analytical content sits in the use side.

¶2 **Table 1d: Natural resource inputs supply and use table – structural template (after SEEA CF Table 3.1)**

Natural input	Unit	Supply from the environment	Fishing (ISIC 03)	Aquaculture (ISIC 03)	Offshore extraction (ISIC 06)	Water supply (ISIC 36)	Energy (ISIC 35)	Oth in-dus-tries
<i>Biological resources</i>								
Wild aquatic resources (gross catch)	t	[q]	[q]	–	–	–	–	[q]
Other wild biomass (sea-weed, shellfish)	t	[q]	[q]	–	–	–	–	[q]
<i>Mineral and energy resources</i>								
Offshore oil and gas	t or m ³	[q]	–	–	[q]	–	–	–
Marine aggregates and seabed minerals	t	[q]	–	–	[q]	–	–	[q]
<i>Water resources</i>								
Seawater abstracted	m ³	[q]	–	[q]	[q]	[q]	[q]	[q]
<i>Energy from natural inputs</i>								
Offshore wind, wave and tidal energy captured	TJ	[q]	–	–	–	–	[q]	–

¶3 *Table 1d: Structural template of the natural resource inputs supply and use table. One row per input, in the physical unit appropriate to it – these are not additive across rows. Supply from the environment must equal total use for every row.*

¶4 **The consistency check this table exists to make possible.** For every input that is also an asset, the quantity recorded here must equal the extraction entry in the corresponding asset account in **TG-3.1**. Gross catch in the wild aquatic resources row equals the “Gross catch/harvest” reduction in TG-3.1 Table 1; offshore extraction equals the “Extraction” reduction in the mineral column of TG-3.1 Table 1a. A discrepancy is not a rounding matter – it means either the flow or the stock account has missed a removal, and the SEEA CF treats reconciling the two as a primary quality control.

¶5 Using the worked coastal zone of Section 3.4 and the fish stock account in **TG-3.1** Section 3.7:

Natural input	Unit	Supply from the environment	Fishing	Total use	Cross-check against TG-3.1
Wild aquatic resources (gross catch)	t	7,200	7,200	7,200	Equals gross catch in TG-3.1 Table 7 ✓

¶6 *Table 1e: Natural resource inputs, worked fragment (hypothetical coastal zone, 2025)*

¶7 Seawater abstraction is a natural input but seawater is not an asset, because the SEEA CF excludes it from the asset boundary on grounds of scale (Section 3.2). Abstraction is therefore recorded as a flow with no corresponding stock reduction, and no cross-check applies to that row.

3.3.2 Ecosystem services supply and use tables

¶1 Physical supply and use tables (PSUTs) provide the accounting structure for recording flows from the environment to the economy in physical terms⁵⁹. The SEEA Central Framework describes the PSUT as organising information on “the extraction or capture of inputs from the environment, the flows of products within the economy, and the flows of residuals to the environment”⁶⁰.

Structure of PSUTs

¶1 The general structure of a PSUT for ecosystem services follows the supply and use framework of national accounts, extended to incorporate ecosystem assets as suppliers⁶¹:

¶2 **Supply table** – records the supply of ecosystem services by ecosystem type and the supply of products by economic units. For ecosystem services, supply is attributed to the ecosystem assets that generate the services.

¶3 **Use table** – records the use of ecosystem services by economic units (industries, government, households) and the use of products as intermediate consumption and final demand. Users of ecosystem services include the economic units that directly benefit from or incorporate the services into their production or consumption activities.

¶4 The SEEA EA describes the ecosystem services supply and use account structure as having multiple “quadrants” that capture⁶²:

- ¶5 Supply of ecosystem services by ecosystem type (ecosystem assets as suppliers)
- ¶6 Use of ecosystem services by economic units (businesses, governments, households)
- ¶7 Supply of products by industries (standard SNA scope)
- ¶8 Use of products by economic units (standard SNA scope)

¶9 Table 2 presents a simplified structure of an ecosystem services supply and use table.

	Ecosystem Types	Industries	Households	Rest of World	Total
SUPPLY					
Ecosystem services	Supply by ET	-	-	-	Total supply
Products	-	Supply by industry	-	Imports	Total supply
USE					
Ecosystem services	-	Use by industry	Use by HH	Exports	Total use
Products	-	Intermediate consumption	Final consumption	Exports	Total use

¶10 Table 2: Simplified structure of ecosystem services supply and use table (adapted from SEEA EA Figure 7.1)⁶³

Ecosystem services supply-use table: worked template

¶1 Table 2a provides a detailed supply-use table template that compilers can adapt for their ocean accounting area. The supply table records ecosystem service quantities by marine ecosystem type, and the use table records which economic units benefit from each service. Total supply must equal total use for each service (the accounting identity).

¶2 Table 2a: Ecosystem services physical supply-use table template

¶3 **SUPPLY TABLE** (Physical units by service type)

Service	Coral Reef	Mangrove	Seagrass	Pelagic	Other Marine	Total Supply
<i>Provisioning</i>						
Fish biomass (tonnes)						
Aquaculture support (tonnes)						
<i>Regulating and maintenance</i>						
Carbon sequestration (tC/yr)						
Coastal protection (km)						
Water filtration (m ³)						
<i>Cultural</i>						

Service	Coral Reef	Mangrove	Seagrass	Pelagic	Other Marine	Total Supply
Recreation (visitor-days)						

¶4 **USE TABLE** (Same physical units)

Service	Fishing	Aquaculture	Tourism	Coastal Properties	Households	RoW	Total Use
Fish biomass (tonnes)							
Aquaculture support (tonnes)							
Carbon sequestration (tC/yr)							
Coastal protection (km)							
Water filtration (m³)							
Recreation (visitor-days)							

¶5 *Table 2a: Ecosystem services physical supply-use table template for ocean accounts (adapted from SEEA EA Table 7.1)*⁶⁴

¶6 The supply-use accounting identity (Total Supply = Total Use for each service) provides a built-in quality check. Compilers should begin with provisioning services where data are most readily available, then progressively extend to regulating and cultural services as methods and data improve.

