CONCEPT PAPER

on

Methodological Approach for Compilation of Experimental Monetary Asset Accounts of Marine Fish Resources

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Executive Summary

Fish resources constitute an important component of natural wealth and play a significant role in food security, nutrition, employment generation, livelihoods and economic development. Marine fish resources provide an important source of animal protein and micronutrients while also supporting processing activities, exports, trade and coastal economies. In addition to their economic contribution, fish resources perform critical ecological functions within marine ecosystems by supporting trophic interactions, biodiversity maintenance and ecosystem stability. Sustained dependence on marine fisheries for nutritional security and economic activity has increased the importance of systematically assessing stock condition, sustainability and long-term productive capacity within an environmental-economic accounting framework.

This study presents an experimental application of the methodological guidance provided in the OECD (2025) *Measuring Natural Resources in the National Accounts: A Compilation Guide*. As a recent publication, the guide offers a comprehensive framework and detailed methodological approaches for compiling natural resource accounts, taking into account alternative estimation methods and varying levels of data availability. Drawing on this methodology, the present paper seeks to assess its practical within the context of available data and institutional arrangements.

Based on the OECD's methodological approach, this study intends to undertakes methodological review and data availability for an integrated assessment of marine fish resources through the preparation of physical and monetary asset accounts at the species level. Methodological approach present in the study combines biological resource assessment indicators with resource rent-based

valuation approaches to evaluate stock condition, exploitation status, expected asset life and the economic value associated with marine fish resources. The framework enables systematic assessment of changes in marine resource wealth in monetary terms and supports evaluation of future economic benefits and long-term sustainability of fish resources.

The physical assessment accounts classify fish resources according to exploitation status, stock condition and estimated asset life over the assessment period. The experimental monetary asset accounts attempt to provide expected future economic benefits derived from fish resources using resource rent-based valuation methods and Net Present Value estimation.

Using the methodology presented, the integrated assessment of physical and monetary accounts demonstrates the importance of viewing fish resources simultaneously as biological resources and economic assets within an environmental-economic accounting framework. The framework developed under the study strengthens the analytical usefulness of fisheries statistics for sustainability assessment, marine resource planning and evidence-based policy formulation.

Contents

SECTION I : Introduction to Aquatic Resources and Fisheries

1.1 Aquatic Resources

1. Aquatic resources [1] refer to living biological resources that exist in water ecosystems and provide economic, ecological, and nutritional value to human societies. These resources include fish, crustaceans, molluscs, shellfish, aquatic mammals, and aquatic plants such as seaweeds. They are harvested for commercial, subsistence, and recreational purposes and form an essential component of global food security and livelihoods.

2. Among aquatic resources, fish constitute one of the most important components due to their significant contribution to food supply, nutrition, employment, trade, and economic production. Fisheries and aquaculture play an important role in supporting livelihoods and ensuring nutritional security, particularly in developing countries. Fish resources are therefore considered an important renewable biological asset within environmental-economic accounting frameworks.

3. Global fisheries databases such as the FAO Aquatic Sciences and Fisheries Information System (ASFIS)[2] classify more than 11,500 aquatic species used for fisheries production. These resources are therefore diverse biological assets that contribute significantly to economic production and environmental sustainability.

4. Fishery resources are broadly classified into marine and inland resources depending on the ecosystem in which they occur. Marine fisheries resources occur in coastal waters, offshore areas within a country's Exclusive Economic Zone (EEZ), as well as in international waters beyond national jurisdiction, and are primarily exploited through marine capture fisheries.

[1] https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf
[2] https://www.fao.org/fishery/en

Inland fisheries resources[3] occur in freshwater and brackish water systems such as rivers, lakes, reservoirs, ponds, canals, floodplain wetlands, estuaries, and backwaters, and support both capture fisheries and aquaculture activities.

5. The SEEA classification of aquatic resources groups them into categories such as freshwater fishes, marine fishes, diadromous fishes, crustaceans, molluscs, aquatic mammals, miscellaneous aquatic animals, aquatic products, and aquatic plants. This classification highlights the biological and ecological diversity of aquatic resources and provides a basis for statistical accounting of fisheries resources.

1.2 Fish Species in India

6. India possesses a rich diversity of fish species distributed across both marine and inland ecosystems. These species are generally classified based on their habitat, biological characteristics, and ecological behavior, which is important for fisheries management as well as for environmental-economic accounting.

7. Marine fish are found in both coastal and offshore waters within India's Exclusive Economic Zone (EEZ) and form a major component of the country's capture fisheries. Commercially important marine species include sardines, mackerel, tuna, ribbonfish, seer fish, pomfrets, anchovies, and sharks, along with crustaceans such as prawns and crabs. Based on ecological characteristics, marine fish are broadly classified into pelagic, demersal, and diadromous groups. Pelagic species inhabit the upper layers of the ocean and often form large schools, while demersal species live near or on the seabed. Diadromous species migrate between marine and freshwater environments during different stages of their life cycle.[4]

[3] https://www.basu.org.in/wp-content/uploads/2020/10/3.-Inland-Fisheries-Resources-of-India.pdf
[4] Fishery Survey of India (FSI). Glossary of Fisheries Terms: https://fsi.gov.in/glossary

8. Inland fish occur in freshwater and brackish water systems such as rivers, lakes, reservoirs, ponds, floodplains, and estuaries, and support both capture fisheries and aquaculture activities. Important inland species include carps such as rohu, catla, and mrigal, along with tilapia, catfish, and hilsa. Brackish water systems support species such as milkfish and mullets, while estuarine fisheries are characterized by species such as hilsa (Hilsa ilisha), bhekti (Lates calcarifer), and prawns, which migrate between freshwater and marine environments.

9. These species collectively form the biological base of India's fisheries sector and are essential for both capture fisheries and aquaculture. Their classification into marine and inland categories, along with their ecological groupings, provides an important basis for analyzing fish stock dynamics, assessing sustainability, and organizing data within physical and monetary asset accounts.

1.3 Fisheries Sector in India

10. The fisheries sector plays a vital role in India's economy, contributing to food security, employment generation, and export earnings. It comprises two main segments: marine fisheries and inland fisheries. Marine fisheries primarily involve capture fishing in ocean waters along the Indian coastline, while inland fisheries utilize rivers, canals, reservoirs, ponds, tanks, floodplain lakes, estuaries, and backwaters.

11. India is the second largest fish producing country in the world and accounts for 8 % of the global production. The total fish production during FY 2024-25 is estimated at 19.77 Million Metric Tons(MMT)with a contribution of 15.16 MMT (~76.7%) from Inland sector and 4.61 MMT(~23.3%) from Marine sector.[5]

[5] https://mofpi.gov.in/sites/default/files/KnowledgeCentre/Sector%20Profile/Sector_Profile_Fisheries

12. The fisheries sector plays an important role in the national economy with the share of Fisheries sector in the total Gross Value Added (GVA), at constant prices, in 2023-24 is estimated at Rs. 1,75,850 Crores that constitutes about 1.09 % of the total national GVA and 7.43 % of agricultural GVA. The annual average growth rate in the Fisheries sector has been 6.93% over the last five years. [5]

13. The sector also supports livelihoods on a large scale. Approximately 28 million fishers and fish farmers are engaged at the primary level, with additional employment generated across harvesting, aquaculture, processing, marketing, transportation, and export-oriented value chains. In many coastal and inland regions, fisheries constitute the principal source of income and economic stability.[6]

14. The development and management of the fisheries sector are supported by the Department of Fisheries, which is responsible for policy formulation, implementation of development programs, and promotion of sustainable fisheries and aquaculture. The Department also facilitates infrastructure development, technological advancement, and data collection for effective planning and management of fisheries resources.

