

Fisheries Accounting: Integrating Stock Assessment

Provides guidance on integrating fisheries stock assessment science with statistical accounting frameworks.

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OUTCOME

This Circular provides guidance on integrating fisheries stock assessment science with statistical accounting frameworks. Upon completion, readers will be equipped to compile fisheries asset accounts that draw on stock assessment outputs whilst maintaining accounting coherence. Stock assessment and ocean accounting support three principal decision use cases:

- MSY-based quota verification (comparing actual catch against assessment-predicted sustainable harvest levels)
- depletion-adjusted fisheries GDP (indicating whether fisheries income derives from sustainable harvest or capital depletion)
- evidence for subsidy reform (quantifying the contribution of public subsidies to fishing capacity under SDG 14.6)

Policy applications are addressed in [TG-1.5 Fisheries Management](#) and [TG-1.1 National Ocean Budgets](#). Derived indicators are compiled under [TG-2.2 Productivity Indicators](#).

This Circular addresses how to transform stock assessment outputs into accounting entries, propagate uncertainty, accommodate multi-species and ecosystem considerations, and align with SDG indicator 14.4.1. Governance and policy aspects of fisheries management are addressed in [TG-1.5 Fisheries Management](#).

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ABOUT THIS CIRCULAR

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¶1 ⓘ Framework Position

¶2 TG-6.7 bridges fisheries science and the SEEA AFF physical asset account structure, providing the methodological interface between stock assessment outputs (biomass estimates, mortality rates, reference points) and the standardised account entries required by SEEA CF and SEEA AFF. It sits within Section 6 (Thematic Methods) and connects the general asset accounting framework in **TG-3.1 Asset Accounts** and the wild-capture/aquaculture boundary established in **TG-3.9 Aquaculture Accounts** to the fisheries governance and policy applications in **TG-1.5 Fisheries Management**.

1. Outcome

¶1 This Circular provides guidance on integrating fisheries stock assessment science with statistical accounting frameworks. Upon completion, readers will be equipped to compile fisheries asset accounts that draw on stock assessment outputs whilst maintaining accounting coherence.

¶2 Stock assessment and ocean accounting support three principal decision use cases:

- ¶3 **MSY-based quota verification** (comparing actual catch against assessment-predicted sustainable harvest levels)
- ¶4 **depletion-adjusted fisheries GDP** (indicating whether fisheries income derives from sustainable harvest or capital depletion)
- ¶5 **evidence for subsidy reform** (quantifying the contribution of public subsidies to fishing capacity under SDG 14.6)

¶6 Policy applications are addressed in **TG-1.5 Fisheries Management** and **TG-1.1 National Ocean Budgets**. Derived indicators are compiled under **TG-2.2 Productivity Indicators**.

¶7 This Circular addresses how to transform stock assessment outputs into accounting entries, propagate uncertainty, accommodate multi-species and ecosystem considerations, and align with SDG indicator 14.4.1¹. Governance and policy aspects of fisheries management are addressed in **TG-1.5 Fisheries Management**.

2. Requirements

¶1 This Circular requires familiarity with:

- ¶2 **TG-4.10 Extending Fisheries Statistics for Ecosystem-Based Management** – the fisheries data pipeline this Circular consumes: which statistics a stock assessment is built from, and how they are extended for ecosystem-based management.
- ¶3 **TG-4.11 Aligning Research Statistical Modelling with Official Statistical Methods** – applies to Section 3.6, where assessment-model uncertainty is carried into an official statistic.
- ¶4 **TG-0.1 General Introduction to Ocean Accounts**
- ¶5 **TG-3.1 Asset Accounts** – general physical and monetary asset account structure, including the treatment of aquatic resources as environmental assets and the opening stock / additions / reductions / closing stock structure
- ¶6 **TG-3.9 Aquaculture Accounts** – distinction between cultivated and natural aquatic resources and the production boundary for wild-capture versus farmed fisheries

¶7 Supplementary references: **TG-2.1 Biophysical Indicators** (indicator framework for biomass and B/BMSY ratios), and **TG-0.7 Quality Assurance** (uncertainty documentation and data revisions).

¶8 **Readiness and sequencing**. Whether a country is positioned to compile this account at all – mandate, data architecture, capacity and the order in which to build – is assessed under **TG-0.8 Implementation Readiness Assessment**, and is not restated here.

3. Guidance Material

¶1 Measuring fish stocks is challenging given the need to rely on biological models rather than direct observation^{2, 3}. The SEEA CF and SEEA AFF provide the accounting framework for aquatic resources. Fisheries science provides the biological models and assessment methods that generate estimates of stock size, natural growth, mortality, and sustainable yield. Stock assessment is “the use of various statistical and mathematical calculations to make quantitative predictions about the reactions of fish populations to alternative management choices”⁴. The outputs of stock assessments (biomass estimates, recruitment indices, mortality rates, and reference points) are the raw material from which accounting entries for natural aquatic resources must be derived.

¶2 To illustrate the gap between fisheries science outputs and accounting requirements, consider a typical result: “B/BMSY = 0.75 with 95% confidence interval of 0.45–1.05”. For the fisheries scientist, this result indicates that the stock is most likely below the level that can produce maximum sustainable yield, but the wide confidence interval means the stock could plausibly be anywhere from severely depleted to slightly above target. For the accountant, this result must be translated into a deterministic opening stock value (in tonnes), a sustainable yield estimate (to calculate depletion), and a sustainability classification (for SDG 14.4.1 reporting). Each requires explicit decisions about how to handle uncertainty.

¶3 This section examines stock assessment concepts (Section 3.1), their integration into asset accounts (Section 3.2), compilation procedures (Section 3.3), a worked example (Section 3.4), multi-species and ecosystem considerations (Section 3.5), uncertainty propagation (Section 3.6), and alignment with SDG 14.4.1 (Section 3.7).

3.1 Stock Assessment Concepts

¶1 Stock assessment science provides the biological foundation for fisheries accounting. For guidance on how these concepts relate to broader economic frameworks, see **TG-1.9 Valuation**.

Biomass and stock structure

¶1 **Biomass** refers to the total weight of fish in a stock or population. Stock assessments distinguish between the biomass concepts summarised in Table 3.1.0⁵.

Biomass concept	Description
Total biomass (B)	The weight of all individuals in the stock, regardless of age or size.
Spawning stock biomass (SSB)	The weight of sexually mature individuals capable of reproduction, used to assess reproductive capacity.
Exploitable biomass	The portion of the stock available for harvest, typically excluding juveniles below minimum landing size.
Virgin biomass (B0)	The theoretical biomass that would exist in the absence of fishing pressure.

¶2 For asset accounting, the SEEA CF recommends SSB because “a primary purpose of fishery management is to maintain an adequate level of spawning stock so as to be able to generate natural growth and to minimize the probability of collapse”⁶. The SEEA AFF notes that the physical asset account “shows the total biomass of all species subject to harvesting or cultivation activity within a national boundary”⁷, covering commercial, aquaculture, subsistence, and recreational harvesting.

