Product Environmental Footprint Category Rules (PEFCR) for Unprocessed Marine Fish Products

2025

PEFCR
Unprocessed
Marine Fish Products

Version 1

2025

Date of expiration: December 31, 2025

Acknowledgements

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[1] https://www.fhf.no/fhf/about-fhf-english/

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Acronyms

AF	Allocation Factor
AR	Allocation Ratio
B2B	Business to Business
B2C	Business to Consumer
BFCR	Biological Feed Conversion Ratio
BoC	Bill of Components
BoM	Bill of Materials
CF	Characterization Factor
CFF	Circular Footprint Formula
CFF-M	Circular Footprint Formula – Modular form
COD	Chemical Oxygen Demand
CPA	Classification of Products by Activity
DC	Distribution Centre
DMI	Dry Matter Intake
DNM	Data Needs Matrix
DQA	Data Quality Assessment
DQR	Data Quality Rating
DQS	Data Quality Score
DW	Dry weight
EA	Economic Allocation
EC	European Commission
EF	Environmental Footprint
EF3.1	Environmental Footprint database version 3.1
EFCR	Economic Feed Conversion Ratio
EI	Environmental Impact
ELCD	European reference Life Cycle Database
EoL	End-of-Life
FEFAC	European Feed Manufacturers' Federation
FU	Functional Unit
GE	Gross Energy intake
GHG	Greenhouse Gas
GR	Geographical Representativeness
GWP	Global Warming Potential
GWP100	Global Warming Potentials with a time horizon of 100 years
Ha	Hectare
HH	Human Health (used in ionizing radiation HH)
ILCD	International Reference Life Cycle Data System
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
JRC	Joint Research Centre
kWh	kilowatt hour
LCA	Life Cycle Assessment
LCDN	Life Cycle Data Network
LCI	Life Cycle Inventory

LCIA	Life Cycle Impact Assessment
LT	Lifetime
LUC	Land Use Change
Lw	Live weight
Lwe	Live weight equivalents
NACE	Statistical classification of economic activities in the European Community
NDA	Non-Disclosure Agreement
NGO	Non-Governmental Organisation
NMVOC	Non-methane volatile compounds
NPK	Nitrogen (N), Phosphorus (P) and Potassium (K)
OEF	Organisation Environmental Footprint
OW	One Way
P	Precision
PCR	Product Category Rules
PDO	Protected Designation of Origin
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
PEF-RP	Product Environmental Footprint study of the Representative Products
ReCiPe	ReCiPe 2016 v1, A harmonized LCA method[2]
RER	Region Europe
RF	Reference Flow
RP	Representative Product
RUaEP	Resource Use and Emissions Profile
SC	Steering Committee
Scope 1	Referring to the GHG Protocol nomenclature, direct emissions from owned or controlled sources.
Scope 2	Referring to the GHG Protocol nomenclature, indirect emissions from the generation of purchased energy.
Scope 3	Referring to the GHG Protocol nomenclature, all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.
SMRS	Sustainability Measurement & Reporting System
TAB	Technical Advisory Board
TeR	Technological Representativeness
TiR	Time Representativeness
Tonne	1000 kg
TS	Technical Secretariat
UNEP	United Nations Environment Programme
UUID	Universally Unique Identifier
WW	Wet weight

[2] https://www.rivm.nl/documenten/recipe2016v11

Definitions

The PEF Method [1] provides a complete list of definitions, and the most relevant ones for this PEFCR are also presented here.

Activity data - This term refers to information which is associated with processes while modelling Life Cycle Inventories (LCI). The aggregated LCI results of the process chains that represent the activities of a process are each multiplied by the corresponding activity data[3] and then combined to derive the environmental footprint associated with that process. Examples of activity data include quantity of kilowatt-hours of electricity used, quantity of fuel used, output of a process (e.g. waste), number of hours equipment is operated, distance travelled, floor area of a building, etc. Synonym of "non-elementary flow".

Additional environmental information – Environmental information outside the EF impact categories that is calculated and communicated alongside PEF results.

Additional technical information – Non-environmental information that is calculated and communicated alongside PEF results.

Allocation – An approach to solving multi-functionality problems. It refers to "partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems" (ISO 14040:2006).

Attributional – Refers to process-based modelling intended to provide a static representation of average conditions, excluding market-mediated effects.

Average Data – Refers to a production-weighted average of specific data.

Benchmark – A standard or point of reference against which any comparison may be made. In the context of PEF, the term 'benchmark' refers to the average environmental performance of the representative product sold in the EU market.

Bill of materials – A bill of materials or product structure (sometimes bill of material, BOM or associated list) is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture the product in scope of the PEF study. In some sectors it is equivalent to the bill of components.

By-catch - The catch of aquatic organisms that are not targeted. This includes organisms that are outside legal-size limits, over-quotas, threatened, endangered and protected species, and discarded for whatever other reasons, as well as nontargeted organisms that are retained and then sold or consumed[4].

Company-specific data – It refers to directly measured or collected data from one or multiple facilities (site-specific data) that are representative for the activities of the

[3] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World Resources Institute, 2011).
[4] http://www.fao.org/documents/card/en/c/CA2905EN/

company. It is synonymous to “primary data”. To determine the level of representativeness a sampling procedure may be applied.

Comparative Assertion – An environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function (including the benchmark of the product category) (adapted from ISO 14044:2006).

Comparison – A comparison, not including a comparative assertion, (graphic or otherwise) of two or more products based on the results of a PEF study and supporting PEFCRs.

Co-product – Any of two or more products resulting from the same unit process or product system (ISO 14040:2006).

Cradle to Gate – A partial product supply chain, from the extraction of raw materials (cradle) up to the manufacturer’s “gate”. The distribution, storage, use stage and end of life stages of the supply chain are omitted.

Cradle to Grave – A product’s life cycle that includes raw material extraction, processing, distribution, storage, use, and disposal or recycling stages. All relevant inputs and outputs are considered for all of the stages of the life cycle.

Data Quality – Characteristics of data that relate to their ability to satisfy stated requirements (ISO 14040:2006). Data quality covers various aspects, such as technological, geographical and time-related representativeness, as well as completeness and precision of the inventory data.

Data Quality Rating (DQR) - Semi-quantitative assessment of the quality criteria of a dataset based on Technological representativeness, Geographical representativeness, Time-related representativeness, and Precision. The data quality shall be considered as the quality of the dataset as documented.

Direct elementary flows (also named elementary flows) – All output emissions and input resource use that arise directly in the context of a process. Examples are emissions from a chemical process, or fugitive emissions from a boiler directly onsite.

Direct land use change (dLUC) – The transformation from one land use type into another, which takes place in a unique land area and does not lead to a change in another system.

Elementary flows – In the life cycle inventory, elementary flows include “material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation” (ISO 14040, 3.12). Elementary flows include, for example, resources taken from nature or emissions into air, water, soil that are directly linked to the characterisation factors of the EF impact categories.

Environmental aspect – Element of an organisation's activities or products or services that interacts or can interact with the environment (ISO 14001:2015).

Environmental Footprint (EF) compliant dataset – Dataset developed in compliance with the EF requirements provided at https://eplca.jrc.ec.europa.eu/LCDN/developerEF.html

Environmental Footprint (EF) Impact Assessment – Phase of the PEF analysis aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product (based on ISO 14044:2006). The impact assessment methods provide impact characterisation factors for elementary flows in order to aggregate the impact to obtain a limited number of midpoint indicators.

Environmental Footprint (EF) Impact Assessment method – Protocol for quantitative translation of life cycle inventory data into contributions to an environmental impact of concern.

Environmental Footprint (EF) Impact Category – Class of resource use or environmental impact to which the life cycle inventory data are related.

Foreground elementary flows - Direct elementary flows (emissions and resources) for which access to primary data (or company-specific information) is available.

Foreground Processes – Refer to those processes in the product life cycle for which direct access to information is available. For example, the producer's site and other processes operated by the producer or its contractors (e.g. goods transport, head-office services, etc.) belong to the foreground processes.

Functional unit – The functional unit defines the qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated. The functional unit definition answers the questions "what?", "how much?", "how well?", and "for how long?".

Gate to Gate – A partial product supply chain that includes only the processes carried out on a product within a specific organisation or site.

Gate to Grave – A partial product supply chain that includes only the distribution, storage, use, and disposal or recycling stages.