15. Overall, the fisheries sector represents a dynamic and growing component of India's blue economy, with significant potential for sustainable resource management and economic development.

1.4 Marine Fisheries Resources

16. India possesses extensive marine fishery resources, supported by a coastline of about 11,098 km and an Exclusive Economic Zone (EEZ) of

[6] https://www.dof.gov.in/static/uploads/2026/06/c591f3591c5923975e7f220bcbc093f0.pdf

approximately 2.02 million square kilometers. The country has an estimated marine fishery potential of around 7.16 million tonnes per annum[7].

17. Institutions such as ICAR–CMFRI and national statistical agencies classify marine fish species based on ecological and commercial characteristics and regularly compile species-wise marine fish landing statistics used for fisheries assessment and resource management in India[8].

18. India's total marine fish production was about 46.15 Lakh tonnes in 2024-25 Over the past years, marine fish production in the country has increased substantially, rising from about 34.43 lakh tonnes in the 2013-14, reflecting the expansion of marine fisheries over time[9].

19. During FY 2024-25, export of marine products stood at 1.70 MMT and valued at Rs. 62,408.45 Crores (USD: 7.45 billion) with an annual growth rate of about 3.11 % (in Quantity).[5]

1.5 Types of Marine Fish resources

20. From a biological perspective, marine fish species are categorized based on habitat, behavior, and ecological characteristics. Two major biological groups are commonly identified:

21. *Pelagic species* – These fish live in the upper layers of the ocean and often form large schools. Examples include sardines, mackerel, and anchovies. These species are typically fast-growing and form the bulk of marine capture fisheries.

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[7] Marine Fisheries Census 2016 - India. ICAR-Central Marine Fisheries Research Institute, Indian Council of Agricultural Research, Ministry of Agriculture and Farmers Welfare; Fishery Survey of India and Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India

[8] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2178659&reg=3&lang=2

[9] https://www.dof.gov.in/static/uploads/2026/05/ed7bc7e6cab04413cde70999596c9fe2.pdf

22. *Demersal species* – These species live near or on the seabed. Examples include perches, sciaenids, sharks, and ribbonfish. Demersal fish are usually caught using bottom trawling methods.

23. Another important category includes *diadromous species*, which migrate between freshwater and marine environments during different stages of their life cycle. For example, some species spawn in freshwater but grow in the sea, while others exhibit the opposite migration pattern.

24. Understanding these biological classifications is important for fisheries management and sustainable harvesting of fish stocks.[10]

1.6 Aquatic Resources in Accounting Frameworks

25. In environmental-economic accounting frameworks such as the System of Environmental-Economic Accounting (SEEA), aquatic resources are recognized as natural biological assets that generate economic benefits over time. Asset accounts are developed to systematically record the stock of these resources and the changes occurring within them during an accounting period. These accounts capture the opening stock, additions due to natural growth and recruitment, reductions resulting from harvesting and natural mortality, and the closing stock at the end of the period.

26. The primary objective of such accounting frameworks is to integrate environmental information with economic statistics. By recording both physical quantities and monetary values of aquatic resources, these accounts enable the assessment of sustainability in resource use as well as the economic contribution of fisheries. In practice, asset accounts generally focus on those resources that are subject to commercial exploitation, while also allowing comparisons between cultivated resources under aquaculture and naturally occurring fish stocks.

[10] Glossary , Fishery Survey of India : https://fsi.gov.in/glossary

27. In the context of national accounts, fisheries and aquaculture are treated as important economic activities within the production boundary of the economy. The sector generates gross value of output through the harvesting and cultivation of aquatic resources. These activities involve the use of labour, capital, and natural resources, thereby generating income in the form of wages, operating surplus, and mixed income.

28. Aquaculture, as a cultivated production activity, is treated in a manner similar to agriculture in national accounts, whereas capture fisheries are classified under primary production activities. Together, fisheries and aquaculture contribute to food supply, industrial inputs, and trade. The integration of environmental-economic accounting with national accounts provides a more comprehensive framework for evaluating both the economic contribution and the sustainability of aquatic resources, thereby supporting informed policy decisions.

SECTION II: Fish Resource Asset Accounts-SEEA Central Framework

2.1 Aquatic Resources in the SEEA Central Framework

29. The System of Environmental-Economic Accounting – Central Framework (SEEA-CF) provides a statistical framework for integrating environmental information with economic accounts. Within this framework, aquatic resources are classified into categories such as freshwater fishes, marine fishes, diadromous fishes, crustaceans, molluscs, aquatic mammals, other aquatic animals, aquatic products, and aquatic plants. This classification reflects the biological and ecological diversity of aquatic systems and provides a structured basis for the compilation and analysis of fisheries statistics.

30. Marine fish resources constitute an important provisioning ecosystem service generated by marine ecosystems. Oceans support continuous flows of food, nutrition, livelihoods and economic benefits through fisheries production, thereby linking marine ecosystem functioning with economic activity and human well-being.

31. Asset accounts for fish resources organize information on the stock of fish resources and the changes in these stocks within a country's economic territory, including marine areas within the Exclusive Economic Zone (EEZ) and inland water bodies. The SEEA framework emphasizes the measurement of both physical quantities and economic values of aquatic resources over time.

32. In practice, for Fish resource accounts it is feasible to focus on commercially exploited species, as reliable biological and economic data are more readily available for these resources.

2.2 Net Present Value Approach for Valuation of Fish Resources

33. Under the SEEA framework, natural resources are treated as economic assets capable of generating future streams of economic benefits over time. Since fish resources are renewable biological assets that provide continuing economic returns through harvesting and fisheries production, their monetary valuation is generally undertaken using the Net Present Value (NPV) approach. The NPV method estimates the economic value of a fish resource as the discounted present value of expected future resource rents generated from the stock over its expected asset life. Resource rent represents the surplus economic return attributable specifically to the fish resource after deducting all production-related costs and normal returns to produced capital used in fishing activities.

34. The NPV approach is particularly relevant for fish resources because the economic value of a fish stock depends not only on current production levels, but also on the expected future productive capacity of the resource. Fish stocks that remain within sustainable exploitation levels are capable of generating future economic benefits over longer time horizons and therefore generally exhibit comparatively higher economic asset values. In contrast, overexploited or depleted resources may experience reductions in future catches, resource rents and long-term productive potential, resulting in comparatively lower asset values.