¶3 Table 3.1.1 provides guidance on selecting the appropriate biomass concept for each accounting entry.

¶4 *Table 3.1.1: Biomass concept selection for accounting entries*

Accounting Entry	Recommended Biomass Concept	Rationale
Opening/Closing stock	Total biomass (B)	Complete population
Sustainable yield calculation	Spawning stock biomass (SSB)	Reproductive capacity basis
Depletion assessment	SSB relative to BMSY	Management reference point
Extraction recording	Exploitable biomass	Harvestable portion
Monetary valuation	Exploitable biomass	Economic value basis
Condition indicator	B/BMSY or B/BO ratio	Relative to reference

¶5 Compilers should use total biomass for opening and closing stock entries, SSB for sustainable yield calculations, and exploitable biomass for monetary valuation. Where only one biomass concept is available, document which concept is used and note implications for comparability.

Recruitment and natural growth

¶1 **Recruitment** is the process by which new individuals enter the fishable stock, typically defined as reaching a specified age or size⁸. **Natural growth** in asset accounting terms encompasses both recruitment (new individuals) and somatic growth (increase in size of existing individuals). The SEEA CF establishes that for renewable natural resources such as fish stocks, the primary addition to stock is natural growth, encompassing recruitment and somatic growth⁹. For the treatment of natural resource additions, see **TG-3.2 Flows from Environment to Economy**.

¶2 The two most common stock-recruitment models are the **Beverton-Holt** (recruitment increases with SSB towards an asymptotic maximum) and **Ricker** (recruitment declines at particularly high SSB due to density-dependent effects)¹⁰. High natural variability in recruitment creates substantial uncertainty in stock projections that must be acknowledged in asset account compilation.

Fishing and natural mortality

¶1 **Fishing mortality (F)** is the instantaneous rate of death due to fishing. **Natural mortality (M)** is the instantaneous rate of death from all other causes (predation, disease, senescence, starvation)¹¹. Total mortality $Z = F + M$.

¶2 For asset accounting, normal losses correspond to natural mortality, and extraction corresponds to fishing mortality (gross catch)¹². The Baranov catch equation, used in Step 4 of the compilation procedure (Section 3.3), relates catch, natural mortality, and fishing mortality.

Maximum sustainable yield and reference points

¶1 **Maximum sustainable yield (MSY)** is the largest average catch that can theoretically be removed from a stock on a sustained basis under prevailing environmental conditions¹³. The SEEA CF describes it as the point “where natural growth exactly replaces removal by fishing”¹⁴.

¶2 Associated biological reference points:

- ¶3 **BMSY**: Biomass level at which MSY is achieved
- ¶4 **FMSY**: Fishing mortality rate that produces MSY
- ¶5 **B/BMSY ratio**: Current biomass relative to BMSY – a key sustainability indicator
- ¶6 **F/FMSY ratio**: Current fishing mortality relative to FMSY – indicates fishing pressure
- ¶7 **Blim / Bpa**: Limit and precautionary approach reference points providing buffer thresholds
- ¶8 **Flim / Fpa**: Corresponding fishing mortality limits

¶9 For accounting purposes, the directly relevant terms are MSY (which determines sustainable yield), BMSY (which determines the sustainability threshold for SDG 14.4.1¹⁵), and depletion (calculated as excess of catch over sustainable yield). Precautionary reference points (Blim, Bpa, Flim, Fpa) are management tools and may be recorded as supplementary metadata in the asset account.

¶10 SDG Target 14.4 specifically references MSY: “restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics”¹⁶.

Stock assessment methods

¶1 The choice of assessment method depends on data availability¹⁷:

¶2 **Data-rich methods** (integrated stock assessments, virtual population analysis) require catch-at-age data, abundance indices, and biological parameters. They provide absolute biomass and detailed population structure, and are applied to commercially important, well-studied stocks.

¶3 **Data-moderate methods** (surplus production models, catch-only models) require catch time series and relative abundance indices. They estimate biomass relative to reference points rather than absolute values.

¶4 **Data-poor methods** (length-based indicators, catch-curve analysis) require only basic catch or length-frequency data. They provide qualitative or semi-quantitative sustainability assessments.

¶5 The SEEA AFF acknowledges that a complete physical asset account “is most likely not possible under current circumstances” and that a more qualitative assessment using “various biological and bioeconomic models and catch statistics” may be appropriate¹⁸. Data-rich assessments can support full physical and monetary asset accounts. Data-moderate assessments may support physical accounts, but monetary valuation requires additional assumptions. Data-poor assessments can support only qualitative sustainability classifications, sufficient for SDG 14.4.1 reporting but not for complete asset accounts. Document the data tier for each stock and apply quality flags accordingly, following **TG-0.7 Quality Assurance**.

3.2 Asset Account Integration

¶1 For the general structure of asset accounts, see **TG-3.1 Asset Accounts**.

Mapping stock assessment outputs to account entries

¶1 *Table 3.2.1: Stock assessment output to account entry mapping*

Stock Assessment Output	Account Entry	Transformation Required
Bt (annual biomass)	Opening/Closing stock	None if same timing
Recruitment estimate	Natural growth (part)	Add to somatic growth
Natural mortality (M)	Normal losses	Convert rate to tonnes
Fishing mortality (F)	Extraction	Convert via Baranov equation
MSY estimate	Sustainable yield	Use directly
Retrospective revisions	Reappraisals	Current vs previous assessment

Opening and closing stocks

¶1 The opening and closing stock entries correspond to biomass estimates from stock assessments. The SEEA CF account structure is:

- ¶2 Opening stock of aquatic resources
- ¶3 Additions to stock (growth in stock, upward reappraisals, reclassifications)
- ¶4 Reductions in stock (gross catch/harvest, normal losses, catastrophic losses, downward reappraisals, reclassifications)
- ¶5 Closing stock of aquatic resources¹⁹

¶6 “Direct measurement of opening and closing stocks and elements of change in stocks usually cannot be observed or measured directly; an exception to this is the measurement of the harvest or gross catch. Accordingly, biological models and assumptions must be used to make estimates”²⁰.

Entry	Source
Opening stock	B _t from stock assessment at year t
Closing stock	B _{t+1} from stock assessment at year t+1
Consistency check	Closing = Opening + Additions – Reductions

¶7 The accounting identity must hold: any discrepancy between the stock assessment biomass trajectory and the sum of recorded additions and reductions indicates either model inconsistency or unrecorded flows.

¶8 When a revised assessment changes historical biomass estimates, record these changes as reappraisals in the current accounting period rather than revising historical accounts. Include metadata indicating the assessment vintage so users can distinguish “as-assessed” from “current-estimate” time series. See **TG-0.7 Quality Assurance** for data revision treatment.

¶9 Figure 6.7.2 shows a hypothetical fish-stock biomass trajectory²¹. The shaded band records 95% assessment confidence intervals used for asset-account uncertainty ranges, and the BMSY reference line marks the threshold below which depletion entries are required in the asset accounts.