Compilation procedure

¶1 The following step-by-step procedure guides the compilation of ecosystem services supply and use tables for ocean accounts:

¶2 **Step 1: Define the accounting area and period.** Specify the spatial extent (e.g., EEZ, coastal zone, sub-national region) and the accounting period (typically one year). Identify the marine and coastal ecosystem types present in the area, drawing on the ecosystem extent account (see **TG-3.1 Asset Accounts**).

¶3 **Step 2: Select ecosystem services to be measured.** Based on Tables 1a and 1b, identify which ecosystem services are relevant to the accounting area. Prioritise services with data availability, policy relevance, and economic significance. Begin with provisioning services (fish harvest, aquaculture), then expand to regulating services (coastal protection, carbon sequestration) and cultural services (recreation).

¶4 **Step 3: Measure supply by ecosystem type.** For each selected ecosystem service, estimate the physical quantity supplied by each ecosystem type during the accounting period. Data sources may include:

- ¶5 Fish provisioning: fisheries statistics (gross catch allocated to fishing grounds by ecosystem type)
- ¶6 Carbon sequestration: biophysical models applied to ecosystem extent and condition data (see **TG-6.2 Mangrove and Coastal Wetland Accounting**)
- ¶7 Coastal protection: spatial analysis of coastal properties protected by different ecosystem types (see **TG-4.1 Remote Sensing and Geospatial Data**)
- ¶8 Recreation: visitor surveys and site counts allocated to ecosystem types

¶9 Record supply quantities in the supply table. Ensure that units are consistent across ecosystem types for each service.

¶10 **Step 4: Identify users of ecosystem services.** For each ecosystem service, identify the economic units that use the service. Users are the direct counterparties in the interaction with the ecosystem:

- ¶11 Fish provisioning: fishing industry (by ISIC division)
- ¶12 Aquaculture provisioning: aquaculture industry
- ¶13 Coastal protection: coastal property owners, local governments, households
- ¶14 Carbon sequestration: rest of the world (following SEEA EA para 6.60)
- ¶15 Recreation: households, tourism industry

¶16 **Step 5: Estimate use by economic unit.** Quantify the use of each ecosystem service by each user. Where direct measurement is not feasible, apply allocation methods:

- ¶17 Provisioning services: use equals the quantity harvested by each industry (from production statistics)
- ¶18 Coastal protection: allocate protected coastline to users based on property value, population, or area protected
- ¶19 Recreation: allocate visitor-days to households and tourism businesses based on survey data

¶20 Record use quantities in the use table.

¶21 **Step 6: Check accounting identity.** For each ecosystem service, verify that Total Supply = Total Use. If the identity does not hold, review data sources and allocation assumptions. Common sources of discrepancy include:

- ¶22 Unidentified users (e.g., recreation by non-residents not captured in surveys)
- ¶23 Incomplete spatial coverage (e.g., fishing grounds extending beyond the mapped ecosystem extent)
- ¶24 Measurement errors in supply or use estimates

¶25 **Step 7: Document methods and assumptions.** Record all data sources, allocation methods, and assumptions in metadata accompanying the accounts. Note areas where measurement quality is limited and where future improvements are planned. This documentation is essential for quality assurance and for interpreting the accounts in policy applications.

¶26 **Step 8: Compile monetary accounts (if applicable).** Apply valuation methods (see Section 3.5) to the physical supply and use tables to derive monetary accounts. The monetary valuation should be compiled separately from physical accounts to maintain transparency and let users assess the valuation assumptions.

Compiling the supply table

¶1 The ecosystem services supply table records the physical quantities of ecosystem services supplied by different ecosystem types⁶⁵. For each ecosystem service, the entry reflects the total flow over the accounting period (typically one year), measured in appropriate physical units.

¶2 Key considerations for compiling the supply table include:

¶3 **Attribution to ecosystem types** – Provisioning services are relatively straightforward to attribute to specific ecosystem types (e.g., fish provisioning to marine shelf ecosystems). However, “for some services, particularly regulating services such as carbon sequestration, the same service will be supplied by more than one ecosystem type”⁶⁶. The SEEA EA recommends that compilers “create a table showing which ecosystem services are likely to be supplied from different ecosystem types for their country or target ecosystem accounting area”⁶⁷.

¶4 **Spatial allocation** – For ecosystem services whose supply depends on interactions among multiple ecosystem types, “some allocation of ecosystem service flow between ecosystem types will be required”⁶⁸. This is particularly relevant for coastal protection and climate regulation services that may be supplied by a mosaic of ecosystem types.

¶5 **Measurement units** – Physical units vary by service type: tonnes for biomass provisioning, tonnes of carbon for climate regulation, hectares protected for coastal protection, visitor-days for

recreation⁶⁹. The SEEA EA provides guidance on possible metrics for each service type.

Compiling the use table

¶1 The ecosystem services use table records the use of ecosystem services by different economic units⁷⁰. The SEEA EA notes that “the focus of the use table is on the link between ecosystem services and different types of users, while the supply table focuses on the supply from ecosystem types”⁷¹.

¶2 Key considerations for compiling the use table include:

¶3 **Identifying users** – Users are the economic units that directly interact with or benefit from the ecosystem service. For provisioning services, users are typically the industries that harvest or extract the resource. For regulating services, users may be more dispersed—coastal protection benefits property owners, local governments, and the broader community. The SEEA EA distinguishes between “users” (direct counterparties in the interaction with the ecosystem) and “beneficiaries” (the broader set of economic units that ultimately receive benefits)⁷².

¶4 **Location of users** – “While the supply of ecosystem services can be directly linked to a spatial area (e.g. to an ecosystem asset), there is no requirement that the location of the user is the same as the location of the area from which the ecosystem service is supplied”⁷³. This is especially relevant for regulating services and cultural services, where benefits may accrue to distant populations.

¶5 **Supply equals use** – In accounting terms, total supply must equal total use for each ecosystem service⁷⁴. This accounting identity ensures consistency and completeness and provides a basis for quality assurance of ecosystem service accounts.