35. Within environmental-economic accounting, the NPV framework enables integration of biological sustainability and economic valuation by linking stock condition, expected asset life and future economic returns. The approach therefore provides a mechanism for assessing fish resources not only as biological stocks, but also as economic assets contributing to marine resource wealth and long-term economic sustainability.

2.3 Structure of Monetary Asset Accounts for Fish Resources

36. The monetary asset account records the value of fish resources and the changes in their value over the accounting period. It includes opening stock, additions, reductions, revaluation, and closing stock. Opening stock represents the value of fish resources at the beginning of the period, while closing stock reflects their value at the end. Additions arise mainly from regeneration, when improvements in stock conditions lead to an increase in asset life and expected future benefits. Reductions occur due to depletion, which is reflected through a decline in asset life resulting from overexploitation or deterioration of fish stocks.

The monetary asset account is compiled using the identity:

$$Closing\ Stock = Opening\ Stock + Additions - Reductions + Revaluation$$

37. In this approach, depletion is captured through reductions in asset value when asset life declines, while no depletion is recorded if asset life remains unchanged, indicating sustainable use. Regeneration may be recorded when there is a clear improvement in stock conditions leading to an increase in asset life. Revaluation is treated as a balancing item to reconcile opening and closing stock values. The account is first prepared at the species level and then aggregated to obtain the total value of fish resources for integration into national accounts.

Table 2.1. Sample Structure of Monetary Asset Account for Fish Resources

Monetary Asset Account	SPECIES				
	Monetary value, Year 1	**Monetary value, Year 2**	**Monetary value, Year 3**	**Monetary value, Year 4**	**Monetary value, Year 5**

Opening stock					
-Additions					
-Regeneration					
Reductions					
-Depletion					
Revaluation					
Closing stock					

38. Following this, the Net Present Value (NPV) method is applied, where the annual resource rent is projected over the estimated asset life and discounted using suitable discount rate. This converts future economic benefits into present value terms, thereby providing the monetary value of fish resources in situ. The final step involves incorporating these values into a monetary asset account, which records the opening and closing stock values along with changes due to extraction, depletion, and revaluation.

39. The monetary asset account framework provides the accounting structure for integrating physical stock condition, asset life, depletion, regeneration and monetary valuation within the SEEA-based environmental-economic accounting system. The framework enables systematic recording of changes in marine fish resource wealth over time and forms the basis for species-wise monetary asset valuation presented in subsequent sections.

Section III: Methodological Steps for developing Fish Resource Accounting

3.1 OECD Framework and Valuation Approach

40. The *OECD 2025 Measuring Natural Resources in the National Accounts A Compilation Guide*[11] provides framework/guidance for measurement of fish resources within environmental-economic accounting distinguishes four broad compilation stages: (i) Delineation of species for assessment and valuation; (ii) collection of physical data on fish resources; (iii) assessment of sustainability status and estimation of asset life; and (iv) compilation of monetary asset accounts. First three compilation stages as provided in the OECD compilation guide and application in Indian scenario are discussed below and last step will be separately discussed in section IV:

Delineation of species for assessment:

41. According to the SEEA CF (§5.398) "The aquatic resources for a given country comprise those resources that are considered to live within the Exclusive Economic Zone (EEZ) of a country throughout their life cycles, in both coastal and inland fisheries. Migrating and straddling fish stocks are considered to belong to a country during the period when those stocks inhabit its EEZ."

42. In case of fish resources, the SNA stipulates: "Assets over which ownership rights have not, or cannot, be enforced, such as open seas or air, are excluded, unless exclusive right on the resources is established, for example in the form of quota regimes for capturing fish." (2025 SNA, §11.22).

43. Therefore, OECD suggest the following relations between the production and asset boundaries: Monetary output = catch by resident

[11] OECD%20report%20on%20valuation%20of%20natural%20resources.pdf

operators (+) Catch by non-resident in the national EEZ (-) Catch by resident operators in other countries EEZ (-) Non-commercial catch (e.g. subsistence fishing by resident and non-residents) = boundary for fish resource assets in national balance sheet (= commercial national EEZ catches + high sea catches by resident operators)

44. However, it is observed that this approach depends on the availability of data in individual countries. In the case of India, separate data for the above-mentioned variables are not available. Generally, data on fish landings or fish production are available. These data can be used, to a limited extent, for the compilation of accounts under both the System of National Accounts (SNA) and the System of Environmental-Economic Accounting (SEEA). Since the SEEA framework provides flexibility based on data availability, it is appropriate to proceed using the available data. This approach is also consistent with the SNA production boundary, as the national accounts in India likewise rely on fish landing data.

45. In SEEA-AFF (§3.156) contains an aggregated list of 12 major groups based on the International Standard Statistical Classification of Fishery Commodities. (ISSCFC): Freshwater fish; Diadromous fish; Demersal fish; Tuna, bonito, billfish; Other pelagic fish; Other marine fish; Crustaceans; Cephalopods; Other molluscs; Aquatic mammals; Other aquatic animals; Aquatic plants, algae. The SNA is exhaustive, implying that all assets with economic value within the asset boundary should be estimated. However, due to the resource-intensive nature of the valuation of fish resources, it is in the manual that to apply a materiality threshold and focus on the valuation of assets that contribute more than 5% of output and for which the long-term average contribution of Fishing to GDP is at least 0.1%. It is recommended to use the 12 major groups as a checklist to assess which fish resources are available in the country and would be above the threshold in terms of output.

46. In India, data on inland and marine fisheries, as well as fisheries-related research, are collected by different institutions. The Department of Fisheries serves as the nodal agency responsible for compiling and maintaining fisheries statistics and coordinating matters related to fishery resources. For the illustrative case presented in this concept paper, the analysis focuses on marine fisheries. Accordingly, the discussion in the following sections on the methodology, data sources, and data availability is confined to marine fish resources, as species-wise and more disaggregated data are more readily available for marine fisheries in India.

47. Further, in the Indian context, a review of the available marine fisheries data indicates that only a few species account for approximately more than 5% of the total marine fish output. Considering the wide diversity of marine species distributed across the east and west coasts of India, species may be selected based on their contribution to marine fish production, economic significance, export importance, and ecological relevance within India's marine fisheries sector for the study. Where adequate data and resources are available, a more detailed analysis can also be undertaken using species-wise and state-wise data.

Valuation Methods:

48. Regarding valuation methods, according to SEEA CF (§5.442), there are two main possibilities. One is to value the aquatic resource using the value of long-term fishing licences and quotas where realistic market values are available. The other is to base the value on the net present value of the resource rent of the aquatic resources.

49. In case of fishing license/quotas, under some circumstances the value of quota sales can be used to value the fish resource. Necessary conditions are that the right was required during an open competition or when it is transferable i.e. it may be sold to other economic agents. Further, some

fisheries are managed under a system of freely tradable individual fishing rights, individual transferable quotas (ITQs). Under the right circumstances, the trading prices for ITQs can reflect the asset value of a fishery. However, only a few fisheries are managed through ITQs, and thus such quota markets do not exist. Even when ITQs are used, the market may be "thin" or subject to other constraints that distort the quota price.