Figure 6.7.2 Illustrative fish-stock biomass trajectory (1990--2030) relative to BMSY, with four management states and a teaching-device intervention. Synthetic series with $\pm 95\%$ band; $0.5 \times BMSY$ limit is illustrative, not a Guidance threshold.

Source: TG-6.7 (GOAP Technical Guidance, Section 6 -- Thematic Methods); reference point definitions per FAO Code of Conduct for Responsible Fisheries, Art. 7.5, and Hilborn & Walters (1992) *Quantitative Fisheries Stock Assessment*, Ch. 8.

Adapted from: SEEA EA 2024, Annex on fisheries asset accounts (stock depletion and recovery trajectories); FAO (2022) *The State of World Fisheries and Aquaculture*, reference point framework (B_{MSY} , B_{lim}).

¶10 The central trajectory (blue line) provides point estimates for opening and closing stock entries. The confidence bands represent assessment uncertainty. The trajectory records a stock that declined below BMSY in the early 2000s, reached a minimum around 2008, and subsequently recovered to approximately BMSY by 2020. During the decline phase, depletion is recorded. During the recovery phase, net additions exceed extractions and no depletion is recorded.

Sustainable yield and depletion

¶1 The SEEA CF establishes that “depletion of natural aquatic resources is derived following the approach... where depletion for renewable resources is shown to be equal to gross catch less sustainable yield”²².

¶2 **Depletion** = Gross catch - Sustainable yield (if positive, otherwise zero)

¶3 ⓘ Sign convention for recovering stocks

¶4 Under this definition, a stock already below BMSY but whose current catch does not exceed its current-biomass sustainable yield records zero current depletion. The biomass deficit relative to BMSY is not a flow in the current period. It represents the cumulative effect of past over-harvesting. Readers familiar with SNA wealth accounting should note that no balance-sheet impairment entry is recorded for a recovering stock: the depletion flow is measured on catch, and the gap between current biomass and BMSY does not enter the calculation.

¶5 The SEEA CF notes that “depletion should therefore be recorded only when the extraction is beyond a normal level of natural growth (less natural losses)”²³.

¶6 Using the reference points defined in Section 3.1, the sustainable yield at current stock size equals MSY only when the stock is at BMSY. At other biomass levels, the current-biomass sustainable yield differs from MSY. For accounting purposes, compilers should calculate depletion using the sustainable yield corresponding to the current stock size, not MSY²⁴.

Recording catch and extraction

¶1 The SEEA CF recommends **gross catch** as the measure of extraction, noting that landings exclude “discards of organisms incidentally caught through harvesting activity (discarded catch) as well as the amount of the catch used for own consumption”²⁵. For treatment of discards and residuals, see **TG-3.4 Flows from Economy to Environment**.

¶2 The FAO defines catch stages as follows²⁶:

Stage	Definition
Gross removal	Total live weight of fish caught or killed during fishing operations.
Gross catch	Gross removal less pre-catch losses.
Retained catch	Gross catch less discarded catch.
Landings	Net weight of quantities landed at port.
Nominal catch	Live weight equivalent of landings.

¶3 For asset accounting, gross catch is preferred as it reflects the full impact on the fish stock. For monetary valuation, value typically derives from landings or retained catch.

¶4 Where subsistence catch represents more than approximately 10% of estimated total harvest, include it using household survey estimates, creel surveys, or regional benchmarks. If subsistence catch cannot be quantified, apply a quality flag per **TG-0.7 Quality Assurance** Section 3.6, document the omission in metadata, and note the likely direction of bias. This is consistent with SEEA AFF scope, which specifies that the physical asset account covers “subsistence and recreational harvesting” alongside commercial operations⁷.

Monetary asset accounts

¶1 For valuation methods, see **TG-2.4 Environmental (including Ecosystem) Goods and Services** Section 3.10. The SEEA CF provides two main valuation approaches²⁷:

¶2 **1. Quota and licence valuation:** Where individual transferable quotas (ITQs) exist and are traded, “it is possible to estimate the value of the aquatic resources from the market prices of these entitlements”²⁸. Where quotas cover only a portion of the stock, the ITQ-based value applies to the commercially quoted portion, and the unquoted portion should be estimated using the net present value of resource rent approach. Document the assumed quota coverage ratio as part of account metadata.

¶3 **2. Net present value of resource rent:** The operating surplus from harvesting is partitioned between user costs of produced assets (vessels, gear, equipment) and the resource rent attributable to the aquatic resource itself. The stock value is the NPV of expected future resource rents²⁹.

¶4 The 2025 SNA provides that “a total value of the fish stock can be calculated as the present value of the future resource rents estimated using the residual value method” where there is evidence of management³⁰. Where “there is no effective management of the fish stock or an associated water body, then there is no legal owner and consequently no asset is recorded on the balance sheet”³¹.

¶5 The recommended approach is to compile physical asset accounts for all commercially exploited stocks regardless of management status. Monetary asset accounts should follow 2025 SNA conventions for the core accounts (recording zero value for unmanaged stocks) but may include supplementary tables showing hypothetical resource rent values. See **TG-3.1 Asset Accounts** for the general treatment of asset boundary issues.

Catch per unit effort as a stock indicator

¶1 Where absolute stock estimates are unavailable, catch per unit effort (CPUE) may serve as a relative abundance indicator: “The ratio of catch per unit effort (CPUE) may provide a good indicator of the relative change in stock size, assuming that population density and population size are closely correlated”³².

¶2 One limitation is **technological creep**: improvements in vessel technology and gear efficiency can cause fishing power to increase over time, so nominal CPUE can remain stable or rise even as the underlying stock declines³³. Where technological creep is a concern, use **standardised CPUE** derived from generalised linear models (GLMs) or generalised additive models (GAMs) accounting for vessel characteristics, gear type, area, and temporal trends in catchability. Unstandardised nominal CPUE should not be used as a stock trend indicator without a quality flag per **TG-0.7 Quality Assurance** Section 3.6, specifying whether standardisation was applied and the likely direction of bias³⁴.

3.3 Compilation Procedure: From Assessment to Accounts

Step 1: Data assembly

¶1 Identify and assemble stock assessment outputs and catch statistics for the target species or stock complex:

- ¶2 **Stock assessment reports:** Obtain the most recent assessment from national fisheries agencies or international bodies.³⁵ Priority outputs: opening and closing biomass estimates (Bt, Bt+1), recruitment indices, natural and fishing mortality rates (M, F), and reference points (BMSY, FMSY, MSY).
- ¶3 **Catch statistics:** Collect reported landings from national agencies and international databases (FAO FishStatJ). Supplement with discard estimates from observer programmes where available.

- ¶4 **Metadata documentation:** Record the assessment vintage, assessment method tier (data-rich, data-moderate, data-poor), primary data sources, and any caveats noted by the assessment scientists.