Practical guidance: Informal and unregistered beneficiaries of regulating services

Coastal protection and water purification services disproportionately benefit low-income coastal communities, subsistence households, and informal settlements that are systematically undercounted in national household surveys and industry registers. Omitting these beneficiaries from the use table breaks the supply = use identity, and assigning them to a residual “households” cell without supporting data produces unreliable indicators. Compilers should:

1. ¶6 Use **population census and spatial settlement data** (including UN-Habitat informal settlement layers and equivalent national datasets) to estimate the **total beneficiary population** within the protective ecosystem’s zone of influence, irrespective of survey-frame coverage.⁷⁵
2. ¶7 Where household-survey data are unavailable, apply a **coastal proximity proxy**: “all resident households within X km of the protective shoreline” (X chosen based on national hazard-zone definitions or the relevant return-period inundation extent) and allocate the relevant share of service use to households on this basis.
3. ¶8 **Document residual unallocated use** explicitly, including the estimation method used for informal beneficiaries and the assumed coastal proximity radius, in compilation metadata. See **TG-4.2 Survey Methods** for survey design options.

Boundary call-out: Wild seed extraction vs nursery habitat services

Where an entry attributes wild juveniles to aquaculture – a “wild seed extraction” row – it represents **extraction of wild juveniles** from coastal ecosystems for transfer to aquaculture pens.

Following SEEA EA paras. 6.11–6.17, this is recorded as a flow that simultaneously appears (a) here in the ecosystem-service use table as a service flow to aquaculture, and (b) in the **aquatic resource asset account** as an extraction reducing the wild stock – consistent with the asset-account treatment in **TG-3.1 Asset Accounts** and **TG-3.9 Aquaculture Accounts**. The conceptually distinct **nursery habitat service** (ecosystem support for wild juvenile recruitment that subse-

quently contributes to commercial fish biomass) is recorded separately as an intermediate regulating service and is not aggregated into the 700-tonne entry. Confusing the two would double-count the ecosystem contribution.

Delineating the service providing and benefiting areas: coastal protection

¶1 SEEA EA §7.66 defines the **service providing area (SPA)** and the **service benefiting area (SBA)** as the spatial boundaries of supply and use for a given service. Coastal protection – a sub-service of flood control services in the Table 6.3 reference list – is the clearest marine case in which the two areas are distinct rather than coincident, and is set out here as the pattern to follow for other spatially separated services.

- ¶2 **Service providing area (SPA):** the spatial extent of coastal ecosystems supplying wave attenuation and surge dissipation in the reference period – typically coral reefs at relevant depth bands, mangrove forests, saltmarsh, seagrass beds and natural coastal dunes. Extent is taken from the ecosystem extent account (**TG-3.1 Asset Accounts** Section 3.5.1).
- ¶3 **Service benefiting area (SBA):** the populated and built-up land behind the SPA whose exposure to storm surge, wave overtopping and erosion is materially reduced by the SPA. Delineated using elevation, surge modelling and population or asset rasters.
- ¶4 **Service flow (physical):** the with/without-ecosystem differential in expected flood depth, area inundated, population exposed or assets exposed, attributed to the SPA over a defined reference period.
- ¶5 **Service flow (monetary):** the with/without-ecosystem differential in expected annual damages, valued using avoided-damage and expected-expenditure methods (Section 3.5).

¶6 The counterfactual is what makes this service measurable: the model is run with current ecosystem extent and again with the ecosystems removed or degraded, and the difference is the service flow attributed to the SPA. Data sources and models for that counterfactual are in **TG-4.1 Remote Sensing and Geospatial Data**. The dependency and vulnerability indicators derived from these entries are in **TG-2.3 Social and Livelihood Dependencies** Section 3.4.

Physical units and measurement

¶1 The SEEA EA recommends that ecosystem services be measured in physical terms before monetary valuation⁷⁶. Physical measurement provides the foundation for understanding the actual flows between ecosystems and the economy, and supports the application of different valuation approaches.

¶2 For marine ecosystem services, relevant physical units include⁷⁷. Table 3.3.1 below summarises the recommended units.

Service	Physical units
Fish provisioning	Tonnes of biomass harvested (gross catch).
Global climate regulation	Tonnes of carbon sequestered (annual sequestration flow).
Coastal protection	Hectares of coastline protected, or metres of coastline; alternative metrics include population or assets protected.
Water purification	Volumes of water filtered (cubic metres), or pollutant loads removed (tonnes).
Recreation	Visitor-days, or area available for recreation (hectares).

¶3 For guidance on spatial data sources and methods for measuring ecosystem service supply, see **TG-4.1 Remote Sensing and Geospatial Data** and **TG-4.2 Survey Methods for Ocean Economic Activity**.

Worked example: supply-use entries under a spatial conversion scenario

¶1 Where a plan or appraisal converts one ecosystem type to another, the change has to be reflected consistently in the extent account and in the services supply-use table. This example traces those entries for a conversion scenario of the kind evaluated in **TG-1.2 OA and Marine Spatial Planning** Section 3.5.

¶2 **Scenario:** a marine spatial plan converts 500 ha of mangrove to an aquaculture zone.

¶3 **Step 1: Extent account adjustment**

¶4 In the ecosystem extent account for the mangrove ecosystem type:

- ¶5 Opening stock: [baseline mangrove area, ha]
- ¶6 Reduction – conversion to aquaculture: –500 ha
- ¶7 Closing stock: [opening stock minus 500 ha]

¶8 In the extent account for the aquaculture zone land use category:

- ¶9 Opening stock: [baseline aquaculture area, ha]
- ¶10 Addition – conversion from mangrove: +500 ha
- ¶11 Closing stock: [opening stock plus 500 ha]

¶12 **Step 2: Services supply-use table adjustments**

¶13 The supply-use table for ecosystem services records, by ecosystem type and service, the physical quantity supplied (by ecosystem) and used (by economic sector or final beneficiary). The following rows change:

Service	Row/column affected	Direction	Basis for estimate
Coastal protection	Mangrove supply row – coastal protection service	Decrease	Proportional to extent lost: if 500 ha represents X% of total mangrove area, coastal protection supply decreases by approximately X% of baseline flow
Carbon sequestration	Mangrove supply row – carbon sequestration service	Decrease	Mangrove carbon sequestration rate (tCO ₂ /ha/yr) × 500 ha lost
Nursery habitat	Mangrove supply row – nursery habitat service	Decrease	Proportional to extent lost, scaled by species-specific habitat dependency ratios
Aquaculture production	Aquaculture zone supply row – provisioning service	Increase	Projected yield (tonnes/ha/yr) × 500 ha × aquaculture production rate

¶14 **Step 3: Cross-account consistency check**

¶15 Verify that the service flow changes in Step 2 are reflected in:

- ¶16 The economic account: reduced fish provisioning from mangrove-dependent fisheries (nursery habitat loss); increased aquaculture output
- ¶17 The condition account: if extent loss reduces structural state variables (e.g., shoreline habitat complexity), update the condition index accordingly following **TG-2.1** Section 3.4.1 and TG-3.1 Section 3.5.2

¶18 The full supply-use table structure and column definitions are given in Section 3.3 above; the extent-account entries are compiled following **TG-3.1 Asset Accounts** Section 3.5.1.