50. There are various types of quota (transferable, tradeable), for a limited number of years or in perpetuity. In case of quotas for a limited number of years, the value of the quota will not represent the total value of (that part of) the resource. However, the compiling economy would likely have a view on the value of its fish stock, if only to be able to negotiate fish quotas with foreign operators, for instance based on the resource rents captured by resident operators (under comparable circumstances). The actual payments would be recorded as rent (received from the rest of the world) in the national accounts. In case no information is available for estimating the fish asset (e.g. in case there is only fishing by non-resident operators), the rent payments can be used (through NPV) to estimate the value of the fish asset.

51. In most cases, however, the residual value method (RVM) would be applied to estimate asset values for fish resources as the NPV of future resource rent. On review of Indian scenario, it appears that India does not have ITQ system for marine fisheries, the license is not tradable and quotas are not present. Fishers obtain licenses from state fisheries departments, but these licenses are not traded in a competitive market. Therefore, the value of the any fish resources cannot be inferred from license prices. It is more feasible to use the NPV approach for estimating asset value.

3.2 Collection of Physical Data on Marine Fish Resources

52. In fisheries statistics, different concepts are used to describe fish production at various stages of harvesting[12] :

- *Gross removal*: The total live weight of fish caught or killed during fishing operations.
- *Gross catch*: The total live weight of fish caught after excluding pre-catch losses.
- *Retained catch*: The portion of the catch that is kept after removing discarded or unwanted catch.
- *Landings*: The net weight of fish that is actually brought ashore and recorded at landing centres.
- *Nominal catch*: The live weight equivalent of the landings.

53. Among these measures, landings are the most commonly used in practice as they are directly observable and closely linked to economic value. Therefore, landings are used as the primary indicator for analysis in this study.

54. For marine aquatic resources, In Indian context two major data sources are available:

- **Central Marine Fisheries Research Institute (CMFRI):** CMFRI maintains comprehensive data on marine fish landings on calendar year basis. It has adopted a robust and adaptive data collection and assessment system based on a two-stage stratified random sampling methodology. CMFRI reports are based on a nationwide

[12] United Nations et al. (2014), System of Environmental-Economic Accounting 2012 — CentralFramework, United Nations, https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf.

marine fisheries data collection programme covering all maritime states and union territories along the Indian coastline. The data collected from representative landing centres are expanded using statistical techniques to estimate total marine fish landings at the state and national levels.

- National-level data are available from 2004 onwards, while state-wise data are available from 2013 onwards. The database includes information for approximately 60-67 major species, along with a miscellaneous species category.
- **Department of Fisheries (DoF):** The Department of Fisheries maintains data on marine/ brackish water fisheries, including state-wise and coast-wise statistics. The primary source of these data is the information submitted by State Fisheries Departments and Union Territory Administrations. Data are available for around 67 species, along with one miscellaneous species category.

55. For the initial analysis, the primary dataset may be considered for estimating marine fish landing in India is the Marine Fish Landings Reports published by the ICAR–Central Marine Fisheries Research Institute (CMFRI)[13] keeping in view of longer landing time series data availability which is essential for assessment of sustainability of fish species. Later stage, with the collaboration with DOF and availability of longer time series data (at least 10 years) , data from DOF can be considered as it provides species wise State/UT wise data which may be more useful for presenting State/UT wise results.

[13] https://eprints.cmfri.org.in/4053/1/Special_Publn_86.pdf

3.3 Assessment of Fishery Status

56. After selection of species to be considered for the study and type of data, in this case landing data from CMFRI, the next step is to assess the sustainability status of individual fish stocks in order to estimate their expected asset life within the monetary asset accounting framework. International guidelines under the OECD compilation guide and SEEA framework recognise multiple approaches for assessing fish stock conditions depending upon the availability and quality of fisheries data.

57. The preferred approach is the use of formal stock assessment methods based on Maximum Sustainable Yield (MSY) estimates and biomass assessments. These approaches evaluate whether fishing pressure remains within biologically sustainable limits and whether spawning biomass levels are adequate to sustain long-term yields. However, such approaches require continuous biological surveys, biomass estimation, scientific stock modelling and long-term monitoring systems.

58. Another commonly used approach is Catch Per Unit Effort (CPUE), which evaluates stock pressure using standardised fishing effort information relative to catch levels. Declining catch relative to increasing fishing effort generally indicates stock depletion and rising exploitation pressure. However, CPUE-based approaches require standardised and continuous effort datasets, which are often unavailable uniformly across species and regions.

59. In situations where detailed stock assessments and standardised CPUE data are not available on a regular basis, sustainability status may be inferred using long-term landing time-series analysis. This approach uses historical landing patterns to assess stock condition by comparing current landings with historical maximum landings and long-term trends. The methodology has been widely adopted in fisheries resource accounting

studies, including applications under the World Bank Changing Wealth of Nations[14] framework, Inclusive Wealth studies and experimental environmental-economic accounting exercises. While applying this methodology, it may be noted that a time series of a given species, genus or family for which the first and last reported landings are at least 10 years apart, for which there are at least 5 years of consecutive catches/landings and for which the cumulative catch in the area under consideration is at least 1000 tonnes. Further in the methodology, required time series under consideration needs to be defines cautiously.

60. In the Indian context, comprehensive stock assessment (MSY estimates) and standardised CPUE datasets are not consistently available across all marine fish species on a long-term and regular basis. Though CMFRI has released a report “Marine Fish Stock Status of India 2022” which presented the status of major commercially important marine fishery resources using MSY method. However, this report does not cover all type of species and regular data availability is not known. Further, Fisheries survey of India has conducted study in 2020 on "Decadal observation on exploratory surveys of oceanic tuna and allied resources in the exclusive economic zones " in which CPUE results are provides for few species. In contrast, species-wise marine fish landing data are available continuously over long time periods at the national level through established fisheries statistical systems. Accordingly, the landing time-series method may be adopted as a practical proxy approach for determining the sustainability status of fish stocks and estimating asset life under existing Indian data conditions.

61. The landing-based approach provides national-level consistency, enables species-wise comparability across years, and remains operationally feasible within the available fisheries statistical framework. The

[14] Home | Sea Around Us

methodology is also consistent with proxy approaches recommended in international environmental-economic accounting literature where detailed biological stock assessment information is limited or unavailable.

62. The landing time-series method can be adopted as a proxy approach to determine the sustainability status of fish stocks and to estimate their asset life. However, in future, with collaboration with CMFRI/Fisheries Survey of India / Concerned department, efforts can be made to collect the data on status of fish stock through MSY method as it is more scientific methods than any other proxy method.

63. To classify the sustainability status of fish stocks, the landing data are interpreted using following standard criteria. These criteria are summarized in Table 3.1.

Table 3.1. Classification of Fishery Status Based on Landing Time-Series Data[15]

Fishery Status	**Criterion Applied**
Developing	The landing level is ≤ 50% of the maximum historical landing and the year of landing is before the year of maximum landing, or the maximum landing is equal to final year of landing
Exploited	The current landing is greater than 50% of the maximum historical landing.
Overexploited	The year of landing occurs after the year of maximum historical landing, and the current landing is between 10% and 50% of the maximum landing.