¶5 **Spatial apportionment of transboundary stocks.** For stocks assessed at RFMO or global scale, the recommended default is catch-based apportionment: the national share of total stock biomass is estimated as national reported catch divided by total assessed-area catch, applied to the total assessment biomass. Where fishery-independent survey data allow direct biomass estimation within the national EEZ, direct estimation is preferred. Document the apportionment method applied and note in metadata that the national account biomass represents an allocated share of a pooled assessment. Cross-country comparisons for transboundary stocks should acknowledge that countries using different apportionment methods will produce incompatible national totals³⁶.

Step 2: Unit standardisation

¶1 Standardise all values to a common unit:

- ¶2 **Mass units:** Convert to a consistent mass unit (e.g., tonnes) throughout the account.
- ¶3 **Number to mass:** Where assessments report abundance in numbers, apply mean weight-at-age to convert to biomass. Document conversion factors used.
- ¶4 **Wet weight to carbon:** For integration with ecosystem carbon accounts, apply species-specific wet weight to carbon conversion factors. For finfish, carbon content is typically 10–12% of wet weight³⁷. Document the conversion factor applied. The 10–12% range reflects whole-body elemental analysis across multiple finfish species and can vary with condition, season, and body composition.

¶5 Fish biomass carbon is distinct from ecosystem carbon stocks held in seagrass meadows and mangrove forests, addressed in **TG-6.2 Mangrove and Coastal Wetland Accounting** and **TG-6.3 Seagrass Accounts**.

Step 3: Temporal alignment

¶1 Align stock assessment timing with the accounting period (typically calendar year):

- ¶2 **Opening stock:** Use biomass at 1 January of the accounting year (Bt). If the assessment provides mid-year or average biomass, extrapolate to 1 January using reported quarterly or monthly growth and mortality rates.
- ¶3 **Closing stock:** Use biomass at 31 December (Bt+1), or 1 January of the following year.
- ¶4 **Catch timing:** Sum reported catch over the accounting period by aggregating monthly or quarterly landing statistics to annual totals.

¶5 Where assessments use a different reference date, document the discrepancy and apply interpolation to align with the standard accounting period.

Step 4: Account entry calculation

¶1 **Opening stock:** Record Bt directly from the stock assessment as the opening biomass.

¶2 **Natural growth:** Calculate as recruitment plus somatic growth. Where the stock assessment provides age-structured population estimates, natural growth equals the sum of:

- ¶3 Recruitment (numbers at age-0 multiplied by mean weight-at-age-0)
- ¶4 Somatic growth (increase in weight of surviving individuals across all age classes)

¶5 Where only total biomass estimates are available, derive natural growth as a balancing item: Natural growth = Closing stock - Opening stock + Gross catch + Normal losses - Other additions + Other reductions. To avoid circular dependence between somatic growth and normal losses when both are residuals, solve for somatic growth first using survey-derived biomass change, then derive

normal losses as the balancing item: Normal losses = Opening stock + Somatic growth - Gross catch - Closing stock.

¶6 **Gross catch:** Sum reported landings and estimated discards. Apply sector-specific discard rates where observer data are available. In particular, observer programmes typically cover large commercial vessels, whilst artisanal and small-scale fisheries frequently have lower discard rates. Applying a commercial observer discard rate to aggregate artisanal and commercial landings will overstate discards for mixed fisheries. Where discard data are unavailable, apply discard ratios from comparable fisheries for each sector separately, and document the estimation method and associated uncertainty.

¶7 **Normal losses:** Convert natural mortality rate (M) to absolute biomass loss. For age-structured models, apply M to each age class and sum. For biomass models, the Baranov-consistent derivation is:

¶8 $\text{Normal losses} = (M / Z) \times \text{Opening biomass} \times (1 - e^{(-Z)})$

¶9 where $Z = F + M$. For example, with $F = 0.25$, $M = 0.18$, $Z = F + M = 0.43$, and opening biomass of 42,000 t:

¶10 $\text{Normal losses} = (0.18 / 0.43) \times 42,000 \times (1 - e^{(-0.43)}) = 0.419 \times 42,000 \times 0.349 \approx 6,148 \text{ t}$

¶11 ① **Why the simple M × average biomass approximation overstates normal losses**

¶12 A common approximation is M multiplied by average biomass (e.g., $0.18 \times 40,250 = 7,245 \text{ t}$ in the example above). This overstates natural mortality because it applies M to the full mid-year population without accounting for the simultaneous removal of individuals by fishing. In the Baranov model, natural and fishing mortality operate concurrently, so the population exposed to natural mortality at any point in time is smaller than the simple average suggests. The Baranov-derived formula corrects for this via the (M/Z) proportional allocation. Where M and F are not available separately, normal losses may be derived as a balancing item: Normal losses = Opening stock + Natural growth - Gross catch - Closing stock. Document which method was used.

¶13 **Sustainable yield:** Use the MSY estimate if the stock is at BMSY. If the stock is below or above BMSY, use the sustainable yield corresponding to current biomass. Stock assessments typically provide sustainable yield curves or tables as a function of stock size. Extract the value corresponding to current biomass. Where not explicitly provided, approximate from the surplus production function using the formula appropriate to the model form (Schaefer, Fox, or other)²⁴.

¶14 **Depletion:** Apply the depletion formula (Section 3.2).

¶15 **Closing stock:** Record B_{t+1} from the stock assessment. Verify the accounting identity: Closing stock = Opening stock + Natural growth - Gross catch - Normal losses ± Other changes. Any discrepancy indicates unrecorded flows or assessment inconsistency and should be recorded as a reappraisal.

Step 5: Reappraisal treatment

¶1 When a new stock assessment revises historical biomass estimates:

- ¶2 **Retrospective revision:** Calculate the difference between the current assessment's estimate of opening stock and the previous assessment's estimate of the same point in time. Record this difference as a reappraisal.
- ¶3 **Metadata:** Document the assessment vintage for each entry, so users can distinguish "as-assessed" from "current-estimate" time series.

¶4 For example, if the 2025 assessment estimates 2024 opening stock at 50,000 tonnes but the 2024 assessment estimated it at 48,000 tonnes, record a +2,000 tonne upward reappraisal in the 2025 account.

Step 6: Quality assurance

¶1 Follow **TG-0.7 Quality Assurance**:

- ¶2 **Accounting identity verification:** Confirm opening stock plus additions minus reductions equals closing stock.
- ¶3 **Consistency with catch data:** Compare assessment-predicted catch (derived from F and biomass via the Baranov equation) with reported catch. Large discrepancies may indicate unreported fishing or assessment misspecification.
- ¶4 **Trend plausibility:** Review biomass and depletion trends for plausibility. Sudden changes should correspond to documented events.
- ¶5 **Uncertainty documentation:** For data-moderate and data-poor assessments, document uncertainty magnitude and apply quality flags.

Step 7: Integration with broader accounts

- ¶1 **Link to TG-3.1 Asset Accounts:** Ensure consistency with monetary valuation methods and reappraisal treatment.
- ¶2 **Link to TG-3.2 Flows from Environment to Economy:** Record gross catch as a natural resource input.
- ¶3 **Link to TG-1.5 Fisheries Management:** Use depletion estimates and sustainability classifications to inform TAC decisions.
- ¶4 **Link to TG-2.2 Productivity Indicators:** Derive resource productivity and depletion intensity indicators from the asset account.