Hotspot analysis – Once the user of the PEF method ensures that the PEF model is robust and conforms to all aspects defined in the goal and scope definition phases, the main contributing elements to the PEF results shall be identified. See paragraph 6.1 in ref. [1]
Indirect land use change (iLUC) – It occurs when a demand for a certain land use leads to changes, outside the system boundary, i.e. in other land use types. These indirect effects may be mainly assessed by means of economic modelling of the demand for land or by modelling the relocation of activities on a global scale.

Input flows – Product, material or energy flow that enters a unit process. Products and materials include raw materials, intermediate products and co-products (ISO 14040:2006).

Life cycle Assessment (LCA) – Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle (ISO 14040:2006).

Life cycle impact assessment (LCIA) – Phase of life cycle assessment that aims at understanding and evaluating the magnitude and significance of the potential environmental impacts for a system throughout the life cycle (ISO 14040:2006). The LCIA methods used provide impact characterisation factors for elementary flows to in order to aggregate the impact to obtain a limited number of midpoint and/or damage indicators.

Live weight (Lw) and live weight equivalents (Lwe) - Used to specify the weight of fish before it is killed. For farmed fish this also indicates the weight before starving and bleeding.

PEFCR supporting study – PEF study based on a draft PEFCR. It is used to confirm the decisions taken in the draft PEFCR before the final PEFCR is released.

PEF report – Document that summarises the results of the PEF study.

PEF study of the representative product (PEF-RP) – PEF study carried out on the representative product(s) and intended to identify the most relevant life cycle stages, processes, elementary flows, impact categories and any other major requirements needed for the definition of the benchmark for the product category/ sub-categories in scope of the PEFCR.

PEF study – Term used to identify the totality of actions needed to calculate the PEF results. It includes the modelling, the data collection, and the analysis of the results. It excludes the PEF report and the verification of the PEF study and report.

Prepared fishery products (Unprocessed fishery products) - Products that have not undergone processing, including products that have been divided, parted, severed, sliced, boned, minced, skinned, ground, cut, cleaned, trimmed, milled, chilled, frozen, deep-frozen or thawed.

Primary data[5] - This term refers to data from specific processes within the supply chain of the user of the PEF Method or user of the PEFCR. Such data may take the form of activity data, or foreground elementary flows (life cycle inventory). Primary data are site-specific, company-specific (if multiple sites for the same product) or supply chain specific. Primary data may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, material/product balances, stoichiometry, or other methods for obtaining data from specific processes in the value chain of the user of the PEF Method or user of the PEFCR. In this method, primary data can be a synonym of "company-specific data" or "supply-chain specific data".

[5] Based on GHG protocol Scope 3 definition from the Corporate Accounting and Reporting Standard (World Resources Institute, 2011).

Processed fishery products – Products that have undergone a process that substantially alters the initial product, including heating, smoking, curing, maturing, drying, marinating, extraction, extrusion or a combination of those processes.

Product Category Rules (PCRs) – Set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories (ISO 14025:2006).

Product Environmental Footprint Category Rules (PEFCRs) – Product category specific, life cycle-based rules that complement general methodological guidance for PEF studies by providing further specification at the level of a specific product category. PEFCRs help to shift the focus of the PEF study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility, and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the PEF method. Only the PEFCRs listed on the European Commission website (http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm) are recognised as in line with this method.

Product flow – Products entering from or leaving to another product system (ISO 14040:2006).

Reference flow – Measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit (based on ISO 14040:2006).

Representative product (model) - The RP may be a real or a virtual (non-existing) product. The virtual product should be calculated based on average European market sales- weighted characteristics of all existing technologies/materials covered by the product category or sub-category. Other weighting sets may be used, if justified, for example weighted average based on mass (ton of material) or weighted average based on product units (pieces).

Round fish - For wild fish this is identical to “live fish”, but for certain aquaculture systems the term “round weight” refers to the biomass after starving and bleeding.

Secondary data[6] - It refers to data not from a specific process within the supply-chain of the company performing a PEF study. This refers to data that is not directly collected, measured, or estimated by the company, but sourced from a third party LCI database or other sources. Secondary data includes industry average data (e.g., from published production data, government statistics, and industry associations), literature studies, engineering studies and patents, and may also be based on financial data, and contain proxy data, and other generic data. Primary data that go through a horizontal aggregation step are considered as secondary data.

Specific Data – Refers to directly measured or collected data representative of activities at a specific facility or set of facilities. Synonymous with “primary data.”

[6] Based on GHG protocol Scope 3 definition from the Corporate Accounting and Reporting Standard (World Resources Institute, 2011).

System boundary – Definition of aspects included or excluded from the study. For example, for a “cradle-to-grave” EF analysis, the system boundary includes all activities from the extraction of raw materials through the processing, distribution, storage, use, and disposal or recycling stages.

Unit process – Smallest element considered in the LCI for which input and output data are quantified (based on ISO 14040:2006).

Unprocessed fishery products = Prepared fishery products - Products that have not undergone processing, and includes products that have been divided, parted, severed, sliced, boned, minced, skinned, ground, cut, cleaned, trimmed, husked, milled, chilled, frozen, deep-frozen or thawed.

User of the PEFCR – a stakeholder producing a PEF study based on a PEFCR.

Waste – Substances or objects which the holder intends or is required to dispose of (ISO 14040:2006).

1 Introduction

This document is a Product Environmental Footprint Category Rule (PEFCR) that specifies how the Product Environmental Footprint (PEF) Method [1] shall be applied to the product category, "unprocessed marine fish for human consumption (wild caught and farmed)". This PEFCR is developed based on the Product Environmental Footprint Representative Product (PEF-RP) study for the Marine Fish PEFCR consumed in the EU market (see 3.4). The purpose of this PEFCR is to provide instruction to companies on what they shall include and how to perform a PEF study of their products.

The PEF Method [1] is a Life Cycle Assessment (LCA)-based method used to quantify the relevant environmental impacts of products (goods or services). It builds on existing approaches and international standards. PEF studies are carried out for a range of reasons, including internal benchmarking and assessments of continuous improvement, as well as to meet voluntary or mandatory reporting requirements.

This PEFCR has been developed according to Annex A in the PEFCR guidance document [1]. Where the requirements in this PEFCR are more specific than those in the PEF Method, this more specific guidance shall be followed. For any requirements that are not specified in this PEFCR, the user shall refer to the documents that this PEFCR is in conformance with.

Users should note that the PEF Method will evolve to take into account future improvements regarding impact assessment methodologies and data availability. Specifically with respect to this PEFCR, the PEF Method currently does not account for the status of the targeted stock and impacts on the seabed (as well as other impacts relating to biodiversity more broadly). Hence, in section 3.10, this PEFCR attempts to address this gap in the assessment of the environmental impact of wild caught fish by including a way to document impacts not captured by the PEF Method's standard 16 impact categories. The fundamental importance of the status of the targeted stock and impacts on the seabed implies that their assessment shall be communicated at the same level of prominence and visibility as the assessment of the 16 standard impact categories.

1.1 Contact information

For questions about this PEFCR please contact:

- Henrik Stenwig: hstenw@online.no
- Andrea Nistad: andrea.nistad@asplanviak.no

2 General information about the Marine Fish PEFCR

The following sections present principal aspects of how this PEFCR was developed and how it shall be used.

2.1 Technical Secretariat

This PEFCR is the product of the work of a Technical Secretariat (TS). *Table 2-1* presents the TS members.

Table 2-1 TS members

Organization	Type of Organization	Contact
EU Fish Processors and Traders' Association (AIPCE-CEP)	Representative organization	ksipic@kellencompany.com
Asplan Viak AS	Research institute	andrea.nistad@asplanviak.no
AquaPEF (Observer)	PEF project	sramos@azti.es
The Bellona Foundation	NGO	silje@bellona.no
Cermaq Norway	Company (aquaculture)	silje.ramsvatn@cermaq.com
Federation of European Aquaculture Producers (FEAP)	Representative organization	Szilvia@feap.info
European Feed Manufacturers' Federation (FEFAC)	Representative organization	avandenbrink@fefac.eu
Force Technology (Observer)	Research institute	mimi@force.dk
Lerøy Seafood Group ASA	Company (fishing and aquaculture)	ahm@leroy.no
Niordseas (Avramar Spain)	Company (aquaculture)	e.soler@avramar.eu
Norwegian Fishermen's Association	Representative organization	jan.henrik.sandberg@fiskarlaget.no
Norwegian Seafood Federation (TS Chair)	Representative organization	hstenw@online.no
Pelagia AS	Company (fishing and feed production)	karen.tonnesen@pelagia.com
PRé Sustainability (Observer)	LCA Consultancy	zampori@pre-sustainability.com
Royal Greenland AS	Company (fishing and retail)	lisc@royalgreenland.com

2.2 Consultations and stakeholders

The development of this PEFCR included public consultations and stakeholder involvement. This included the following activities:

- Public consultation of the PEF-RP studies;
- Public consultation of PEFCR drafts;
- Establishment of a website for outreach to interested parties; and
- Contact and engagement with NGOs and other stakeholders that were considered relevant.