[15]https://documents1.worldbank.org/curated/en/099350006152239793/pdf/P1772780b3c6140a%2010b4950 65961f4328e5.pdf

Rebuilding (Recovering)	The year of landing is after the year of post-maximum minimum landing and the minimum landing after the maximum is less than 10% of the maximum, and the current landing is between 10% and 50% of the maximum landing.
Collapsed	The year of landing occurs after the maximum historical landing year, and the current landing is less than 10% of the maximum historical landing.

Source: https://www.seaaroundus.org/data/#/global/stock-status , Table 9 from https://documents1.worldbank.org/curated/en/099350006152239793/pdf/P1772780b3c6140a10b495065961f4328e5.pdf , https://www.seaaroundus.org/stock-status-plots-method/

64. As per the landing time series methodology, we may require all the available time series data to know the the peak catch for the time series. However, with the availability of updated data for any year, the status of stock may change accordingly. Hence, at this experimental stage, the stock status analysis may be undertaken based on species-wise landing time series data (10 years previous to the assessment year) compiled over time instead of whole time series data. The limitation of using the restricted time series, is that the developing fishery status category will not be applicable as the condition for developing category may not be true as the year of current landing is never before the year of maximum landing and final year of landing is not applicable for restricted time series.

65. By comparing current landings with the historical maximum and minimum levels, fish species can be categorized into different status viz. developing, exploited, collapsed, overexploited, Rebuilding etc. This classification is important for environmental-economic accounting because it provides an indication of the sustainability of fish resources and

determination of proxy asset life for the species. The steps involved in this methodology are summarized in Table 3.2.

Table 3.2. Step-by-Step Methodology for Landing Time-Series Analysis[16]

Step	**Methodological Step**	**Description**
Step 1	Selection of species for analysis	The CMFRI marine fish landing reports provide landing data for around **60-65** species groups. However, for the purpose of resource accounting, we may select either all species or specific species selected as per the study objective.
Step 2	Compilation of landing time-series data	Historical species-wise landing data are compiled from the CMFRI marine fish landing reports for the species. These reports provide annual estimates of marine fish landings based on nationwide sampling of landing centers.
Step 3	Identification of maximum historical landing	For each species, the maximum landing observed in the historical time series (10 years) is identified. This value serves as a benchmark for assessing the exploitation status of the fishery.
Step 4	Comparison with current landing levels	The current landing level is compared with the historical maximum landing to determine the relative exploitation level of the fish stock. The percentage of current landings relative to the maximum landing is calculated.

[16] A history and evaluation of catch-only stock assessment models - Ovando - 2022 - Fish and Fisheries - Wiley Online Library

Step 5		Classification of fishery status	Based on OECD guidelines, fisheries are classified into categories such as developing, exploited, overexploited, rebuilding, or collapsed, depending on criteria such as whether current landings are above 50% of the historical maximum or have declined significantly after the peak year.
Step 6		Assignment of asset life	Once the status of each species is determined, an appropriate asset life is assigned. In OCED guide, it is suggested that sustainably managed but exploited stocks may assigned longer asset lives (around 25 years), while overexploited or declining stocks are assigned shorter asset lives (around 10 years) to reflect greater depletion risk.
Step 7		Use in resource valuation	The estimated asset life values are used in the Net Present Value (NPV) method for calculating the monetary value of fish resources and estimating depletion in environmental-economic accounts.

66. Table 3.2 outlines the sequential procedure used to analyze fisheries landings and derive the status of fish stocks. The process begins with selecting the major species groups, followed by compiling historical landing data and identifying the maximum catch level. The comparison of current landings with the maximum landing helps determine whether a fishery is expanding, stable, or declining. Based on this analysis, each species is assigned a fishery status category, which forms the basis for determining the asset life used in economic valuation.

3.4 Estimation of Asset Life, Depletion and Regeneration

67. Once the fishery status is determined, asset life is assigned to each species. Asset life represents the expected period over which a fish stock can continue to generate economic benefits. In the manual, it is suggested that if it is not possible to estimate the asset life of each fish species, but it is known that the species is in scope of the asset boundary and is sustainably managed, a default asset life can be used. In this case, rather than using an infinite asset life, it is recommended to use a finite asset life of 25 years as the default in light of the critical state of most of the world's fisheries, unless compilers have better information about the expected asset life. In the Indian context, there is no such studies/research on the determination of expected asset life on the basis for status of stock. Hence, we may consider the asset life of 25 years for exploited category.

68. In addition, while assignment of asset life for overexploited and rebuilding resources, it is suggested to use fishery-specific information, sourced from a fisheries management authority when available. If that type of information is not available, an expert guess could be made of the asset life, with ten years used as the default asset life. Hence, at this experimental stage, we may consider asset life of 10 years for overexploited/rebuilding category and 5 years for collapsed category. Further, efforts will be made with association of CMFRI/FSI for assessment of asset life of species.

69. The fishery status of each species is assessed by comparing the current year landing with the maximum historical landing observed in the available time series. Species exhibiting relatively stable landings and remaining close to their historical maximum levels are classified under the "Exploited" category and are treated as sustainably managed, reflecting the continued renewable capacity of the fish stock. Accordingly, the assigned asset life for such species remains constant over time, indicating that the

resource is being utilized without reducing its long-term productive capacity. Under sustained management conditions, no depletion is recorded in the monetary accounts, as the productive capacity of the fish stock is considered to be maintained over time.[11]

70. For non-cultivated biological resources yielding once-only products, such as fish resources, the occurrence of depletion depends upon the manner in which the resource is managed. Fish resources are renewable biological assets capable of natural regeneration through growth and reproduction. Accordingly, where fish stocks are managed under sustainable exploitation conditions, no depletion may be recorded, as the productive capacity of the resource is maintained over time. Conversely, in situations of overexploitation or stock stress, management interventions such as reduction in fishing pressure, seasonal restrictions, or stock rebuilding measures may allow regeneration and recovery of fish resources over subsequent periods. The accounting treatment adopted in the present study therefore links depletion and regeneration directly with changes in stock condition and expected asset life.

71. In contrast, species showing substantial and persistent declines relative to their historical peak landings are classified as overexploited, rebuilding, or collapsed. For these categories, the remaining asset life is progressively reduced in subsequent accounting periods if the same stock condition persists, reflecting the decline in expected future economic benefits associated with stressed fish stock. This reduction in asset life is interpreted as depletion in the monetary accounts. Conversely, if the condition of a stock improves over time, resulting in an increase in asset life, the corresponding increase in future economic potential is treated as regeneration of the resource. However, Regeneration should only be recorded in case there is a clear indication, for instance as substantiated in a fishery management plan,

that the higher future yields are expected to be harvested. The estimated asset life is used in the valuation of fish resources. It determines the time horizon over which future benefits from fisheries are projected.

72. The estimated asset life values derived from the physical assessment framework are subsequently incorporated into the Net Present Value (NPV) methodology for estimating the monetary value of fish resources and recording depletion, regeneration and revaluation within the monetary asset accounts.