Which account entries each data tier supports

¶1 The table below maps each assessment tier to the physical asset account entries it can support, and is the operative rule for which cells a compiler may populate at a given data tier. Entries marked “proxy” require an indicative estimate rather than a model-based value. Entries marked “omit (document)” should be left blank with an explanatory metadata note.

¶2 *Table 3.3.1: Tier-to-account-entry mapping for physical asset accounts*

Account Entry	Tier 1 (CPUE index)	Tier 2 (Surplus production)	Tier 3 (Age- structured)
Opening stock (absolute tonnes)	Omit (document)	Computable	Computable
Natural growth	Proxy (CPUE trend)	Computable	Computable
Gross catch/harvest	Computable	Computable	Computable
Normal losses (natural mortality)	Omit (document)	Proxy	Computable
Uncompensated seizure (IUU)	Proxy	Proxy	Proxy
Closing stock (absolute tonnes)	Omit (document)	Computable	Computable
Sustainable yield	Omit (document)	Computable	Computable
B/B _{MSY} ratio	Qualitative only	Computable	Computable
Depletion (tonnes)	Qualitative signal only	Computable	Computable

¶3 At Tier 1, accounts can still support directional judgements (improving/stable/declining) useful for flagging potential sustainability concerns, even without absolute biomass estimates.

¶4 The management consequence – that a quota set at the lowest tier carries a wider error band than a single number implies – is set out in **TG-1.5 OA and Fisheries Management** Section 3.4.1.

3.4 Worked Example: Demersal Fish Stock Asset Account

Scenario description

¶1 The accounting area is a coastal zone supporting a demersal fish stock harvested by commercial and artisanal fisheries. A data-rich stock assessment using age-structured analysis provides annual estimates of total biomass, spawning stock biomass, recruitment, natural mortality, and fishing mortality, as well as BMSY and MSY estimates. The accounting period is calendar year 2025. Commercial landings: 5,000 tonnes. Artisanal landings: 1,800 tonnes. Total landings: 6,800 tonnes.

Stock assessment outputs (2025 assessment)

Parameter	Value	Unit
Opening stock (1 Jan 2025)	42,000	tonnes
Spawning stock biomass (SSB)	28,000	tonnes
Recruitment (age-0 fish, 1 Jan)	120 million	individuals
Mean weight at recruitment	0.05	kg/individual
Natural mortality rate (M)	0.18	per year
Fishing mortality rate (F)	0.25	per year
Total mortality (Z = F + M)	0.43	per year
BMSY	38,000	tonnes
MSY	6,500	tonnes/year
Sustainable yield at current B	6,200	tonnes/year
Closing stock (31 Dec 2025)	38,500	tonnes

¶1 Note: $Z = F + M = 0.25 + 0.18 = 0.43$, which confirms internal consistency.

Catch statistics (2025)

¶1 Observer data from commercial vessels indicate an 8% discard rate by weight for the commercial sector: $5,000 \times 8\% = 400$ tonnes of commercial discards. Artisanal discards are assumed negligible based on local fleet characteristics.³⁸ Gross catch = $6,800 + 400 = 7,200$ tonnes.

Compilation step-by-step

¶1 **Step 1:** Stock assessment and catch statistics assembled as above. Metadata: 2025 assessment conducted March 2026 using data through December 2025, age-structured model, data tier = data-rich.

¶2 **Step 2:** All values already in tonnes (wet weight). No conversion required.

¶3 **Step 3:** Assessment provides 1 January opening stock and 31 December closing stock, matching the calendar year. No adjustment required.

¶4 **Step 4: Account entry calculation:**

- ¶5 **Opening stock:** 42,000 tonnes
- ¶6 **Gross catch:** 7,200 tonnes (commercial landings 5,000 + artisanal landings 1,800 + commercial discards 400)
- ¶7 **Normal losses:** Using the Baranov-consistent formula with $F = 0.25$, $M = 0.18$, $Z = 0.43$, opening biomass = 42,000 t:

$$\text{Normal losses} = (0.18 / 0.43) \times 42,000 \times (1 - e^{(-0.43)}) = 0.4186 \times 42,000 \times 0.3495 \approx 6,148 \text{ t}$$
The accounts table uses the **balancing-item value of 4,244 tonnes**, derived from the accounting identity: Normal losses = Opening stock + Natural growth - Gross catch - Closing stock = $42,000 + 7,944 - 7,200 - 38,500 = 4,244$ tonnes. The balancing-item value is internally consistent with the assessment-provided opening and closing stocks.

The 1,904 t difference between the Baranov-formula estimate (6,148 t) and the balancing-item value (4,244 t) reflects a genuine biological divergence: the Baranov formula applies instantaneous mortality rates to opening biomass without accounting for the growth offset during the year, whilst the balancing item captures net mortality after somatic growth. New recruits (6,000 t) join the stock partway through the year and are not exposed to natural mortality for the full period. Use the balancing-item value for the accounts table. Present the Baranov estimate in a footnote as a biological cross-check. Document which method was used.

¶8

Recruitment biomass: 120 million individuals × 0.05 kg/individual = 6,000 tonnes

¶9

Somatic growth (balancing item): $38,500 - 42,000 + 7,200 + 4,244 - 6,000 = 1,944$ tonnes

¶10

Total natural growth: $6,000 + 1,944 = 7,944$ tonnes

¶11

Sustainable yield: 6,200 tonnes (at current spawning stock biomass of 28,000 t, below BMSY of 38,000 t, surplus production is below its maximum, so sustainable yield is below MSY of 6,500 t, see Section 3.2)

¶12

Depletion: $7,200 - 6,200 = 1,000$ tonnes

¶13 **Step 5: Verify accounting identity:** Closing = Opening + Natural growth - Gross catch - Normal losses $38,500 = 42,000 + 7,944 - 7,200 - 4,244$ $38,500 = 38,500$ ✓

¶14 **Physical asset account table:**

¶15 *Table 3.4.1: Physical asset account for coastal demersal fish stock, 2025*

Accounting Entry	Value (tonnes)
Opening stock (1 Jan 2025)	42,000
Additions to stock	
Natural growth (recruitment + growth)	7,944
Upward reappraisals	0
<i>Total additions</i>	7,944
Reductions in stock	
Gross catch (landings + commercial discards)	7,200
Normal losses (natural mortality)	4,244
Catastrophic losses	0
Downward reappraisals	0
<i>Total reductions</i>	11,444
Closing stock (31 Dec 2025)	38,500
Metadata	
Assessment vintage (opening stock)	2025 assessment (March 2026) ³⁹
Derived measures	
Sustainable yield (at current B)	6,200
Depletion (catch - sustainable yield)	1,000
B/BMSY ratio (condition indicator, Table 3.1.1)	1.11
SSB/BMSY ratio (depletion assessment, Table 3.1.1)	0.74
Sustainability classification (SDG 14.4.1)	Unsustainable (overfished)

¶16 **Interpretation:** The stock declined from 42,000 to 38,500 tonnes during 2025 (8.3% reduction). Gross catch (7,200 t) exceeded sustainable yield by 1,000 tonnes, indicating depletion. Spawning stock biomass is below BMSY ($SSB/BMSY = 0.74$, the measure Table 3.1.1 prescribes), so the stock is classified as overfished (unsustainable) under SDG 14.4.1, and continued overharvesting at this rate would drive it further below the sustainability threshold. The sustainable yield at current biomass (6,200 t) is below MSY (6,500 t) because the spawning stock is below BMSY (see Table 3.7.1, lower-right cell). A reduction in the TAC is therefore indicated.