2.3 Review of the PEFCR development

Table 2-2 presents the members of the independent panel that provided external reviews throughout the development of this PEFCR. Their reviews were performed according to section A.2.9 in Annex A of the PEF Method [1].

Table 2-2 Members of the PEFCR review panel

Category	Name	Affiliation
Industry expert	Tom Maidment	Hilton Foods
LCA expert	Angel Avadí	CIRAD
LCA expert	Ian Vázquez-Rowe	PUCP

Annex 10.1 presents the biographical sketches of the Review Panel members.

2.3.1 Review statement

This PEFCR was developed in compliance with the PEF method adopted by the Commission (December 2021).

The representative products correctly describe the average products sold in Europe for the product category/sub-categories in scope of this PEFCR.

PEF supporting studies carried out in compliance with this PEFCR would reasonably lead to reproducible results and the information included therein may be used to make comparisons and comparative assertions under the prescribed conditions (see chapter 3.11 on limitations).

The validation statement of the Review Panel is included in Appendix 2.

2.4 Geographic validity

This PEFCR is valid for fisheries and aquaculture providing the EEA market with marine fish.

2.5 Language

The PEFCR is written in English. The original in English supersedes translated versions in case of conflicts.

2.6 Conformance to other documents (guiding documents for this PEFCR)

This PEFCR has been prepared in conformance with the following documents (in prevailing order):

- The PEF Method as defined in [1] . **This PEFCR provides specifications for how the PEF Method shall be applied for Marine fish consumed in the EU market.**
- Annex A - REQUIREMENTS TO DEVELOP PEFCRS AND PERFORM PEF STUDIES IN COMPLIANCE WITH AN EXISTING PEFCR in [1].

2.7 Terminology: shall, should and may

This PEFCR uses precise terminology to indicate the requirements, the recommendations and options that could be chosen when a PEF study is conducted.

- The term “shall” is used to indicate what is required in order for a PEF study to be in conformance with this PEFCR.
- The term “should” is used to indicate a recommendation rather than a requirement. Any deviation from a “should” recommendation has to be justified and made transparent when developing a PEF study.

- The term “may” is used to indicate an option that is permissible. Whenever options are available, the PEF study shall include adequate argumentation to justify the chosen option.

The section on Definitions provides more useful definitions of selected terms.

3 PEFCR scope

In addition to the PEFCR scope, Section 3 also provides instructions on the system/stages/processes that this PEFCR covers and thus shall be addressed in a Marine Fish PEF. Note that the production of feed is to be included according to the PEFCR Feed for food-producing animals [3] as described in section 3.2.1.

3.1 PEFCR Product scope

The product scope (product category) of this PEFCR is unprocessed wild and unprocessed farmed marine fish for direct human consumption in the EU market. This scope includes anadromous species (fish that migrate from the sea up into fresh water to spawn, such as salmon). This scope excludes crustaceans, molluscs and other aquatic invertebrates as well as freshwater fish, both wild and farmed (see section 3.1.1 for more detail).

The product scope considers how Regulation (EC) no 852/2004[7] defines “*processing”* as any action that substantially alters the initial product, including heating, smoking, curing, maturing, drying, marinating, extraction, extrusion or a combination of those processes. This is different from “*unprocessed products”,* which refers to foodstuffs that have not undergone processing, and includes products that have been divided, parted, severed, sliced, boned, minced, skinned, ground, cut, cleaned, trimmed, husked, milled, chilled, frozen, deep-frozen or thawed.

Likewise, per Regulation (EC) No 853/2004 [8], which provides specific hygiene rules for food of animal origin, “*prepared fishery products”* refers to unprocessed fishery products that have undergone an operation affecting their anatomical wholeness, such as gutting, heading, slicing, filleting, and chopping.

For fish that undergo processing, the Marine Fish PEFCR shall work as a module for the life cycle from cradle to processing gate.

3.1.1 Product scope classification

The Classification of Products by Activity (CPA) codes for the products that this PEFCR is valid for are:

- 03.0 Fish and other fishing products
    - 03.00 Fish and other fishing products

[7] Regulation (EC) no 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs (OJ L 139, 30.4.2004, p. 1)
[8] Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 (OJ L 226, 25.6.2004, p. 22)

- 03.00.1 Fish, live
- 03.00.12 Live fish, marine, not farmed
- 03.00.14 Live fish, marine, farmed
- 03.00.2 Fish, fresh or chilled
- 03.00.21 Fresh or chilled fish, marine, not farmed
- 03.00.23 Fresh or chilled fish, marine, farmed

In addition to these stages, the following classes under C Manufactured products 10.20 Processed and preserved fish, crustaceans and molluscs will also be covered:

- 10.20.1 Fish, fresh, chilled or frozen
- 10.20.11 Fish fillets and other fish meat (whether or not minced), fresh or chilled
- 10.20.12 Fish livers and roes, fresh or chilled
- 10.20.13 Fish, frozen
- 10.20.14 Fish fillets, frozen
- 10.20.15 Fish meat, (whether or not minced), frozen
- 10.20.16 Fish livers and roes, frozen

Products that are **not** included in the scope:

- 03.00.13 Live fish, freshwater, not farmed
- 03.00.15 Live fish, freshwater, farmed
- 03.00.22 Fresh or chilled fish, freshwater, not farmed
- 03.00.24 Fresh or chilled fish, freshwater, farmed
- 03.00.31 Crustaceans, not frozen, not farmed
- 03.00.32 Crustaceans, not frozen, farmed
- 03.00.4 Molluscs and other aquatic invertebrates, live, fresh or chilled
- 03.00.5 Pearls, unworked
- 03.00.6 Other aquatic plants, animals and their products
- 03.00.7 Support services to fishing and aquaculture
- 03.00.11 Live ornamental fish
- 10.20.2 Fish, otherwise prepared or preserved
- 10.20.21 Fish fillets, dried, salted or in brine, but not smoked
- 10.20.22 Fish livers and roes dried, smoked, salted or in brine
- 10.20.23 Fish, dried, whether or not salted, or in brine
- 10.20.24 Fish, including fillets, smoked
- 10.20.25 Fish, otherwise prepared or preserved, except prepared fish dishes
- 10.20.26 Caviar and caviar substitutes

  - 10.8 Other food products
    - 10.85.1 Prepared meals and dishes
    - 10.85.12 Prepared meals and dishes based on fish, crustaceans and molluscs

3.2 PEFCR system scope

The scope of this PEFCR covers the life cycle stages of wild and farmed marine fish products as illustrated in Figure 3-1 for wild products and Figure 3-2 for farmed products.

The life cycle of marine fish products is divided into the following stages:

- Feed production: Growing, fishing and other production of feed raw materials, processing of feed ingredients and compound feed production and their packaging (see paragraph 3.2.1 regarding use of PEFCR Feed for food-producing animals).

- Production: Fishing (including onboard preparation). Transport of the fish from fishing to shore is part of the production stages. Aquaculture juvenile production and grow out. For farming of anadromous fish with the grow out stage in the sea, the juvenile production in fresh water is within the scope of this PEFCR.
- Distribution: Transport of fish from landing to preparation to retailer (including transhipment at sea). This stage also includes storing of the fish and transport packaging.
- Preparation: Harvest (slaughter), gutting, filleting, and refrigeration and/or freezing.
- Manufacturing: This includes production of the packaging materials, packing of the final retail product, and waste handling of the materials after use.
- Retailer and Consumption (use): This stage includes the retail of the product, transport from the retailer to the consumer, and packaging materials as listed above. (Retail may include food service or sale of goods.)