Section IV: Key steps in compilation of monetary account for fish resources

4.1 Monetary Valuation of Fish Resources

73. This section presents the key steps, terminology adopted for compilation of monetary valuation of fish resources based on the physical indicators derived in Section 3, Methodological guidance presented in OECD 2025 compilation guide and its application in Indian scenario. While physical indicators such as landings provide information on the status and sustainability of fish stocks, monetary valuation enables the estimation of the economic value associated with these resources.

74. There are eight steps involved in compilation of the monetary asset accounts:

- Calculation of resource rents
- Project the physical asset account and physical output until end of the asset life of the resource.
- Calculate the unit resource rent.
- Smooth unit resource rents to address price volatility.
- Project future resource rents.
- Calculate NPV for the opening stocks.
- Calculate NPV for the closing stocks.
- Put together the monetary asset account.

Details of the steps are discussed in section 4.5 of this concept paper and more details may be extracted from section 5.3 of compilation guide of OECD on "Measuring Natural Resources in the National Accounts"

4.2 Net Present Value (NPV)

75. The monetary value of fish resources is estimated as the present value of expected future resource rents over the asset life of each species. The NPV formula applied as

$$V_t = \sum_{\tau=1}^{T} \frac{RR_{t+\tau-1}}{(1 + r)^{\tau}}$$

where:

- n= asset life
- r= discount rate
- V_t = opening stock value at time t
- RR_t = resource rent generated during year t

This method converts future streams of benefits into present value terms, enabling their inclusion in the national balance sheet.

4.3 Concept of Resource Rent

76. Resource rent, as defined under the System of National Accounts (SNA) and the SEEA Central Framework, represents the economic surplus attributable specifically to a natural resource after accounting for all production costs, including labour and produced capital, and therefore captures the true economic value generated by the resource itself rather than by human or capital inputs. In fisheries, it reflects the net economic benefit derived from harvesting fish stocks and is essential because conventional national accounts such as Gross Value Added (GVA) do not distinguish

between returns to fishing capital and returns to the natural fish resource, thereby masking depletion of natural wealth even when fisheries output remains high. Resource rent provides the basis for valuing fish stocks as natural assets through the Net Present Value (NPV) method and serves as an important indicator of sustainability. Positive and rising resource rents suggest that fish stocks are generating sustained economic surplus, while declining or negative resource rents may indicate overfishing, stock depletion, rising extraction costs, or economic stress within the fishery sector. In the context of India's marine fisheries, tracking resource rent is therefore critical for assessing whether fisheries are generating genuine long-term wealth or progressively depleting the country's natural capital base.

77. Resource rent represents the economic return derived from the exploitation of fish resources after accounting for all production costs, including labour, intermediate consumption, taxes on production, subsidies, and the cost of produced capital.

78. The estimation of resource rent begins with a residual approach, using gross value of output to represent the total revenue generated from fisheries activities. Intermediate consumption is deducted to account for production-related expenses, followed by compensation of employees and taxes less subsidies to isolate the surplus beyond labor contribution. Taxes less subsidies are deducted to account for net production-related fiscal obligations associated with fisheries activities. Consumption of fixed capital is then deducted to account for depreciation of fishing assets such as vessels and gear. A normal return to fixed capital is further deducted, and the remaining amount represents the resource rent attributable to the fish resource. Following Statement provides the simplify version of resource rent calculation:

- ***Resource Rent = Gross operating surplus (GOS) - User cost of capital***

- ***Gross operating surplus (GOS) = Output at basic prices- Operating costs (Intermediate consumption +Remuneration of employees + Other taxes less subsidies on production) – specific taxes less Specific subsidies***
- ***User cost of capital =Depreciation + Return to capital used in production(excl. natural resources)***

79. The rate of return to capital used in production (excl. natural resources) in practical terms rather consist of the "rate of return to fixed capital". To calculate the return to capital (excluding natural resources), we need the net stock of fixed assets and choose a suitable rate of return. The chosen rate of return is then multiplied by the net stock of fixed assets. International guidelines under the SEEA framework and OECD discuss different approaches for estimating the rate of return to fixed capital, including the activity-specific approach, economy-wide approach, "everything but" approach, and approaches based on financing costs. Among these, the activity-specific rate of return is the preferred option. However, data on this indicator are not available in many countries. In India, an activity-specific rate of return is not available. Instead, the Reserve Bank of India (RBI) publishes occupation-based rates of return, which may not be appropriate for estimating the return to capital in the fisheries sector. Therefore, the use of these occupation-based rates may not adequately reflect the characteristics of the fishing activity.

80. Next preferred approach is the "everything but" approach [17] as it excludes natural resource extraction activities while estimating the normal

[17] https://www.oecd.org/en/publications/measuring-natural-resources-in-the-national-accounts_420c7c2a-en/full-report/valuation-of-natural-resources_ba221

return to produced capital. The rate of return is obtained by dividing the net operating surplus of all economic activities minus the activities of the natural resources industry and minus the net operating surplus of non-market production, by the net fixed assets of the same set of activities and sectors. It is recommended to use following scope of activities and sectors under natural resources and non-market production activities: ISIC A (Agriculture, Forestry and Fishing), minus B (Mining and Quarrying), minus D3512 (Electric power generation activities from renewable sources), minus S121 (Central bank), S13 (General government) and S15 (Non-profit institutions serving households). For the study purpose, "everything but" approach can be adopted to approximate the normal return to fixed capital. This helps ensure a clearer separation between returns attributable to produced capital and those attributable to fish stock resources.

81. Under this approach, the rate of return is estimated using Net Operating Surplus and net fixed assets after excluding natural resource industries and non-market government activities. Accordingly, Agriculture, Forestry and Fishing; Mining and Quarrying; and general government and related administrative activities are excluded from the estimation framework. It is noted that disaggregated National Accounts Statistics data for specific institutional sectors viz. D3512 (Electric power generation activities from renewable sources), S121 (Central bank), and S15 (Non-profit institutions serving households) recommended under the OECD framework are not separately available. Accordingly, broader sectoral aggregates relating to Electricity, Gas, Water Supply and Other Utility Services, Non-profit institutions and Financial Services are retained within the estimation framework.

82. The data relating to gross value of output, intermediate consumption, compensation of employees, taxes and subsidies on production, consumption

of fixed capital, and return to fixed capital are available at the aggregate fisheries sector level from the National Accounts Statistics (NAS).

83. For compiling species level monetary account, calculating resource rent for each species is the most appropriate approach which is compiled using species-specific data for each indicator. In practical applications, species wise data points required to calculate resource rent are often not available. Therefore, resource rent is approximated using the species contribution to total output.

84. For determining contribution of species, the best possible way is to estimate species wise share in monetary terms. Currently, comprehensive and uniform price data for individual marine fish species are not available across the country. Although the National Fisheries Development Board (NFDB) collects state-wise, species-wise fish price data, the information is classified into three broad size categories—small, medium, and large. Fish price information of 138 fish species (95 Marine fishes and 43 inland fishes) are presently captured. The species group indicated in CMFRI dataset and species indicated in the price statistics dashboard by NFDB are different. There is need to set concordance between species nomenclature used by NFDB and CMFI/DOF. Further, there is also considerable variation in species prices across states, making it difficult to derive representative national average prices for each species.