¶17 ⓘ **Corrected 24 September 2026**

¶18 This example previously classified the stock as sustainable on total biomass ($B/BMSY = 1.11$); Table 3.1.1 prescribes spawning stock biomass for the assessment against BMSY, on which the ratio is 0.74, so the stock is now classified as overfished.

3.5 Multi-Species and Ecosystem Considerations

¶1 For ecosystem accounting approaches, see **TG-2.1 Biophysical Indicators** and **TG-3.1 Asset Accounts** Section 3.5 (Ecosystem Assets).

Multi-species fisheries

¶1 Many fisheries harvest multiple species simultaneously, which complicates catch allocation, aggregate stock indices, and bycatch treatment. The SEEA CF notes that “commonly, particularly in tropical areas, multiple species may be harvested at one time”⁴⁰. For mixed-species fisheries, aggregate biomass indicators may be more practical than species-specific accounts: “accessing relevant indicators and models of the overall stock size consisting of multiple species that supports this harvest may be the most appropriate measurement approach”⁴¹.

¶2 Bycatch discarded dead represents fishing-induced mortality that affects the stock but does not enter economic activity. Record discarded bycatch as part of gross catch (consistent with the SEEA CF definition) with a corresponding discard entry. Recording discarded bycatch in this way captures the full impact of fishing on the stock and keeps the treatment coherent with **TG-3.4 Flows from Economy to Environment**.

Trophic interactions

¶1 Natural mortality rates implicitly incorporate predation. If fishing pressure on one species substantially alters predation mortality on another, this represents an indirect fishing impact that standard single-species accounts do not capture. The SEEA AFF refers to the **mean trophic index** as an indicator that may be used to understand the state of marine environments⁴². Declining mean trophic level in catches (fishing down the food web) can indicate ecosystem-level impacts.

Ecosystem-based approaches

¶1 Ecosystem-based fisheries management^{43, 44} links fisheries asset accounts to broader ecosystem asset accounts. The SEEA AFF notes that “another approach is to consider indicators of the condition of marine and inland water ecosystems with a view to understanding the state of fish and other aquatic resources”⁴⁵. Relevant ecosystem condition indicators include Ocean Health Index, mean trophic level, marine biodiversity indices, and habitat extent and condition (see **TG-2.1 Biophysical Indicators**).

¶2 A conceptual issue arises from the relationship between fish stocks as individual environmental assets and the marine ecosystems within which they exist. Under SEEA CF, fish stocks are recorded as individual environmental assets in physical asset accounts. Under SEEA EA, fish are components of marine ecosystem assets, and harvested fish represent provisioning services flowing from the ecosystem to the economy. Aggregating both individual asset values and ecosystem asset values creates a double-counting risk. The SEEA EA addresses this through the provisioning service

framework: fish are treated as an output (service flow) of the ecosystem asset rather than a component of its stock value⁴⁶.

¶3 **Procedural rule for compilers compiling both sets of accounts.** When both SEEA CF fish stock asset accounts and SEEA EA marine ecosystem accounts are compiled for the same spatial unit, the fish provisioning service value (annual flow) from the SEEA EA should be used in ecosystem wealth aggregates. The SEEA CF individual asset NPV should be compiled separately, clearly labelled as the stand-alone fisheries asset value, and excluded from total ecosystem asset values to avoid double-counting. Cross-reference this treatment in the metadata of both accounts. Ensure consistency with the treatment of ecosystem assets in **TG-6.1 Coral Reef Accounts**, **TG-6.2 Mangrove and Coastal Wetland Accounting**, and **TG-6.3 Seagrass Accounts**.

Carrying capacity and environmental limits

¶1 Fish stock productivity depends on environmental conditions and habitat availability. The SEEA AFF notes that “measures of water quality, for example, that take into account eutrophication, are likely to be important in understanding the sustainability of fisheries activities”⁴⁷. Climate change is altering the environmental parameters that govern the potential productivity of marine areas and the distribution of fish stocks. Asset accounts should be interpreted in the context of changing environmental baselines.

3.6 Uncertainty Propagation and Quality Assurance

¶1 Stock assessment outputs carry substantial uncertainty from observation error, process error in biological parameters, model structural uncertainty, and parameter estimation uncertainty. For accounting purposes, uncertainty can be addressed through⁴⁸:

- ¶2 **Central estimates:** Use point estimates (e.g., median biomass) for main accounts.
- ¶3 **Supplementary uncertainty ranges:** Report confidence intervals alongside point estimates.
- ¶4 **Sensitivity analysis:** Test how accounting entries change under alternative stock assessment scenarios.
- ¶5 **Quality indicators:** Flag entries derived from data-poor assessments.

¶6 The SEEA AFF acknowledges that “estimates of the absolute size of stocks can be imprecise”⁴⁹.

¶7 For species or areas without formal stock assessments, alternative approaches include:

- ¶8 extrapolation from assessed proxy species
- ¶9 indicator-based assessment using length-frequency or catch trends
- ¶10 catch-only production models
- ¶11 structured expert judgement on stock status categories

¶12 The SEEA CF notes that for multi-species tropical fisheries, aggregate stock indicators “may be the most appropriate measurement approach”⁵⁰.

3.7 Sustainability Status and Depletion

¶1 **SDG 14.4.1 is derived in TG-2.10 Multilateral Environmental Agreement Indicators Section 3.4**, which owns the indicator definition, the FAO custodian methodology and the reporting route⁵¹. This Section supplies what TG-2.10 draws on: which account entry carries the stock status, and how status interacts with the depletion entry. The two are easily conflated, because a stock can be classified sustainable and still record depletion in the same period.

Relationship to asset accounts

Asset account metric	SDG 14.4.1 alignment
Opening/closing stock (B)	Compared to BMSY to determine sustainability status

Asset account metric	SDG 14.4.1 alignment
Depletion	Recorded when $B < \text{BMSY}$ and/or catch $>$ sustainable yield
Stock trajectory	Indicates movement toward or away from BMSY

¶1 The management decision framework that reads off this relationship – which TAC response follows from each combination of stock status and catch – is set out in **TG-1.5 OA and Fisheries Management** Table 3.4.1 and is normative for the publication. Table 3.7.1 below records the same four combinations from the compiler's side, stating what is entered in the accounts rather than what the manager should do.