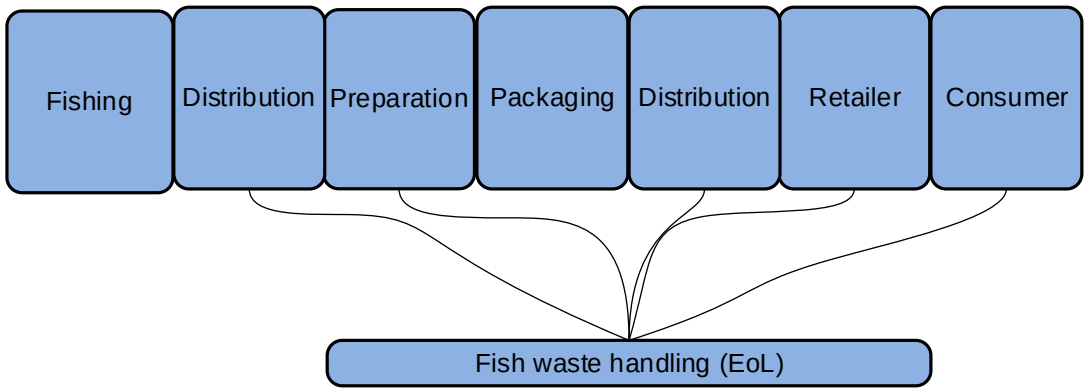

Figure 3-1 System scope wild marine fish products

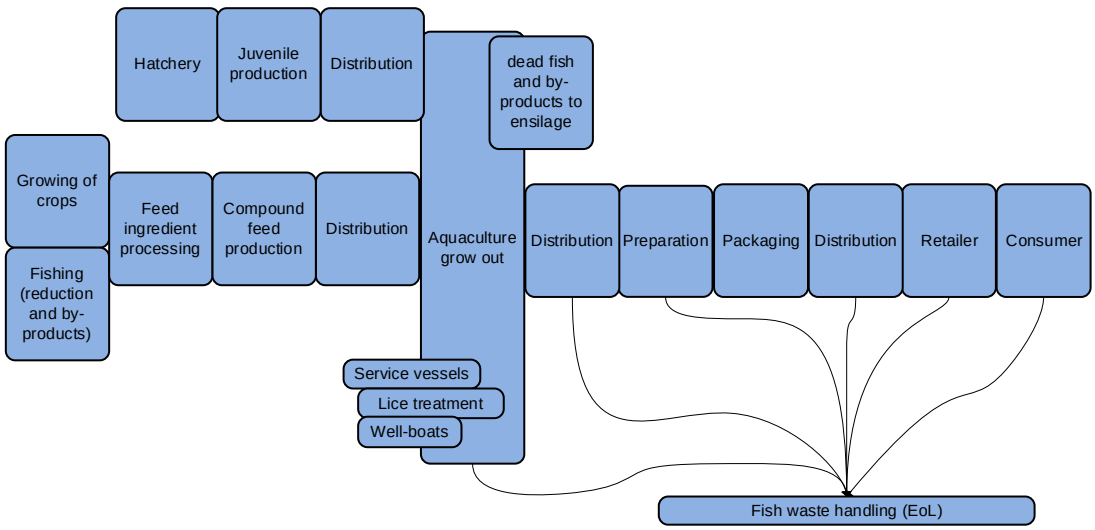

Figure 3-2 System scope farmed marine fish products

3.2.1 Feed for fish farming and system boundaries

Feed for fish farming is within the system boundaries of this PEFCR, meaning that the feed production shall be included in the PEF profile of farmed marine fish products, but the instructions on how the PEF profile of the feed (to the fish farm) shall be calculated are found in the PEFCR Feed for food-producing animals [3]. Section 6.2 provides more detail on how feed shall be included.

The PEF profile of the feed reported to the fish farmer shall cover the impact categories identified as most important in section 4.

3.3 Targeted audience, comparability, and data quality requirements

The main purpose of this PEFCR is to set rules for how a company that produces marine fish calculates and documents the PEF profile of their products.

The PEF will be calculated by many different actors in the marine fish life cycle and this PEFCR provides solutions for different cases, but the basic principle is that the analysis is performed with the availability of the most important data for the PEF of marine fish products (section 5.3). The most important activities of marine fish production are the *fishing* of the "wild fish products" and *keeping and feeding* regarding the "farmed fish products". Thus, the operators of these stages (covering cradle to end-gate of their production units) are the most relevant contributors of product specific, primary information needed to assess the PEF impacts of the product. This makes the fishing vessel operators and fish farmers the most central intended users of this PEFCR. Solutions for other operators to carry out a PEF study are presented in section 5.6. However, regardless of who is conducting the study, the following rules apply regarding the allowable data quality scores for different uses of the results from this PEFCR:

1) If the calculated PEF-profile shall be used to substantiate comparative assertion at product level, it is required that the DQR total score shall be **less than or equal to 2.**
2) If the calculated PEF-profile shall be used for comparison at product level, it is required that the DQR total score shall be **less than or equal to 3.**

3.3.1 Default values and data

This PEFCR presents EF datasets that can be used to cover some of the inputs and activities that constitute the marine fish life cycle. These datasets are presented in the inventory data Excel file located at www.marinefishpefcr.eu/resources. This PEFCR does not include default values. If the applicant is missing data to complete the PEF analysis, they shall find the best available proxies for these data, and this shall be reflected in the Data Quality Rating (DQR) score.

3.4 Representative products and studies

The development of this PEFCR included the establishment of representative products (RP). These products are virtual products that represent the product category as they are consumed in the EU market. These representative products are analysed in what is referred to as a PEF-RP study. This is a mandatory exercise in the development of a PEFCR and it is used to identify the environmental hotpots of the product category that the PEFCR covers. The full documentation of the PEF-RP study and how the RPs are defined is in a separate report[9].

[9] Current draft of the Marine Fish PEF-RP Report available at www.marinefishpefcr.eu/resources.

The two representative products modelled are presented in Table 3-1. Both are a "virtual (non-existing) product", since they are made up of different technologies/materials and calculated based on average sales-weighted characteristics of all technologies/materials covered by the scope of the PEFCR.

Additionally, results of the overarching product category are calculated for the RP of *marine fish*, which is a weighed combination of the RP of the sub-categories *wild marine fish* and *farmed marine fish*. The RP values of the *marine fish* allows comparative assertion between the sub-categories via the benchmark for the overarching product category.

Table 3-1 The representative products

Overarching Product category	Representative product	Product sub-categories	Representative product (one for each sub-category)
Marine Fish for Human Consumption	Virtual product based on data on EU consumption of marine fish both farmed and captured	Wild caught marine fish	Virtual product based on data on EU consumption of marine fish and global fisheries.
		Farmed marine fish from aquaculture	Virtual product based on data on EU consumption of marine fish and global aquaculture production.

3.5 Supporting studies

A PEFCR supporting study is a PEF study based on a draft PEFCR. It is used to confirm the decisions taken in the draft PEFCR before the final PEFCR is released. Five supporting studies were completed and reviewed as part of the process to improve the draft PEFCR.

3.6 Functional unit and reference flow

The functional unit shall be 1 kg of consumed product as presented in Table 3.2, consumed at home, in restaurants or elsewhere.

The reference flow is the amount of product needed to fulfil the defined function and shall be measured in kg.

See section 3.1 for a description of the types of products for which this PEFCR is valid.

Table 3-2 Definition of functional unit

What	Marine fish products for human consumption and the packaging needed to deliver it.
How much	1 kg consumed edible[10] fraction of fish.
How well	The product should be appropriate for human consumption.
How long	Available for consumption before the expiry date. Losses shall be included in the assessment all the way through final consumption.
Where	Consumption in the EU27+EFTA and all types of final consumption, e.g. households, restaurants and hotels etc.

Details and default data for the consumption (e.g. loss rates), yields and preparation methods are presented in section 6.5.

3.7 System boundary

Table 3-3 presents the life cycle stages that shall be included and a non-exhaustive list of activities each life cycle stage includes.

Table 3-3 Description of life cycle stages that shall be included

Life cycle stage	**Farmed**	**Wild**
Feed Production	Growing, fishing and other production of feed raw materials. Processing of feed ingredients and compound feed production and packaging.	N/A
Production (Manufacturing)	Hatchery, juvenile production and grow out of fish.	Fishing (including transport to land and onboard preparation).
Preparation (Manufacturing)	Harvest (slaughter), gutting, filleting, refrigeration and/or freezing.	Gutting, filleting, refrigeration and/or freezing.
Distribution	Packing of the final retail product, packaging materials and transport, including cooling, from preparation to retailer.	
Consumption (Use)	Retail of the product and consumption.	
End of life	Handling of fish mass that is not sold as a commercial product, or not consumed.	

In reality, fish might be:

- caught and gutted in the vessel before landing;
- caught and not gutted before landing;
  - caught and not killed before being transported to land and kept alive in cages; (but not fed) before landed and killed (this is not defined as aquaculture (as not fed));
- farmed and transported when living and killed on land;

[10] The concept "edible" is product/species specific and is defined by the "yield-factor". Examples: Small pelagic species are eaten whole with bones; the liver from several species are eaten; the head and bones might be used when preparing soups, etc. The default edible yield factor is presented in the inventory data Excel file (see the current version of the Marine Fish PEFCR Inventory Data file at www.marinefishpefcr.eu/resources).