¶19 Scenario projections of this kind are estimates, not account entries. They should be labelled as projections and reconciled against the compiled accounts once the conversion has occurred.

3.4 Worked Example: Coastal Zone Ecosystem Services Account

¶1 This section presents a worked example of ecosystem services supply and use tables for a hypothetical coastal zone, using synthetic data to illustrate the compilation procedure described in Section 3.3. The example demonstrates how to organise data, apply allocation methods, and verify accounting identities.

Accounting context

¶1 The hypothetical accounting area is a 50km coastal zone with four ecosystem types: mangroves (500 ha), coral reefs (1,200 ha), seagrass meadows (800 ha), and open marine shelf (5,000 ha). The accounting period is one year (2025). Three ecosystem services are measured: fish provisioning (tonnes harvested), carbon sequestration (tonnes C per year), and coastal protection (km of coastline protected). Three user categories are identified: fishing industry, coastal properties, and rest of world (RoW).

Step 1: Supply table compilation

¶1 **Fish provisioning (tonnes):** Gross catch statistics indicate 2,400 tonnes of fish harvested from the zone. Spatial analysis of fishing grounds and ecosystem productivity estimates allocate catch as follows:

- ¶2 Mangroves: 400 tonnes (nursery habitat for inshore species)
- ¶3 Coral reefs: 600 tonnes (reef-associated species)
- ¶4 Seagrass meadows: 300 tonnes (seagrass-associated species)
- ¶5 Open marine shelf: 1,100 tonnes (pelagic and demersal species)

¶6 **Carbon sequestration (tonnes C/yr):** Biophysical models estimate annual carbon sequestration rates per hectare for each ecosystem type, then scale by extent:

- ¶7 Mangroves: 500 ha × 2.5 tC/ha/yr = 1,250 tC/yr
- ¶8 Coral reefs: limited sequestration (calcification offsets), estimated at 50 tC/yr
- ¶9 Seagrass meadows: 800 ha × 1.5 tC/ha/yr = 1,200 tC/yr
- ¶10 Open marine shelf: phytoplankton sequestration estimated at 500 tC/yr for the shelf area

¶11 **Coastal protection (km):** Spatial analysis identifies 30 km of coastline within the zone. Coastal protection service is attributed to ecosystems based on their position and protective capacity:

- ¶12 Mangroves: 8 km (direct frontal protection)
- ¶13 Coral reefs: 12 km (offshore wave attenuation)
- ¶14 Seagrass meadows: 5 km (supplementary wave dampening in shallow areas)
- ¶15 Open marine shelf: 0 km (no direct coastal protection function)
- ¶16 Overlap: 5 km protected by multiple ecosystem types (mangroves + coral reefs). This is allocated 3 km to coral reefs (primary protection) and 2 km to mangroves (secondary protection) to avoid double counting.

¶17 Adjusted total: Mangroves 10 km, Coral reefs 15 km, Seagrass 5 km.

¶18 Supply table (Table 3a)

Service	Mangroves	Coral Reefs	Seagrass	Open Marine	Total Supply
Fish biomass (tonnes)	400	600	300	1,100	2,400
Carbon sequestration (tC/yr)	1,250	50	1,200	500	3,000
Coastal protection (km)	10	15	5	0	30

¶19 *Table 3a: Supply of ecosystem services by marine ecosystem type (hypothetical coastal zone, 2025)*

Step 2: Use table compilation

¶1 **Fish provisioning (tonnes):** All 2,400 tonnes are used by the fishing industry. Production statistics indicate industrial fishing operations harvest 1,800 tonnes and small-scale fishing operations harvest 600 tonnes.

¶2 **Carbon sequestration (tC/yr):** Following SEEA EA para 6.60, global climate regulation services are attributed to the rest of world (RoW). All 3,000 tC/yr are recorded as used by RoW.

¶3 **Coastal protection (km):** The 30 km of protected coastline benefits coastal properties (residential, commercial, and government infrastructure). Survey data indicate that 25 km protects private properties and 5 km protects public infrastructure (recorded under government/households).

¶4 **Use table (Table 3b)**

Service	Fishing Industry	Coastal Properties	Households/Government	RoW	Total Use
Fish biomass (tonnes)	2,400	0	0	0	2,400
Carbon sequestration (tC/yr)	0	0	0	3,000	3,000
Coastal protection (km)	0	25	5	0	30

¶5 *Table 3b: Use of ecosystem services by economic unit (hypothetical coastal zone, 2025)*

Step 3: Accounting identity verification

¶1 For each service, Total Supply = Total Use:

- ¶2 Fish biomass: 2,400 = 2,400 ✓
- ¶3 Carbon sequestration: 3,000 = 3,000 ✓
- ¶4 Coastal protection: 30 = 30 ✓

¶5 The accounting identity holds for all services, confirming internal consistency.

Interpretation for policy analysis

¶1 These accounts provide the foundation for deriving indicators that support policy questions:

¶2 **Ecosystem dependency:** The fishing industry depends entirely on marine ecosystem services for its inputs (2,400 tonnes of fish). This dependency can be expressed as a ratio of ecosystem service input to industry output value. A high ratio signals exposure to ecosystem degradation, not vulnerability. Whether a decline in the service would cause loss also depends on how sensitive the industry's output is to that decline and on its capacity to substitute for the service or adapt; the accounts do not generally record substitutability or adaptive capacity, which need separate analysis⁷⁸ (for the community-level equivalent, see the livelihood vulnerability index in **TG-2.3 Social and Livelihood Dependencies**).