¶2 The relationship between stock status and depletion recording requires careful interpretation. A stock below BMSY but recovering (catch below sustainable yield at current stock size) records no current depletion. A stock at or above BMSY (classified as sustainable) can experience depletion if catch temporarily exceeds MSY. Table 3.7.1 summarises all four combinations.

¶3 *Table 3.7.1: Stock status and depletion interaction*

	Catch $\leq$ Sustainable Yield	Catch $>$ Sustainable Yield
B $>$ BMSY (Sustainable)	No depletion; SDG sustainable	Depletion recorded; SDG sustainable but at risk
B $<$ BMSY (Unsustainable)	No current depletion; stock recovering; SDG unsustainable	Depletion recorded; stock declining further; SDG unsustainable

¶4 Both SDG status (stock-based) and the depletion flow (catch-based) should be compiled and reported as complementary measures.

Using the status classification inside the accounts

¶1 The status classification compiled under TG-2.10 is useful back inside the asset account: it stratifies the account by sustainability status, weights aggregate biomass by category, and lets depletion be reported separately for overfished and sustainably fished stocks⁵². Compilers should take the classification from the same source that feeds national SDG reporting rather than deriving a parallel one, so that the account and the indicator cannot diverge.

Overfished stock treatment

¶1 For overfished stocks ($B < \text{BMSY}$), asset accounts should record:

- ¶2 **Depletion:** When catch exceeds the sustainable yield corresponding to current (depressed) stock size
- ¶3 **Sustainability deficit:** The cumulative impact of past overexploitation, measured as the difference between current biomass and BMSY – recorded as supplementary information rather than as an asset account entry, since it represents unrealised potential rather than a flow or stock change within the accounting period
- ¶4 **Recovery trajectory:** Tracking progress towards BMSY through successive accounting periods

¶5 Analytical construct – not an accounting liability

¶6 **Potential recovery value is an analytical construct for policy illustration only.** It is not an SEEA account entry, does not represent a recognised environmental liability, and should not be aggregated with or compared to balance-sheet asset values. The SEEA framework explicitly declined to include contingent or potential asset values in core accounts. Supplementary tables presenting this figure must carry a prominent label: “*Analytical estimate – not part of SEEA accounts.*” Citing potential recovery value as an accounting liability figure would misrepresent its methodological status and is inconsistent with SEEA CF asset boundary conventions⁵³.

¶7 Potential recovery value may be recorded in supplementary tables alongside the main accounts to illustrate the economic cost of past overexploitation. The SEEA CF notes that “a total permissi-

ble catch resulting in earnings that are higher than this level will mean that some of those earnings should be regarded as depletion of the aquatic resources and not as income”⁵⁴.

Climate-adjusted reference points

¶1 Where BMSY or MSY reference points are revised to reflect changed environmental productivity, the change in opening stock value arising solely from the reference point revision should be recorded as a reappraisal in the asset account, not as depletion⁵⁵. SDG 14.4.1 time-series comparisons should note any years in which reference point changes drove stock reclassifications independently of changes in actual fishing pressure⁵⁶. Metadata for each accounting period should record the BMSY and MSY reference point values in use.

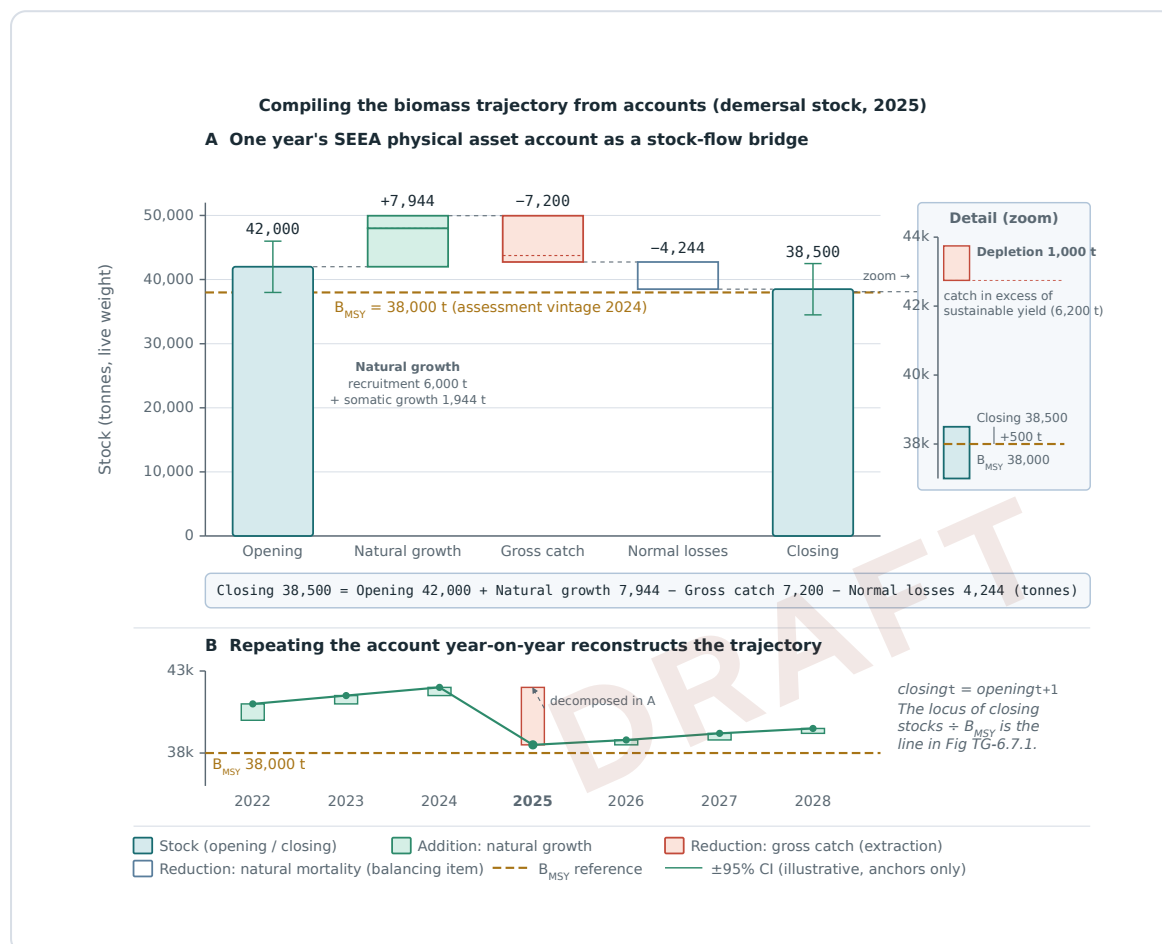


Figure 6.7.1 Two-panel bridge: Panel A compiles one year of the SEEA CF physical asset account; Panel B stacks years to reconstruct the biomass trajectory. Values are worked-example tonnes; depletion and normal losses are memorandum items.