- farmed and killed at site and transported to land and then prepared; or
- farmed and killed and gutted at site in special vessels (that is, there is no transport between *production* and *preparation).*

Hence, the activities in each life cycle stage shall be clearly described. Some processes are excluded due to missing data (see section 3.11.2).

3.7.1 Cut-off

The rules for cut-off are defined by the PEF method[11] and states that any cut-off shall be avoided, unless under the following rules:

- Processes and elementary flows may be excluded up to 3.0% (cumulatively) based on material and energy flows and the level of environmental significance (single overall score). The processes subject to a cut-off shall be made explicit and justified in the PEF report, in particular with reference to the environmental significance of the cut-off applied.
- This cut-off must be considered in addition to the cut-off already included in the background datasets. This rule is valid for both intermediate and final products.
- The processes that (cumulatively) account for less than 3.0% of the material and energy flow, as well as the environmental impact for each impact category may be excluded from PEF study.

3.8 Impact Assessment: List of EF impact categories

The impact assessment is done using the EF3.1 method[12]. Table 3.4 presents the impact categories this method includes. For the full detail on the different models for each category refer to the Environmental Footprint reference packages[13].

Table 3-4 Impact categories and reference substances in the current EF3.1 impact assessment method

EF Impact category	Impact category indicator	Unit	Characterisation model	Robustness
Climate change, total	Global warming potential (GWP100)	kg CO_2 eq	Bern model - Global warming potentials (GWP) over a 100-year time horizon (based on IPCC 2013)	I
Ozone depletion	Ozone depletion potential (ODP)	kg CFC-11 eq	EDIP model based on the ODPs of the World Meteorological Organisation (WMO) over an infinite time horizon (WMO 2014 + integrations)	I
Human toxicity, cancer	Comparative toxic unit for humans (CTUh)	CTUh	based on USEtox2.1 model (Fantke et al. 2017), adapted as in Saouter et al., 2018	III
Human toxicity, non-cancer	Comparative toxic unit for humans (CTUh)	CTUh	based on USEtox2.1 model (Fantke et al. 2017), adapted as in Saouter et al., 2018	III
Particulate matter	Impact on human health	Disease incidence	PM model (Fantke et al., 2016 in UNEP 2016)	I
Ionising radiation, human health	Human exposure efficiency relative to U^{235}	kBq U^{235} eq	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)	II

[11] https://environment.ec.europa.eu/system/files/2021-12/Annexes%201%20to%202.pdf
[12] The current EF impact assessment method can be found here: https://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml
[13] EF reference package spreadsheet (see above link).

Photochemical ozone formation, human health	Tropospheric ozone concentration increase	kg NMVOC eq	LOTOS-EUROS model (Van Zelm et al, 2008) as applied in ReCiPe 2008	II
Acidification	Accumulated exceedance (AE)	mol H^+ eq	Accumulated exceedance (Seppälä et al. 2006, Posch et al, 2008)	II
Eutrophication, terrestrial	Accumulated exceedance (AE)	mol N eq	Accumulated exceedance (Seppälä et al. 2006, Posch et al, 2008)	II
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P eq	EUTREND model (Struijs et al, 2009) as applied in ReCiPe	II
Eutrophication, marine	Fraction of nutrients reaching freshwater end compartment (N)	kg N eq	EUTREND model (Struijs et al, 2009) as applied in ReCiPe	II
Ecotoxicity, freshwater	Comparative toxic unit for ecosystems (CTUe)	CTUe	based on USEtox2.1 model (Fantke et al. 2017), adapted as in Saouter et al., 2018	III
Land use	Soil quality index	Dimensionless (pt)	Soil quality index based on LANCA model (De Laurentiis et al. 2019) and on the LANCA CF version 2.5 (Horn and Maier, 2018)	III
Water use	User deprivation potential (deprivation- weighted water consumption)	m^3 water eq of deprived water	Available WAter Remaining (AWARE) model (Boulay et al.,2018; UNEP 2016)	III
Resource use, minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb eq	van Oers et al., 2002 as in CML 2002 method, v.4.8	III
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)	MJ	van Oers et al., 2002 as in CML 2002 method, v.4.8	III

3.9 Additional technical information

The following additional technical information shall be reported:

Farmed products:

- The system descriptions shall include the types of technologies that are used and where the different stages and activities are taking place. Examples of relevant aspects to describe:
    - Kind of containment. Describe the system so that the level and system for containment is clear. Clearly state how/if the system includes collection of sludge and type of wastewater treatment.
    - Density of fish in cage expressed as:
- kg fish per m^3 at the time of the start of slaughter (before removing any from the cage for slaughter) and
- Number of fish per m^3 at the time of start of the grow-out period
    - Fallowing period expressed in number of days.
- State if the system is land-based, semi land-based or in sea. The location of the fish farming shall be explained in terms of distance from shore and GPS coordinates (according to the ETRS89 system).
- The length of an average production cycle shall be presented. If the production from roe to fish ready for slaughter include different locations, this system shall be explained by a flow chart together with a description of the duration for each stage. The average size (weight) of the juveniles shall be clearly stated.

Wild products: For fishing it is important to include a good explanation of how, where and when the fishing is performed. This requires a complete explanation that shall include, but not be limited to, the following clarifications:

- Classify the fishing gear(s) used according to Annex 3 in the Regulation (EU) No 1379/2013[14] of the European Parliament on the common organisation of markets in fishery and aquaculture products.
- Specify fishing area according to the most detailed level of FAO codes for Major Marine Fishing Areas[15]. If the vessel operated in different areas, indicate all of them and which months each area was fished.
- Other relevant information:
  - Specify the main targeted species.
- Specify if there are clearly separated seasons or if it is a more continuous fishery with number of distinct seasons during one year for a given species and in which months) Example: Some fishing is almost exclusively performed during a specific time of the year.
  - Specify by-catch by species and weight per year.
  - Specify the use of different fishing gears throughout the fishing period. Specify month by month what gears were used.
  - Specify, if relevant, the on-board preparation or processing done as part of the fisheries.

3.10 Additional environmental information

Marine fishing and marine aquaculture are highly relevant for a number of environmental impacts not directly captured by the current PEF Impact assessment method (EF3.1, section 3.8). Among these other impacts, direct and indirect biotic impacts on targeted and non-targeted stocks, species and marine ecosystems are very important. Feed used for farmed marine products is a very important input in this regard, as it links farmed marine fish to the biodiversity impacts of global agricultural systems and capture fisheries.

The additional environmental information required by this PEFCR is limited by the requirements in the PEF Method (section A.3.2.7.1) [1], which states that *"Additional environmental information may be included only if the PEFCR specifies the method that shall be used for its calculation"*, thus only impacts that can be quantified are suggested as additional environmental information.

In particular, the sustainability of the targeted fish stock is a key factor in the overall environmental impact of a wild-caught fishery product. In 2019, more than a third of all fish stocks globally were fished at unsustainable levels according to the FAO[16], while almost 60% were fished at their Maximum Sustainable Yield (MSY). Overfishing can lead to a decrease in fish populations, disrupting the balance of marine ecosystems and poses a threat to global food security as many people rely on fish as a primary source of protein. Consequently, the PEFCR should suggest a method that should be used for the stock sustainability assessment in PEFCR studies on wild-caught products.

[14] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R1379
[15] https://www.fao.org/fishery/en/area/search
[16] Towards blue transformation (fao.org)

The Scientific, Technical and Economic Committee for Fisheries STECF is the scientific body that the Commission consults regarding the conservation and management of living marine resources, including biological, economic, environmental, social and technical considerations. In its report *Marketing standards: review of fishery criteria and underlying methodologies* (EWG 22-12)[17], the STECF proposes a comprehensive method for grading / scoring the sustainability of a stock on a 5-point scale (i.e. A for highest sustainability grade down to E for the lowest grade). Section 3.1.8 of the EWG 22-12 report describes the grading method in detail. The decision tree in figure 2 of the report visualizes the approach. A summary of the approach is provided in Annex 5[18].

In addition to the indicator regarding stock sustainability, STECF concluded in the same report that an indicator regarding the impact on the seabed has been fully developed. EWG 22-12 provided an updated version of the Excel file (control panel in Annex 1 of the report) developed by the ad hoc contract supporting the EWG including the revision of gear and habitat scores. The Excel file for calculating the impact on the seabed is available here: https://stecf.jrc.ec.europa.eu/documents/d/stecf/stecf-22-12-annex-1-impact-on-seabed.