¶3 **Coastal protection value:** The 30 km of protected coastline can be valued using replacement cost or avoided damage cost methods (see Section 3.5). The replacement cost of equivalent engineered coastal protection is estimated at USD 5 million per km of coastline, yielding a total replacement cost of USD 150 million for 30 km. Annualising this over a 20-year infrastructure lifespan at a 5% discount rate yields an annual equivalent service value of approximately USD 12 million per year (USD 0.4 million per km per year). Alternatively, avoided damage costs may be estimated from storm surge modelling.

¶4 **Carbon sequestration contribution:** The 3,000 tC/yr sequestered by coastal ecosystems can be valued at the social cost of carbon (e.g., USD 50 per tonne CO₂-equivalent, or approximately USD 183 per tonne C), yielding an annual service value of approximately USD 550,000. This service flows to the rest of the world, representing a contribution to global climate regulation.

¶5 **Cross-stack linkages:** These flow accounts connect downward to **TG-4.1 Remote Sensing and Geospatial Data** (ecosystem extent mapping), sideways to **TG-3.1 Asset Accounts** (ecosystem

condition and capacity), and upward to **TG-2.4 Ecosystem Goods and Services** (indicator derivation). They inform sustainable yield calculations for fisheries (**TG-6.7 Fisheries Accounting: Integrating Stock Assessment**), blue carbon policy (**TG-6.2 Mangrove and Coastal Wetland Accounting**), and coastal zone management (**TG-1.2 Marine Spatial Planning**).

3.5 Monetary Valuation of Flows

¶1 Monetary valuation of ecosystem service flows enables comparison across service types, aggregation with other economic flows, and integration into economic decision-making⁷⁹. Because most ecosystem services are not traded in markets, most entries require estimation.

¶2 **Where the method is specified.** The value concepts, the SEEA EA five-level preference order, the methods available at each level, the methods that are not admissible in accounts, and a worked application across four marine services are all in **TG-2.4 Environmental (including Ecosystem) Goods and Services** Section 3.10, which is normative for the choice of method. **TG-1.9 Safe Usage of Monetary Valuation** covers whether and when to value at all, and how the resulting figures should be communicated. Asset-level valuation – the NPV of service flows, the discount rate and the horizon – is **TG-3.1 Asset Accounts** Section 3.3. None of that is restated here.

¶3 What this Circular specifies is how a monetary value attaches to a **flow entry** in the supply and use table, which is a different question from which method produced the number.

Attaching values to supply and use entries

¶1 **Value the same physical flow that the physical table records.** Each monetary entry corresponds cell-for-cell to a physical entry compiled under Section 3.3. Where the physical table splits a service across ecosystem types, or across final and intermediate uses, the monetary table carries the same split. A monetary total that cannot be decomposed back onto the physical rows is not a supply and use entry.

¶2 **Exchange values, not welfare values.** The accounts record the values at which services are or could be exchanged, excluding consumer surplus⁸⁰. This is what makes the entries additive with the rest of the national accounts, and it is the single most common reason a published valuation study cannot be used as an account entry without adjustment.

¶3 **The identity applies to the monetary tables too.** Total monetary supply equals total monetary use for each service, at the same unit prices. Where supply and use are valued differently – for instance a service supplied domestically and used by the rest of the world – the price basis for each side must be documented.

¶4 **Value only what the physical account can support.** Where a service has been recorded in physical terms but the compiler has no admissible method for valuing it, the monetary cell is left empty and flagged, not filled with a benefit-transfer figure carried over from another country. Physical accounts should always be compiled as the primary output.

¶5 The SEEA EA describes monetary valuation principles as “internationally recognised statistical principles and recommendations” (SEEA EA Preface, para 8) rather than a full international statistical standard. Compilers should document the methods, assumptions and uncertainties involved in their valuations.

Valuation of provisioning services

¶1 Provisioning services are generally the most amenable to valuation, as they contribute to marketed goods⁸¹. The **resource rent** approach is commonly applied, estimating the ecosystem service value as the residual after deducting costs of labour, produced assets, and intermediate inputs from the value of output⁸².

¶2 For fish provisioning services, the resource rent is calculated as⁸³:

Resource rent = Output value - Intermediate consumption - Compensation of employees - Consumption of fixed capital - Return on produced assets

¶3 This residual represents the return attributable to the natural resource input and the ecosystem's contribution to fish growth. The SEEA EA notes that "exchange values for provisioning services are likely to be estimated based on observed market transactions"⁸⁴. The SEEA Valuation Guidelines elaborate that "the residual value and resource rent methods estimate the value for an ecosystem service by first taking the gross output value of the final marketed good to which the ecosystem service provides an input, and then deducting the cost of all other inputs"⁸⁵.

Valuation of regulating and maintenance services

¶1 Regulating and maintenance services present greater valuation challenges, as they typically contribute to non-marketed benefits. Several approaches may be applied⁸⁶:

¶2 **Replacement cost method** estimates the cost of replacing an ecosystem service with an engineered or artificial substitute⁸⁷. For coastal protection, this might involve comparing the protection provided by a coral reef or mangrove with the cost of constructing a sea wall or breakwater. The SEEA Valuation Guidelines note that "mangroves may be planted or restored as a 'green infrastructure' alternative to 'hard' engineered flood defences"⁸⁸. The validity of the replacement cost method depends on three conditions: "the substitute can provide exactly the same function of the good or service substituted for; the substitute is actually the least-cost alternative; and evidence indicates an actual demand for the substitute"⁸⁹.

¶3 **Avoided damage cost method** estimates value based on the damages that would occur in the absence of the ecosystem service⁹⁰. For coastal protection, this involves estimating the expected damages from flooding or erosion that are prevented by the ecosystem. The SEEA Valuation Guidelines state that "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"⁹¹.

¶4 **Productivity change method** estimates value based on the contribution of ecosystem services to the productivity of economic activities⁹². This approach can be applied where ecosystem services (such as nursery habitat for fish) enhance the productivity of commercial fisheries.