Source: TG-6.7 Section 3.4 worked example (GOAP Technical Guidance, Section 6 -- Thematic Methods).

Adapted from: SEEA CF physical asset account structure (opening stock + additions – reductions = closing stock), Table 5.2 / paras 5.43--5.46; SEEA AFF physical asset account for aquatic resources; depletion per SEEA CF (gross catch less sustainable yield). Cf. Figure TG-3.1.1 (asset-account identity).

4. Acknowledgements

¶1 **Authors:** [To be confirmed]

¶2 **Reviewers:** [To be confirmed]

5. References

¶1 This Circular draws upon the following authoritative sources:

- ¶2 United Nations et al. (2014). *System of Environmental-Economic Accounting 2012: Central Framework*
- ¶3 United Nations et al. (2021). *System of Environmental-Economic Accounting—Ecosystem Accounting*
- ¶4 FAO (2020). *System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries (SEEA AFF)*
- ¶5 United Nations (2025). *System of National Accounts 2025*
- ¶6 FAO (2020). *The State of World Fisheries and Aquaculture (SOFIA)*
- ¶7 United Nations (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*

FOOTNOTES

1. ¶1 SDG Indicator 14.4.1, Proportion of fish stocks within biologically sustainable levels.
2. ¶2 FAO (2020), *The State of World Fisheries and Aquaculture*.
3. ¶3 SEEA AFF, para. 3.179.
4. ¶4 Hilborn, R. and Walters, C.J. (1992), *Quantitative Fisheries Stock Assessment*.
5. ¶5 SEEA Central Framework, para. 5.421.
6. ¶6 SEEA Central Framework, para. 5.421.
7. ¶7 SEEA AFF, para. 3.182.
8. ¶8 Haddon, M. (2011), *Modelling and Quantitative Methods in Fisheries*.
9. ¶9 SEEA Central Framework, para. 5.48(a) on growth in stock for biological resources; see also para. 5.82 on sustainable yield.
0. ¶10 Ricker, W.E. (1954), Stock and Recruitment, *Journal of the Fisheries Research Board of Canada*.
1. ¶11 Haddon, M. (2011), *Modelling and Quantitative Methods in Fisheries*, 2nd ed., Chapman and Hall/CRC. See also SEEA Central Framework, para. 5.437, for the accounting treatment of normal losses.
2. ¶12 SEEA Central Framework, para. 5.48(a) on growth in stock net of normal losses; see also para. 5.415 on natural mortality of aquatic resources.
3. ¶13 Schaefer, M.B. (1954), Some aspects of the dynamics of populations important to the management of commercial marine fisheries.
4. ¶14 SEEA Central Framework, para. 5.82.
5. ¶15 SDG Target 14.4.
6. ¶16 SDG Target 14.4.
7. ¶17 Carruthers, T.R. et al. (2014), Evaluating methods for setting catch limits in data-limited fisheries.
8. ¶18 SEEA AFF, para. 3.188.
9. ¶19 SEEA Central Framework, table 5.22.
0. ¶20 SEEA AFF, para. 3.186.
1. ¶21 Hypothetical illustration based on stock assessment trajectory patterns described in FAO (2020), *The State of World Fisheries and Aquaculture*.
2. ¶22 SEEA Central Framework, para. 5.431.
3. ¶23 SEEA Central Framework, para. 5.432.
4. ¶24 SEEA Central Framework, figure 5.2.
5. ¶25 SEEA Central Framework, para. 5.429.
6. ¶26 SEEA Central Framework, para. 5.428.
7. ¶27 SEEA Central Framework, para. 5.442.
8. ¶28 SEEA Central Framework, para. 5.448.
9. ¶29 SEEA Central Framework, para. 5.453.
0. ¶30 2025 SNA, para. 27.37.
1. ¶31 2025 SNA, para. 27.38.
2. ¶32 SEEA Central Framework, para. 5.425.
3. ¶33 SEEA AFF, para. 3.189.
4. ¶34 Maunder, M.N. and Punt, A.E. (2004), Standardizing catch and effort data: a review of recent approaches. *Fisheries Research*, 70(2-3), 141–159.
5. ¶35 For stocks managed by RFMOs (such as WCPFC, IOTC, or CCSBT), the RFMO stock assessment outputs provide the primary input. National compilers should coordinate with RFMO data teams to obtain stock-specific outputs apportioned to the national EEZ where relevant.
6. ¶36 FAO Fisheries Technical Paper y5438e, Conservation and management of shared fish stocks; SDG 14.4.1 indicator metadata, UN Statistics Division, unstats.un.org.

7. ¶37 Czamanski, M., Nugraha, A., Pondaven, P., Lasbleiz, M., Masson, A., Caroff, N., Bellail, R. and Tréguer, P. (2011). Carbon, nitrogen and phosphorus elemental stoichiometry in aquacultured and wild-caught fish and consequences for pelagic nutrient dynamics. *Marine Biology*, 158(12), 2543–2556. <https://doi.org/10.1007/s00227-011-1783-7> (<https://doi.org/10.1007/s00227-011-1783-7>)
8. ¶38 Quality flag: Artisanal discard rate assumed negligible. If artisanal discards are later quantified and found to be material, gross catch and depletion figures should be revised accordingly.
9. ¶39 Assessment vintage indicates the stock assessment used to derive the opening stock estimate. Non-zero reappraisal entries would arise if the 2025 assessment revised the estimate of the 1 January 2025 opening stock relative to the 2024 assessment. In this example the assessments agree, so reappraisals are zero. See Section 3.3 Step 5 for the reappraisal treatment.
0. ¶40 SEEA Central Framework, para. 5.426.
1. ¶41 SEEA Central Framework, para. 5.426.
2. ¶42 SEEA AFF, para. 3.190.
3. ¶43 FAO (2003), *Fisheries Management: The Ecosystem Approach to Fisheries*.
4. ¶44 Pikitch, E.K. et al. (2004), *Ecosystem-Based Fishery Management*.
5. ¶45 SEEA AFF, para. 3.190.
6. ¶46 SEEA EA, para. 5.19–5.22 (provisioning services and asset boundary).
7. ¶47 SEEA AFF, para. 4.108.
8. ¶48 ICES (2021), *Guidelines for ICES advice on fishing opportunities*.
9. ¶49 SEEA Central Framework, para. 5.424.
0. ¶50 SEEA Central Framework, para. 5.426.
1. ¶51 SDG Indicator 14.4.1.
2. ¶52 FAO (2020), *The State of World Fisheries and Aquaculture, Methodology*.
3. ¶53 SEEA Central Framework, para. 5.411–5.412 (asset boundary); SEEA EA, Chapter 5 (scope of ecosystem asset values).
4. ¶54 SEEA Central Framework, para. 5.452.
5. ¶55 SEEA Central Framework, para. 5.432 (reappraisals for improved information).
6. ¶56 IPBES (2019), *Global Assessment Report on Biodiversity and Ecosystem Services*, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

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