In PEFCR studies, the stock sustainability assessment and the indicator of the impact on the seabed shall be communicated at the same level of prominence and visibility as the assessment of the 16 standard impact categories.

The following additional environmental information shall also be reported:

Wild products:

- Ghost fishing
    - Number of fishing gears lost per unit of catch (referencing the most detailed level of FAO codes for Major Marine Fishing Areas[19]).
    - Information about systems to retrieve lost fishing gear in the fishing areas (referencing the most detailed level of FAO codes for Major Marine Fishing Areas).
    - The properties of the fishing gears are expected to be reported under “additional technical information”.
- Area trawled within the specific areas specified under section 3.10 as distance trawled per unit of catch landed.
- Number of mammals killed per unit of catch landed. Specify species.
- Number of birds killed per unit of catch landed. Specify species.
- Plastic lost to sea (number of gears containing plastics and weight of ropes and floats).

Farmed products:

- Escapees: number of fish escaped per tonne of fish produced.
- Number of mammals killed per tonne of production (specify species as well as accidental versus deliberate animal removals).
- Number of birds killed per tonne of production (specify species).

[17] https://publications.jrc.ec.europa.eu/repository/handle/JRC132121

[18] Based on the method developed by the STECF, DG MARE is currently working on an information system that would enable operators (and other stakeholders) to determine the stock sustainability.

[19] https://www.fao.org/search/en/?cx=018170620143701104933%3Aqq82jsfba7w&q=FAO+codes+for+Major+Marine+Fishin&cof=FORID%3A9

- Plastics lost to sea (number of fishing gears and weight of ropes and floats).

3.10.1 Antifouling chemicals

Emission of toxic chemicals to marine water is not covered by the current EF Impact assessment method. The exclusion of marine ecotoxicity from the PEF method limits its applicability to comparison with comparable (terrestrial) protein sources.

To include information about this environmental impact the following shall be reported:

- The antifouling chemicals used on equipment and vessels (list the product name and antifouling agents included).
- The mass input of these chemicals per unit of catch or production. The time frame specified for this factor shall reflect the durability of the antifouling chemicals.
- A statement (expert judgement) on the percentage of the overall system (vessels and equipment) covered by this information.
- A statement (expert judgement) on the end-of-life of the antifouling paints. Example: Are they mainly lost to the marine environment or is some of it collected during maintenance or onshore washing?
- A statement (expert judgement) on the emissions to sea of antifouling chemicals (either as % of the antifouling chemicals used or as a total number).

3.11 Limitations

This section presents the most important limitations of this PEFCR and the use of results from applying this PEFCR.

3.11.1 Comparisons and comparative assertions

Comparability is addressed in section 3.3.

3.11.2 Data gaps and proxies

Solutions for frequently encountered data gaps for company-specific data are presented in Chapter 5.

Processes excluded from this PEFCR due to missing datasets that shall not be filled-in by the user of the PEFCR are:

- Emissions from antifouling chemicals on vessels and farming equipment. As of February 2025, the EF impact assessment method does not include marine ecotoxicity.
- Use and production of medicines and other micro-ingredients administered through the feed.
- Fish vaccines and antibiotics.
- For combustion of fuel in fishing vessel, no EF-specific dataset was available at the time of publication (March 2025). The proxy dataset indicated shall be used until a more specific EF dataset is available.

A list of processes for which the user of the PEFCR shall apply ILCD entry level (ILCD-EL) compliant proxies are presented in Chapter 5.

3.12 Sensitivity analysis

Sensitivity analysis shall be carried out in alignment with the PEF method [1]. The reliability of the results shall be checked with respect to uncertainty in inventory data, allocation methods (mass allocation), values for allocation and calculation of impacts.

4 Most relevant impact categories, life cycle stages, processes, and elementary flows

This chapter presents conclusions based on a PEF study of the representative products specified in section 3.4. The results of this study are used to determine the most relevant impact categories, stages, processes, and flows. In this document, only the most relevant impact categories and stages are presented. The Excel file "Marine Fish PEF-RP Results" presents the complete hotspot analysis. This file can be downloaded at: www.marinefishpefcr.eu/resources.

4.1 Most relevant EF impact categories

Table 4-1, Table 4-2 and Table 4-3 present the most relevant impact categories for overarching representative product (marine fish) and the wild and farmed representative products of the two sub-categories as they are identified by the hotspot analysis defined by the PEF method (i.e. the categories that when listed from largest to smallest add up to 80% of the normalized and weighted results).

Table 4-1 Most relevant impact categories according to hotspot analysis for the overarching product category marine fish

Impact category	**% of normalised and weighted results**
Climate change	24%
Resource use, fossils	15%
Particulate Matter	13%
Ecotoxicity, freshwater	11%
Eutrophication, marine	11%
Photochemical ozone formation	6%
Acidification	6%
Eutrophication, terrestrial	5%
Water use	3%
Land use	2%
Sum of selected categories to total normalized and weighted result	80%

Table 4-2 Most relevant impact categories according to hotspot analysis for wild marine fish products

WILD FISH MOST RELEVANT IMPACT CATEGORIES	
Impact categories	% of normalised and weighted results
Climate change	25%
Resource use, fossils	20%
Particulate Matter	18%
Photochemical ozone formation	9%
Acidification	7%
Eutrophication, terrestrial	6%
Sum of selected categories to total normalized and weighted result	84%

Table 4-3 Most relevant impact categories according to hotspot analysis for farmed marine fish products

FARMED FISH MOST RELEVANT IMPACT CATEGORIES	
Impact categories	% of normalised and weighted results
Climate change	22%
Ecotoxicity, freshwater	21%
Eutrophication, marine	20%
Resource use, fossils	9%
Particulate Matter	6%
Land Use	4%
Sum of selected categories to total normalized and weighted result	83%

4.2 Most relevant life cycle stages

Figure 4-1 and Figure 4-2 present how the different stages of the wild and the farmed RPs contribute to their respective most relevant impact categories.