¶5 For **global climate regulation services**, valuation typically applies the **social cost of carbon** or market prices from carbon trading systems⁹³. However, the SEEA EA notes that "global climate regulation services represent a final ecosystem service with the user typically recorded as the global community"⁹⁴, raising questions about attribution of values to national accounts. For guidance on carbon accounting and valuation in the marine context, see **TG-6.2 Mangrove and Coastal Wetland Accounting**.

Valuation of cultural services

¶1 Cultural services, particularly recreation, can be valued using **travel cost** and **consumer expenditure** methods⁹⁵. The travel cost method estimates demand for recreation sites based on the costs visitors incur to reach them. The consumer expenditure method uses actual expenditures (travel, accommodation, entry fees) as a proxy for willingness to pay⁹⁶.

¶2 The SEEA Valuation Guidelines describe the travel cost method as "based on measuring the costs incurred (and the foregone income) by households or individuals to reach a site and hence receive an ecosystem service from the site, usually in the context of recreation activity"⁹⁷. For marine recreation, this method has been applied to value diving and snorkelling at coral reefs, coastal fishing, and beach visits.

¶3 **Hedonic pricing** may be applied to visual amenity services, estimating the premium on property values attributable to proximity to or views of marine environments⁹⁸. The SEEA Valuation Guidelines note that “applications of hedonic pricing have grown substantially in recent years” for nature views, open spaces, and water quality⁹⁹.

The monetary ecosystem services supply and use table

¶1 The methods above value a service. They do not, on their own, produce an account. **SEEA EA** (https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf) **Chapter 9** specifies the monetary supply and use account, which takes the physical table compiled in Section 3.3 and restates every cell in currency units at the exchange value of the service. It is the bridge between the physical service flows recorded here and the net present value of the ecosystem asset in **TG-3.1** Section 3.5.3: the asset value is the discounted stream of the flows in this table, and cannot be compiled without it.

¶2 The four rules in *Attaching values to supply and use entries* above govern every cell of this table: cell-for-cell correspondence with the physical entry, exchange values rather than welfare values, the supply-equals-use identity in currency units, and an empty flagged cell wherever no admissible method exists. The table adds one requirement of its own.

¶3 **The unit value is an explicit column, not an implied one.** Total monetary supply for a service equals its physical quantity multiplied by a unit exchange value, and the account records all three. Recording only the product hides which of the two moved. This is the same separation the revaluation entry provides in the asset account, and without it a rise in the value of a service is indistinguishable from a rise in the flow of it.

¶4 **Table 2b: Ecosystem services monetary supply-use table – structural template (after SEEA EA Chapter 9)**

¶5 **MONETARY SUPPLY TABLE** (currency units)

Service	Physical quantity	Unit exchange value	Valuation method and preference level	Coral Reef	Mangrove	Seagrass	Pelagic
<i>Provisioning</i>							
Fish biomass	[t]	[cur/t]	Resource rent (L3)				
Aquaculture support	[t]	[cur/t]	Resource rent (L3)				
<i>Regulating and maintenance</i>							
Carbon sequestration	[tC/yr]	[cur/tC]	[method] (L5)				
Coastal protection	[km]	[cur/km]	Avoided damage cost (L5)				
Water filtration	[m³]	[cur/m³]	Replacement cost (L5)				
<i>Cultural</i>							
Recreation	[visitor-days]	[cur/day]	Travel cost (L4)				
Total	–	–	–				

¶6 **MONETARY USE TABLE** (currency units)

Service	Fishing	Aquaculture	Tourism	Coastal properties	Households	Government	I
Fish biomass							
Aquaculture support							
Carbon sequestration							
Coastal protection							
Water filtration							
Recreation							
Total							

¶7 *Table 2b: Structural template of the monetary ecosystem services supply and use table. Rows and columns mirror Table 2a exactly. The preference level in the method column is the level from the hierarchy in Table 3.5.1 and in **TG-2.4** Section 3.10, and recording it in the account is what lets a user judge how far a figure sits from an observed price.*

¶8 **Worked example, continuing the coastal zone of Section 3.4.** Applying the unit values derived in that section's interpretation to the physical quantities in Tables 3a and 3b:

Service	Physical quantity	Unit exchange value	Method (level)	Mangroves	Coral reefs	Seagrass
Fish biomass (t)	2,400	USD 450/t	Resource rent (L3)	180,000	270,000	135,000
Carbon sequestration (tC/yr)	3,000	USD 183/tC	Social cost of carbon (L5)	228,750	9,150	219,600
Coastal protection (km)	30	USD 400,000/km/yr	Annualised replacement cost (L5)	4,000,000	6,000,000	2,000,000
Total supply	—	—	—	4,408,750	6,279,150	2,354,600

¶9 *Table 3d: Monetary supply of ecosystem services by marine ecosystem type (hypothetical coastal zone, 2025, USD/year)*

Service	Fishing industry	Coastal properties	Households/Government	RoW	Total use
Fish biomass	1,080,000	0	0	0	1,080,000
Carbon sequestration	0	0	0	549,000	549,000
Coastal protection	0	10,000,000	2,000,000	0	12,000,000
Total use	1,080,000	10,000,000	2,000,000	549,000	13,629,000

¶10 *Table 3e: Monetary use of ecosystem services by economic unit (hypothetical coastal zone, 2025, USD/year)*

¶11 Total supply equals total use for each service and in aggregate (USD 13,629,000), the same check as Section 3.4 Step 3 applied in currency units.

¶12 **Reading the monetary table against the physical one.** The two tables rank the ecosystems differently, and that difference is the analytical payload. In physical terms the open marine shelf is the largest single supplier of fish (1,100 of 2,400 tonnes) and mangroves the largest supplier of carbon sequestration. In monetary terms coral reefs are the most valuable ecosystem in the zone

(USD 6.28 million of USD 13.63 million), on the strength of coastal protection alone – a service measured in kilometres, whose unit value is two orders of magnitude above anything else in the table. Carbon sequestration, which dominates the physical regulating-service rows, is 4 per cent of the monetary total.