85. Accordingly, under the present data scenario, it is appropriate to use the species share in total landings (volume terms) as the basis for allocating values. The Central Marine Fisheries Research Institute (CMFRI) also provides landing-center-wise price data for selected marine species. However, these data are not comprehensive and do not fully meet the requirements for estimating species-specific monetary shares.

86. As an advancement, efforts may be undertaken in collaboration with the NFDB and CMFRI to broaden the scope and coverage of species-wise price data collection, thereby facilitating more robust and accurate estimation of species-specific economic values in line with the requirements of the SEEA framework.

87. Since separate share of marine species in monetary terms in overall marine sector is not available, the marine species contribution for each year can be estimated using the share of marine species in total marine fisheries landing. Subsequently, species-wise resource rent is derived by allocating the marine fisheries resource rent across species groups based on their contribution to total marine fish landings. This enables the estimation of resource rent for individual marine fish species included in the study.

4.4 Choice of Discount Rate

88. The last part of the NPV calculation involves discounting to convert future resource rents (flows) into a current period estimate of value (stock). The choice of a particular discount rate has a major impact on estimates of natural resources value and some impact on estimates of depletion of (relevant) natural resources. The role of discounting in creating a current period estimate of asset values reflects the finding (e.g. from behavioral economics) that people put a lower value on income they expect to receive in the future than on income they receive now. The further into the future the income will be received, the lower its perceived value in the current period. However, peoples' perceptions of the value of something in the future differ depending on their views of the importance of the asset being valued as well as factors such as whether they are naturally risk averse or risk takers, their consumption patterns and inflation.

89. A high discount rate will imply that resource rents in future years will not contribute much to the current asset value; therefore, the use of higher discount rates will produce lower estimates of the asset value. The selection of the discount rate is guided by international recommendations developed by the Expert Group on National Accounts (EGNC). The current compilation approach follows these recommendations.

90. A key consideration in selecting the discount rate is whether it should reflect market-related risks or represent a risk-free rate. It is recommended that market-related risks be captured through the rate of return to capital rather than through the discount rate used for valuing natural resource assets.

91. To ensure comparability of results across countries, a common and stable discount rate is preferred. The EGNC recommends the use of a 2 % real discount rate as a standard benchmark for natural resource valuation. This rate is based on long-term government bond yields, which are considered to represent a risk-free rate. It also reflects the long-term nature of natural resource assets and aligns with international practices in environmental-economic accounting.

92. Countries may choose to apply alternative discount rates depending on national circumstances. In practice, this can be implemented easily by adjusting the discount rate parameter in the valuation model.

4.5 Compilation of Monetary asset account

Step 1: Calculation of resource rent

93. Following tables provides the indicators for calculation of resource rent. In Indian context, the data on OS/MI is available in the NAS for fishing and aquaculture Economic Activity (statement no. 7.1 Output, value added, CE, OS/MI, by industry). This OS/MI data from NAS provides the value of Gross

operating surplus (sr no. 15 of below table) less Depreciation (sr. no. 17 of below table). For calculating return to fixed capital (sr no. 18), Data on rate of return, under "Everything But" approach, can be calculated using data from National Account Statistics on Net Operating Surplus (Statement 7.1: Output, Value Added, CE, OS/MI by industry) and net fixed assets (Statement 7.4: Net Fixed Capital Stock by Industry of Use (as on 31st March). The value of fixed asset data may be extracted from NAS for fishing and aquaculture Economic Activity (data on NFCS from Statement 7.4: Net Fixed Capital Stock by Industry of Use (as on 31st March).

Table 4.1. Calculation for Resource Rent

Sr no.	Variables (in ₹ crores)	(Year)
1	**Output (sales of gross catch/harvest at producer prices)**	
2	Less Taxes on products	
3	Plus Subsidies on products	
4	Equals Output (at basic prices)	= (1)-(2) +(3)
5	**Less Operating costs specifically:**	=(6) +(7)+(8)-(9)
6	Less Intermediate consumption (input costs of goods and services at purchasers' prices)	-
7	Less Remuneration of employees (input costs for labour)	
8	Less Other taxes on production	
9	Plus Other subsidies on production	

10	**Equals Gross operating surplus (GOS) and gross mixed income (GMI)**	=(4)-(5)
11	Less Specific subsidies on products	
12	Plus Specific taxes on products	
13	Less Specific other subsidies on production	
14	Plus Specific other taxes on production	
15	**Equals GOS and GMI for the derivation of resource rent**	=(10)-(11)+(12)-(13)+(14)
16	Less User costs of capital, specifically:	=(17)+(18)
17	Less Consumption of fixed capital (depreciation)	
18	Less Return to fixed capital (rate of return* Value of fixed assets)	
19	Equals Resource rent	=(15)-(16)

94. The estimation process of resource rent is based on data from the National Accounts Statistics[18] at current prices , published by Ministry of Statistics and Programme Implementation (MoSPI) which provide key variables such as gross value of output, intermediate consumption, compensation of employees, and consumption of fixed capital for the fisheries sector and rate of return is calculated using everything but approach as discussed above. The data sources are already mentioned in para above.

Step 2: Project the physical asset account and physical output until end of the asset life of the resource

[18] https://www.mospi.gov.in/publications-reports/innerpage/432

95. At Stage 2, project the physical over the estimated asset life using the landing data figures and the estimated asset life derived from the landing time-series data, as discussed in Section 3. Assume that the landing remains constant throughout the asset life.

96. Specifically, for a given time period '*t*', use the physical output (landing) from period '*t-1*' as the baseline and assume that this output remains unchanged over the estimated asset life corresponding to period *t* for the respective species.

97. For example, consider the Hilsa shad species. If the estimated asset life for 2019 is 10 years, use the landing data for 2018 as the baseline output and assume that this level of output remains constant from 2019 through the end of the asset life i.e. till 2028.

Step 3: calculate unit resource rent

98. The unit resource rent is the resource rent (from Step 1) for a species divided by the landing during the same accounting period. It can be considered a price measure. To build monetary asset accounts of year '*t*', OECD (2025) recommends using anywhere between 3-10 years resource rents for smoothing. For initial illustrative purpose for understanding the steps, we can choose three years, resource rents for each of the three years preceding the accounting years *(t-3, t-2, t-1*) are taken. Unit resource rents are then computed for each of these three years by dividing resource rent by output (landing data) in each year

Step 4: Smooth unit resource rents to address price volatility

99. Since resource rents are assumed to accrue at the midpoint of the accounting period, unit resource rents reflect mid-period average price levels. To address price volatility, unit resource rents then smoothed over the past

three years after rebasing them to prices of the current accounting year 't' using WPI price index data for marine fish. The average of these three rebased unit resource rents gives the smoothed unit resource rent for year 't', assumed to remain constant over all future projection periods in the absence of specific policy changes.