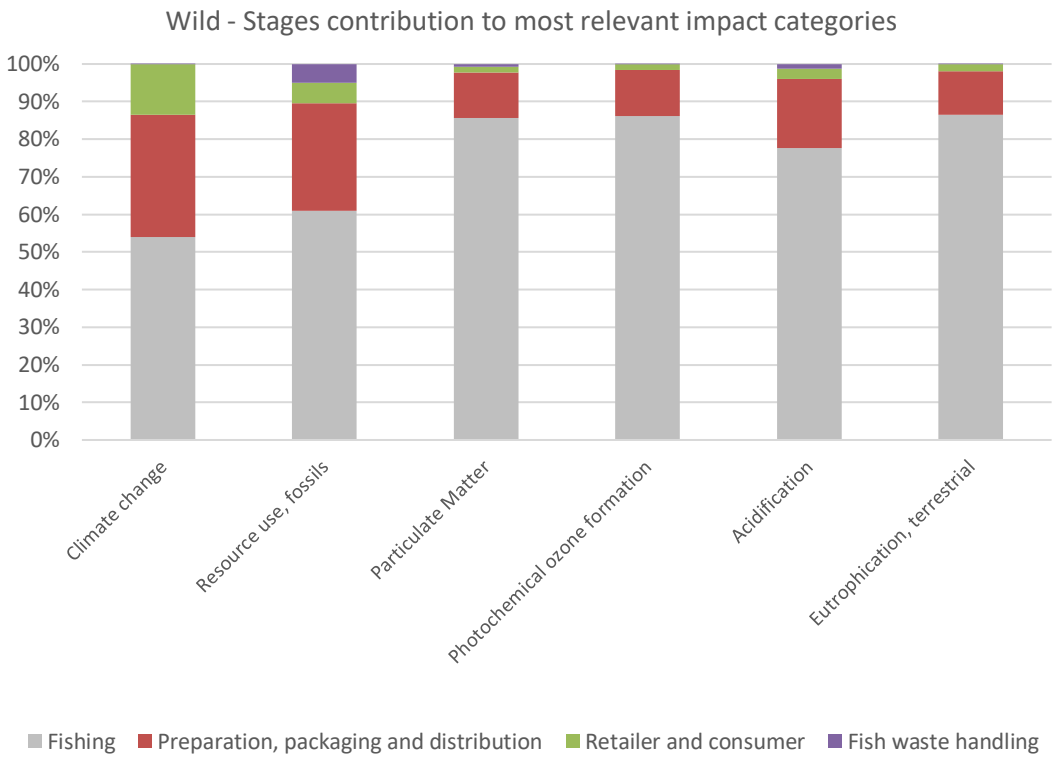

Figure 4-1 Wild RP: Stages contribution to most relevant impact categories

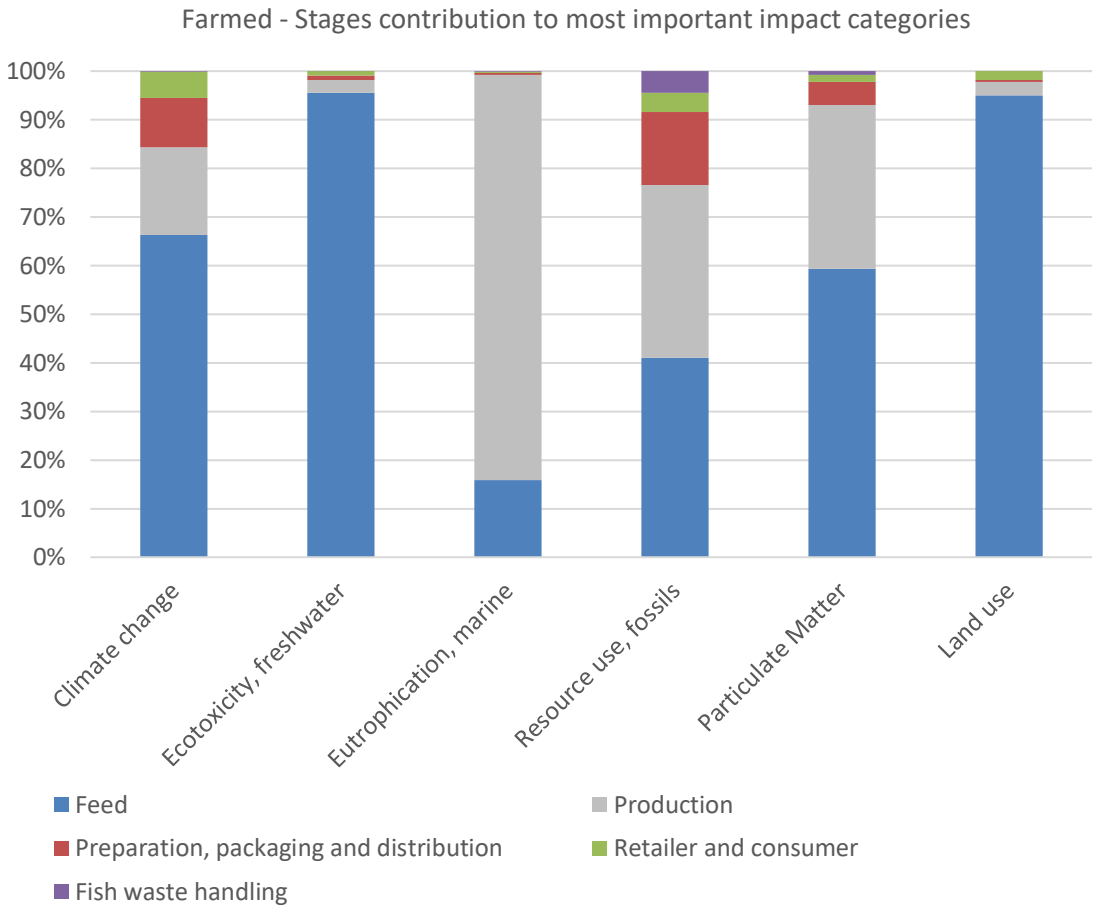

Figure 2-2 Farmed RP: Stages contribution to most relevant impact categories

4.3 Most relevant processes and flows

The Excel file "Marine Fish PEF-RP Results" presents the complete hotspot analysis. This file is available at: www.marinefishpefcr.eu/resources.

5 Life Cycle Inventory

This section introduces the rules regarding the data that the PEF study shall include and the data quality requirements.

5.1 Periodicity of data collection

Primary data should be an average of data collected for a period of the **last three years**. This includes the data used for allocation.

If data that are used are only representative for a period less than three years, this shall be clearly stated and reflected in the data quality rating.

These specifications apply, if applicable, also to Additional technical and Additional environmental information (see 3.9 and 3.10).

5.2 Data sampling

If sampling is needed, it shall be conducted as specified in this PEFCR. However, sampling is not mandatory and any user of this PEFCR may decide to collect the data from all the plants or farms, without performing any sampling. A full description of the PEF requirements regarding sampling are available in section A.4.2.5 of the PEF Method [1].

In some cases, a sampling procedure is needed to limit the data collection to only a representative sample. For marine fish products, a typical situation that requires sampling is when multiple fishing vessels or multiple farms sites are involved in the sourcing of the fish.

If sampling is needed, a stratified sample shall be used (i.e. one that ensures that sub-populations (strata) of a given population are each adequately represented within the whole sample of a research study). This should consider geography, feed composition, farm type, species, and capture method. With this type of sampling, it is guaranteed that subjects from each sub-population are included in the final sample, whereas simple random sampling does not ensure that sub-populations are represented equally or proportionately within the sample.

When sampling is used the user of this PEFCR shall report:

- Farmed products:
    - The percentage of the total mass of fish to harvest that is covered with sampling.
    - The percentage of total farming sites/farms that are involved that are covered with sampling.
    - The sampling of feed shall cover 95 % of the feed used.
- Wild products:
    - The percentage of mass of fish landed that are covered with sampling.
    - The percentage of vessels involved in the sourcing that are covered with sampling.

When sampling is used this shall also be reflected in the Data Quality Rating (DQR) score (section 5.5).

5.3 List of mandatory company-specific data

This section presents the data that shall be modelled with data that are specific for the products that are studied (i.e. company-specific data). Without these company-specific data the results cannot be presented as compliant with this PEFCR. Section 5.5 and 5.6 provide more on data requirements of this PEFCR. Chapter 6 presents more detail on these processes and the data that shall be collected for them.

Table 5-1 Mandatory company-specific data for farmed products

Data	Comment
BFCR (biological feed conversion ratio)	Mass of feed per mass of fish farmed
Fish mass balance over the farming stage	A complete mass balance for all fish that enter the fish farm[20]. This includes a quantification of all flows and clear definition of their fate. This includes escapees, losses, commercial products, and all other fish biomass.
The PEF profile of the feed used	According to the PEFCR Feed for food-producing animals [3]
Direct emissions from the fish farm	This includes nutrients from uneaten feed, faeces, and combustion of fuels.
Use of freshwater in fish grow out and juvenile production	

Table 5-2 Mandatory company-specific data wild products

Data	Comment
Energy (fuel, electricity) use efficiency in fishery	Energy input per unit of fish landed
Fish mass balance of fishery	Complete mass balance for all fish that are retrieved from the sea (fished). This includes all fish that are caught independent of how it is classified. Each mass flow shall be specified in terms of species and fate after it is fished, and quantified. If the fishing includes onboard preparation the preparation yields shall be company specific.
Emission of refrigerants from fishing vessel	Specify type and mass emitted per unit of catch.

Table 5-3 Mandatory company-specific data farmed and wild products

Data	Comment
Fish mass balance for the preparation stage	Complete mass balance for the fish that enters preparation and how it leaves. This includes specification of the fate of each mass flow, unambiguous definition of state (e.g. fillet, head off gutted) and the fate of all mass flows.
Transport to market	Transport from preparation or landing to retailer/market shall be included with company-specific data on transport type (road, air or sea) and distances (transport route).

5.4 List of processes expected to be run by the company

Farmed products:

- Energy use at the fish farm and by vessels supporting fish grow out and transport of fish from grow out to preparation.
- Management of wastewater and sludge from land-based systems.

[20] Excluding fish that is part of the feed and live fish used in parasite treatment.

- Relative price of the fish co-products from the fish farm (co-product price relative to the price of the main product).

Wild products:

- Relative price of the fish products from fishing (co-product price relative to the price of the main product). This includes all fish biomass that are landed, independent of how they are classified by regulations, etc.

All products (wild and farmed):

- Energy use in preparation stage.
- Relative price of the fish co-products from preparation (co-product price relative to the price of the main product).
- Water consumption, including water source and emissions to water from the plant.
- Type of refrigerants used in preparation plant and leakage rate.
- Packaging materials (Bill of Materials). This includes packaging used during production, distribution, and consumer stage.

See Annex 3 for detailed instructions.

5.5 Data quality requirements

The data quality of each dataset and the total PEF study shall be calculated and reported according to section B.5.3 of the PEF Method [1].