¶13 Two cautions follow, and both should be carried into any use of these figures. First, the ranking is a ranking of *unit values*, and the three unit values here come from three different levels of the preference hierarchy: the fish rent is close to an observed price, the coastal protection figure is an annualised engineering cost, and the carbon figure is a policy parameter. Aggregating across levels is permitted but the composition should be disclosed. Second, USD 12 million of the USD 13.6 million total rests on a single replacement-cost estimate, so the total is about as reliable as that one number. Present the composition, not only the total.

Integration with ecosystem asset valuation

¶1 The monetary value of ecosystem services provides the basis for valuing ecosystem assets themselves. Under the net present value (NPV) approach, ecosystem asset value equals the discounted stream of expected future ecosystem service flows¹⁰⁰:

$$\text{Ecosystem asset value} = \text{Sum of (Expected future ecosystem service flows / (1 + discount rate)^t)}$$

¶2 This creates an important link between flow accounts (ecosystem services) and stock accounts (ecosystem assets) as described in **TG-3.1 Asset Accounts**.

¶3 Changes in ecosystem service flows—whether due to changes in ecosystem extent, condition, or external factors—directly affect ecosystem asset values. The concept of **degradation** in SEEA EA captures the loss in asset value attributable to decline in ecosystem condition and associated reduction in ecosystem service supply¹⁰¹. The SEEA EA describes degradation as involving “measuring the value of degradation in terms of loss in future value of ecosystem services due to a decline in ecosystem condition”¹⁰². This linkage between flow and asset accounts ensures consistency in the accounting framework and supports analysis of the sustainability of ecosystem use.

Implementation Considerations

¶1 For minimum institutional capacity, data infrastructure, and human skills requirements for compiling these accounts, see TG-0.8 Implementation Readiness Assessment. For guidance on adapting these methods to sub-national scales, see TG-3.11 Sub-National Ocean Accounts.

4. Acknowledgements

¶1 **Authors:** [To be confirmed]

¶2 **Reviewers:** [To be confirmed]

FOOTNOTES

1. ¶1 SEEA EA, para 1.12. The SEEA EA framework “describes the relationship between the environment and the economy” through ecosystem services.
2. ¶2 SEEA EA, para 1.12
3. ¶3 SEEA CF, para 3.45; SEEA EA, para 6.8
4. ¶4 SEEA EA, para 2.14. “Ecosystem services are the contributions of ecosystems to the benefits that are used in economic and other human activity.”
5. ¶5 SEEA EA, para 6.10. “In ecosystem accounting, ecosystem services are recorded as flows between ecosystem assets and economic units.”
6. ¶6 SEEA EA, para 6.43–6.45 and Table 6.3
7. ¶7 CICES (Common International Classification of Ecosystem Services). The SEEA EA Technical Recommendations note that “the use of a classification of ecosystem services, such as CICES, FECS-CS or NESCS is an important as-

pect in compiling estimates of ecosystem services flows.” (para 5.67)

8. ¶8 Adapted from SEEA EA Table 6.3
9. ¶9 SEEA EA Technical Recommendations, para 5.22. Compilers are encouraged to create a mapping table showing which ecosystem services are likely to be supplied from different ecosystem types for their accounting area.
0. ¶10 SEEA EA, para 6.51 and Table 6.3. The reference list encompasses three broad categories: provisioning services, regulating and maintenance services, and cultural services.
1. ¶11 SEEA EA, para 6.35 and Table 6.1. The SEEA EA framing of contributions from the environment distinguishes (a) ecosystem services, (b) abiotic flows, and (c) spatial functions. Abiotic flows are “contributions to benefits from the environment that are not underpinned by, or reliant on, ecological characteristics and processes.”
2. ¶12 SEEA EA, Table 6.3 and para 6.44-6.54. The reference list of selected ecosystem services provides labels and descriptions for a set of key ecosystem services relevant for ecosystem accounting.
3. ¶13 SEEA EA, para 6.46
4. ¶14 SEEA EA, Table 6.3, row 1
5. ¶15 SEEA EA, para 1.81
6. ¶16 SEEA EA, para 7.31-7.33
7. ¶17 SEEA EA, para 7.33. “The aim in ecosystem accounting is to isolate and record the ecosystem’s contribution to the benefits received.”
8. ¶18 SEEA EA, Table 6.3
9. ¶19 SEEA CF, para 3.186-3.188
0. ¶20 SEEA EA, para 6.47
1. ¶21 SEEA EA, Table 6.3, rows 12-13
2. ¶22 IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (2019); Mcleod et al. (2011) “A blueprint for blue carbon”
3. ¶23 SEEA EA, para 6.60
4. ¶24 SEEA EA, Table 6.3, row 10
5. ¶25 SEEA EA, para 6.36. “Ecosystem services encompass services that are both predominantly biotic... and predominantly abiotic (e.g. coastal protection services provided by sand dunes).”
6. ¶26 Ferrario et al. (2014) “The effectiveness of coral reefs for coastal hazard risk reduction and adaptation”; Beck et al. (2018) “The global flood protection savings provided by coral reefs”
7. ¶27 SEEA EA, Table 6.3, row 8
8. ¶28 SEEA EA, Table 6.3, row 14
9. ¶29 SEEA EA, para 6.25
0. ¶30 SEEA EA, Table 6.3, row 15
1. ¶31 SEEA EA, Table 6.3, row 9
2. ¶32 SEEA EA, para 6.48
3. ¶33 SEEA EA, Table 6.3, row 18
4. ¶34 SEEA EA, para 7.65
5. ¶35 SEEA EA, Table 6.3, row 19
6. ¶36 SEEA EA, Table 6.3, rows 21-22
7. ¶37 SEEA EA, Table 6.3, rows 20, 23
8. ¶38 SEEA EA, para 7.70
9. ¶39 2025 SNA, Figure 35.4 and Chapter 35, paras 35.1-35.10. The physical flow structure shows how natural inputs and residuals connect the environment and economy.
0. ¶40 SEEA CF, para 3.45
1. ¶41 SEEA CF, para 3.45. “Natural inputs are all physical inputs that are moved from their location in the environment as a part of economic production processes or are directly used in production.”
2. ¶42 SEEA CF, para 5.393
3. ¶43 SEEA CF, para 5.429. “The SEEA CF recommends using gross catch rather than landings as the measure of extraction.”
4. ¶44 SEEA CF, para 3.194-3.196
5. ¶45 SEEA CF, para 3.186
6. ¶46 SEEA CF, para 5.173
7. ¶47 SEEA Energy, para 1.27
8. ¶48 SEEA Energy Technical Note, para 13. “Energy from natural inputs comprise flows of energy from the removal and capture of energy from the environment by resident economic units.”
9. ¶49 SEEA EA, para 1.79-1.82
0. ¶50 SEEA EA, para 1.81
1. ¶51 SEEA EA, para 1.81
2. ¶52 SEEA EA, para 7.31
3. ¶53 SEEA EA, para 1.82. Discards are included in gross catch (the extraction measure for asset accounts) and are also recorded as natural resource residuals (flows returned to the environment). The two recordings serve different

analytical purposes: gross catch captures the full pressure on fish stocks, while the natural resource residual records the portion returned to the environment.