Step5: Project future resource rent

100. Multiply the smoothed unit resource rent estimated in **Step 4** by the projected physical production (i.e., projected landing) for each year over the estimated asset life. This yields the projected annual resource rent associated with the fish resource. The resulting stream of future resource rents needs to be then discounted to its present value using year-specific discount factors derived from a real discount rate. For the present analysis, a 2% real discount rate is recommended for the valuation of fishery resources and the estimation of resource depletion.

101. The opening stock say for year 't' is valued at the beginning of the accounting period (i.e., the start of year 't') and Resource rents are assumed to accrue, on average, at the midpoint of each accounting period, reflecting the fact that harvesting activities occur throughout the year rather than at a single point in time. Accordingly, a half-year adjustment is applied to the discount factor for the first year.

102. The discount factor for period 't' is therefore: $(1+r/2)$ where r denotes the discount rate.

For subsequent periods, the discount factors are:

Period $t + 1$: $(1 + r/2) \times (1 + r)$

Period $t + 2$: $(1 + r/2) \times (1 + r)^2$

In general, for period $t + n$, the discount factor is:

$$(1 + r/2) \times (1 + r)^n$$

where *n* is the number of years after the beginning of the accounting period. Applying these discount factors to the projected annual resource rents provides the present value of the future resource rent stream, which forms the basis for estimating the opening value of the fishery asset.

Step 6: Calculate NPV for the opening stocks

103. The opening stock value for the accounting period (i.e., year '*t*') can now be obtained by discounting the projected future resource rents over the estimated asset life to their present value. Specifically, multiply the projected resource rent for each future year by its corresponding discount factor and then sum the discounted values over the entire projection period. The resulting total represents the opening stock value of the fishery asset at the beginning of year '*t*'.

Step 7: Estimate the Net Present Value (NPV) of the Closing Stock

104. The closing stock value for period '*t*' is estimated by applying the same NPV approach used for the opening stock. However, the valuation is carried out at the end of the accounting period using the projected value of future resource rents from year '*t + 1*' onwards, discounted to the end of period *t*.

105. To estimate the closing stock value for accounting year '*t*', it is necessary to repeat Steps 1–6 using the updated information that is now available for year '*t*'. This enables the estimation of the opening stock value for year '*t + 1*', which, by definition, is equal to the closing stock value for year '*t*'.

106. By year 't', observed data are available for both physical output (landing data) and the user cost of fixed assets. Using these updated data, resource rent and unit resource rent are re-estimated in mid-year prices of period t. As in the previous estimation, the monetary series is smoothed using observations from years '$t-3$', '$t-2$', '$t-1$' and 't', with all values expressed in the price level of the base year ('t').

107. Following the smoothing procedure, remaining steps are repeated to estimate the opening stock value for year 't + '1. This value is, by accounting identity, the closing stock value for year 't'. The opening stock value for year 't' is not recalculated at this stage; instead, it is carried forward from Step 6. This treatment is consistent with the forward-looking (ex ante) valuation approach used in asset accounts, where opening and closing stock values are linked through successive accounting periods to describe changes in the value of the asset over time.

108. The key difference between Step 6 and Step 7 lies in the information used for the valuation:

- Step 6 estimates the opening stock value for year t using monetary data from years '$t-3$', '$t-2$' and '$t-1$'. The projected physical production is based on the observed landing data for year '$t-1$', which is assumed to remain constant from year ''t until the end of the estimated asset life for that period.
- Step 7 estimates the opening stock value for year '$t+1$' (equivalent to the closing stock value for year 't') using the updated monetary data from years '$t-3$' through 't'. The observed landing data for year 't' are taken as the baseline physical output and are assumed to remain constant from year '$t+1$' until the end of the estimated asset life corresponding to year '$t+1$'.
- In both steps, the monetary data are smoothed using the same four-year moving average approach, with all values expressed in the prices of

the base year ('*t*'), ensuring consistency in the valuation of the fishery asset across accounting periods.

109. Need to repeat Steps 1-7 for compiling asset account for year 't+1' and onwards.

Step 8: Put together the monetary asset account

110. We now have the NPV of each species of fish resources at the start of the accounting period and end of the accounting period. It is important to realize that these NPV estimates represent the value of the assets in current prices. The approach to estimate the cost of depletion differs from the method applied for the other resources as we do not have a physical asset account. The cost of depletion for year '*t*' is calculated by dividing the NPV for opening(*t*) and closing stocks (*t*) by the corresponding asset life and taking the average.

111. If the asset life remains equal (indicating sustainable management), no depletion or regeneration cost should be recorded. If the asset life is increasing, a value for regeneration should be recorded in the monetary asset account, and this is calculated in the same way as the cost of depletion. Regeneration should only be recorded in case there is a clear indication, for instance as substantiated in a fishery management plan, that the higher future yields are expected to be harvested. It should be noted that although regeneration may be recorded in the monetary asset account, in the production and generation of income account it would be recorded as negative depletion.

Section V: Study Limitations and Way Forward

112. The present methodological approach suggested is experimental in nature and is based primarily on proxy approaches necessitated by existing data limitations within the marine fisheries sector. The sustainability assessment and estimation of asset life suggested in the paper rely largely on landing time-series analysis due to the limited availability of continuous species-wise biological stock assessments and standardized Catch Per Unit Effort (CPUE) datasets across all marine fish resources. Similarly, due to limited data availability, the estimation of species-wise resource rent is suggested to derive using physical volume wise share in the absence of detailed species-level Monetary share. Further, fish landing data is available on a calendar-year basis from CMFRI, whereas the economic indicators are available on a financial-year basis. The overall approach presented in this study is based on current understanding and the availability of the data. This approach may be further refined as the methodological understanding evolves and through the verification and reconciliation of results with additional data sources, wherever available.

113. The methodological approach for compilation of monetary asset estimates presented in the study should therefore be interpreted as indicative estimates developed within the current data and methodological framework. Future improvements in fisheries resource accounting may involve integration of scientific biomass assessments, species-wise economic cost structures, ecosystem-based indicators, geospatial fishery information systems, and regular stock monitoring frameworks. Strengthening fisheries statistics and institutional coordination between statistical agencies, fisheries research institutions, and marine resource management authorities would further improve the robustness, comparability, and policy relevance of marine fish resource accounts within India’s environmental-economic accounting system.

114. The study demonstrates integration of physical stock assessment with monetary valuation which provides a systematic framework for evaluating marine fish resources as both biological resources and economic assets.

115. The methodological approach for developing monetary asset accounts in this study demonstrate the usefulness of SEEA-based accounting in linking the fisheries economy with natural capital valuation, resource sustainability assessment, and policy evaluation. By capturing changes in fish stock value over time - including additions through regeneration, reductions through depletion, and adjustments through revaluation. The accounts provide an economic perspective to fisheries resource assessment that goes beyond conventional production measures. The framework can support evidence-based fisheries management, policy formulation, and long-term monitoring of marine fishery resources, and provides a replicable methodology for institutionalizing fish stock accounts within India's environmental-economic accounting system.

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