4. ¶54 SEEA CF, Annex A5.4 and para 5.428. The catch concept hierarchy defines the progressive refinement from gross removal to nominal catch.
5. ¶55 UN SEEA EA (2021), para 4.34 and Table 4.2. The ecosystem type change matrix presents the area of different ecosystem types at the beginning of the accounting period (opening extent, rows) and at the end (closing extent, columns); off-diagonal cells record area converted between ecosystem types.
6. ¶56 UN SEEA EA (2021), para 4.35. Sum of cell entries in a row equals opening extent for that type (unchanged area plus reductions); sum of cell entries in a column equals closing extent (unchanged area plus additions). Where the EAA total area is unchanged between the two points in time, total row sums equal total column sums.
7. ¶57 UN SEEA EA (2021), para 4.23. Ecosystem conversions are situations in which, for a given location, there is a change in ecosystem type involving a distinct and persistent change in ecological structure, composition and function, which is reflected in the supply of a different set of ecosystem services.
8. ¶58 UN SEEA EA (2021), para 4.31. The structure of Table 4.1 (and by extension Table 4.2) allows for recording changes that are managed and unmanaged; an extension to the extent account may be developed to enable classification of ecosystem conversions by reasons for change (e.g., urban expansion, salinization, afforestation).
9. ¶59 SEEA CF, para 3.13
0. ¶60 SEEA CF, para 3.7
1. ¶61 SEEA EA, para 7.21-7.26
2. ¶62 SEEA EA Technical Recommendations, para 5.11
3. ¶63 Adapted from SEEA EA Figure 7.1
4. ¶64 SEEA EA, Table 7.1 and paras 7.21-7.33. The supply-use table structure extends the SNA supply-use framework to incorporate ecosystem assets as suppliers and ecosystem services as products.
5. ¶65 SEEA EA, para 7.27
6. ¶66 SEEA EA Technical Recommendations, para 5.23
7. ¶67 SEEA EA Technical Recommendations, para 5.22
8. ¶68 SEEA EA Technical Recommendations, para 5.23
9. ¶69 SEEA EA Technical Recommendations, Table 5.2
0. ¶70 SEEA EA, para 7.34
1. ¶71 SEEA EA Technical Recommendations, para 5.29
2. ¶72 SEEA EA, para 6.31
3. ¶73 SEEA EA Technical Recommendations, para 5.30
4. ¶74 SEEA EA, para 7.26. "In accounting terms, supply must equal use, the unit of measurement applied for each ecosystem service must be the same in both the supply and use account."
5. ¶75 UN-Habitat (2023). *World Cities Report*. Nairobi: UN-Habitat. Provides population and informal-settlement data and methodologies relevant to estimating beneficiary populations for coastal regulating services where standard survey frames undercount informal coastal communities. Compilers should also consult the most recent biennial edition of the *World Cities Report* and national census informal-settlement layers.
6. ¶76 SEEA EA, para 7.4. "The information on ecosystem services in physical terms can also be used to demonstrate the nature of the connection to the SNA production boundary."
7. ¶77 SEEA EA Technical Recommendations, Table 5.2 and 5.3
8. ¶78 Bradley, C., Taylor, S., Vardon, M., Lyons, M., Clement, S., & Obst, C. (2026). *Tracking nature dependencies and nature-related risks: integrated environmental-economic accounting in Australia* [Preprint, not peer reviewed; version 1, 19 September 2026], §4, p. 16. SocArXiv. https://doi.org/10.31235/osf.io/mq6bv_v1 (https://doi.org/10.31235/osf.io/mq6bv_v1). SEEA and SNA accounts are not well suited to tracking vulnerability; most vulnerability information sits in other statistics or needs separate analysis, such as of the substitutability of inputs.
9. ¶79 SEEA EA, para 8.1
0. ¶80 SEEA EA, para 8.20. "Exchange values are defined as the values at which goods, services, labour or assets are exchanged or could be exchanged for cash."
1. ¶81 SEEA EA, para 9.28
2. ¶82 SEEA CF, para 5.114-5.121
3. ¶83 SEEA CF, Figure 5.1 and Annex A5.1
4. ¶84 SEEA EA Technical Recommendations, para 5.94; SEEA Valuation Guidelines, para 664
5. ¶85 SEEA Valuation Guidelines, para 692
6. ¶86 SEEA EA, Chapter 9
7. ¶87 SEEA EA, para 9.50-9.52
8. ¶88 SEEA Valuation Guidelines, para 981
9. ¶89 SEEA Valuation Guidelines, para 973-977
0. ¶90 SEEA EA, para 9.53
1. ¶91 SEEA Valuation Guidelines, para 987
2. ¶92 SEEA EA, para 9.38-9.39
3. ¶93 SEEA EA, para 9.43

4. ¶94 SEEA EA, para 6.60
5. ¶95 SEEA Valuation Guidelines, para 791-820
6. ¶96 SEEA Valuation Guidelines, para 921-932
7. ¶97 SEEA Valuation Guidelines, para 805
8. ¶98 SEEA EA, para 9.40-9.42
9. ¶99 SEEA Valuation Guidelines, para 753-756
0. ¶100 SEEA EA, para 10.28-10.35
1. ¶101 SEEA EA, para 11.25-11.30
2. ¶102 SEEA EA, para 12.30

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