The following presents a short description of the procedure. The Excel file "Marine Fish PEFCR DQR" includes two sheets with a prepared setup for the DQR of company specific ("17) Product-specific data DQR") and generic ("18) Secondary data DQR") data. This document is available at www.marinefishpefcr.eu/resources.

The calculation of the DQR shall be based on the following formula with four criteria:

$$DQR = \frac{TeR+GeR+TiR+P}{4} \qquad \textit{Equation 1}$$

where TeR is technological representativeness, GeR is geographical representativeness, TiR is time representativeness, and P is precision. The representativeness (technological, geographical and time-related) characterizes to what degree the processes and products selected are depicting the system analysed, while the precision indicates the way the data is derived and the related level of uncertainty.

5.5.1 DQR company-specific datasets

The DQR shall be calculated at level-1 disaggregation before any aggregation of sub-processes or elementary flows is performed. The DQR of product-specific datasets shall be calculated as following:

1) Select the most relevant activity data and direct elementary flows: most relevant activity data are the ones linked to sub-processes (i.e. secondary datasets) that account for at least 80% of the total environmental impact of the product-specific dataset, listing them from the most contributing to the least contributing one. Most relevant direct

elementary flows are defined as those direct elementary flows contributing cumulatively at least with 80% to the total impact of the direct elementary flows.

2) Calculate the DQR criteria TeR, TiR, GeR and P for each most relevant activity data and each most relevant direct elementary flow. The values of each criterion shall be assigned based on

3) Table 5-4.
   a. Each most relevant direct elementary flow consists of the amount and elementary flow named (e.g. 40 g carbon dioxide). For each most relevant elementary flow, the user of the PEFCR shall evaluate the 4 DQR criteria named TeR-EF, TiR-EF, GR-EF, PEF. For example, the user of the PEFCR shall evaluate the timing of the flow measured, for which technology the flow was measured and in which geographical area.
   b. For each most relevant activity data, the 4 DQR criteria shall be evaluated (named TiR-AD, PAD, Gr-AD, Ter-AD) by the user of the PEFCR.
   c. Considering that the data for the mandatory processes shall be company-specific, the score of P cannot be higher than 3, while the score for TiR, TeR, and GR cannot be higher than 2 (The DQR score shall be ≤1.5.).
4) Calculate the environmental contribution of each most relevant activity data (through linking to the appropriate sub-process) and direct elementary flow to the total sum of the environmental impact of all most-relevant activity data and direct elementary flows, in % (weighted, using all EF impact categories). For example, the newly developed dataset has only two most relevant activity data, contributing in total to 80% of the total environmental impact of the dataset:
   a. Activity data 1 carries 30% of the total dataset environmental impact. The contribution of this process to the total of 80% is 37.5% (the latter is the weight to be used).
   b. Activity data 2 carries 50% of the total dataset environmental impact. The contribution of this process to the total of 80% is 62.5% (the latter is the weight to be used).
5) Calculate the TeR, TiR, GeR and P criteria of the newly developed dataset as the weighted average of each criterion of the most relevant activity data and direct elementary flows. The weight is the relative contribution (in %) of each most relevant activity data and direct elementary flow calculated in step 3.
6) The user of the PEFCR shall calculate the total DQR of the newly developed dataset using Equation B.2, where $\bar{\bar{T}}\bar{e}\bar{R}$, $\bar{G}\bar{e}\bar{R}$, $\bar{\bar{T}}\bar{i}\bar{R}$, $\bar{P}$ are the weighted average calculated as specified in point 4.

Table 5-4 How to assess the value of the DQR criteria for datasets with company-specific information

	P_{EF} and P_{AD}	**$T_{iR\text{-}EF}$ and $T_{iR\text{-}AD}$**	**$T_{eR\text{-}EF}$ and $T_{eR\text{-}AD}$**	**$G_{R\text{-}EF}$ and $G_{R\text{-}AD}$**
1	Measured/calculated and externally verified	The data refers to the most recent annual administration period with respect to the EF report publication date	The elementary flows and the activity data exactly the technology of the newly developed dataset	The activity data and elementary flows reflect the exact geography where the process modelled in the newly created dataset takes place
2	Measured/calculated and internally verified, plausibility checked by reviewer	The data refers to maximum 2 annual administration periods with respect to the EF report publication date	The elementary flows and the activity data is a proxy of the technology of the newly developed dataset	The activity data and elementary flows) partly reflects the geography where the process modelled in the newly created dataset takes place
3	Measured/calculated /literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer	The data refers to maximum three annual administration periods with respect to the EF report publication date	Not applicable	Not applicable
4 - 5	Not applicable	Not applicable	Not applicable	Not applicable

P_{EF}: Precision for elementary flows; **P_{AD}**: Precision for activity data; **$T_{iR\text{-}EF}$**: Time Representativeness for elementary flows; **$T_{iR\text{-}AD}$**: Time representativeness for activity data; **$T_{eR\text{-}EF}$**: Technology representativeness for elementary flows; **$T_{eR\text{-}AD}$**: Technology representativeness for activity data; **$G_{R\text{-}EF}$**: Geographical representativeness for elementary flows; **$G_{R\text{-}AD}$**: Geographical representativeness for activity data.

5.5.2 DQR when default values are used

For the datasets that include the use of default values presented in this PEFCR the DQR cannot be less than 3.

5.5.3 DQR score “not applicable” for company-specific data

If one of the criteria in the DQR for company-specific data are rated as “not applicable” that means that the dataset is not sufficiently company specific. Data quality then must be improved to be compliant with this PEFCR.

one of the criteria in the DQR for company-specific data are rated as “not applicable” that means that the data set is not sufficiently company specific. Data quality then must be improved to be compliant with this PEFCR.

5.5.4 DQR secondary data sets

This section describes the procedure to calculate the DQR of secondary datasets used in a PEF study. This means that the DQR of the EF compliant secondary dataset (calculated by the data provider) shall be re-calculated, when they are used in the modelling of most relevant processes, to allow the user of the PEF method to assess the context specific DQR criteria (i.e. TeR, TiR and GeR of most relevant processes). The TeR, TiR and GeR criteria shall be re-evaluated based on

Table 5-5. It is not allowed to modify any criteria. The total DQR of the dataset shall be recalculated using:

$$DQR = \frac{TeR+GeR+TiR+P}{4} \qquad \textit{Equation 1}$$

Table 5-5 How to assign the values to DQR criteria when using secondary datasets

Rating	Ti_R	Te_R	Ge_R
1	The EF report publication date happens within the time validity of the dataset	The technology used in the EF study is exactly the same as the one in scope of the dataset	The process modelled in the EF study takes place in the country the dataset is valid for
2	The EF report publication date happens not later than 2 years beyond the time validity of the dataset	The technologies used in the EF study is included in the mix of technologies in scope of the dataset	The process modelled in the EF study takes place in the geographical region (e.g. Europe) the dataset is valid for
3	The EF report publication date happens not later than 4 years beyond the time validity of the dataset	The technologies used in the EF study are only partly included in the scope of the dataset	The process modelled in the EF study takes place in one of the geographical regions the dataset is valid for
4	The EF report publication date happens not later than 6 years beyond the time validity of the dataset	The technologies used in the EF study are similar to those included in the scope of the dataset	The process modelled in the EF study takes place in a country that is not included in the geographical region(s) the dataset is valid for, but sufficient similarities are estimated based on expert judgement.
5	The EF report publication date happens later than 6 years after the time validity of the dataset, or the time validity is not specified	The technologies used in the EF study are different from those included in the scope of the dataset	The process modelled in the EF study takes place in a different country than the one the dataset is valid for

5.6 Data needs matrix (DNM)

All processes required to model the product and outside the list of mandatory company-specific data (listed in section 5.3) shall be evaluated using the Data Needs Matrix (DNM)[21] (see Table 5-6). These evaluations shall be documented.

[21] Described in section B.5.4 of the PEFCR guidance document [1].

The DNM indicates the level of influence the company has on the process and if product-specific or generic data are used. The following three cases are found in the DNM and are explained in the following sections:

1. Situation 1: the process is run by the company applying the PEFCR;

2. Situation 2: the process is not run by the company applying the PEFCR but the company has access to (company-)specific information;

3. Situation 3: the process is not run by the company applying the PEFCR and this company does not have access to (company-)specific information.

The user of the PEF method shall:

1. Determine the level of influence (Situation 1, 2 or 3) the company has for each process in its supply chain. This decision determines which of the options in Table 5-6 is pertinent for each process;
2. Provide a table in the PEF report listing all processes and their situation according to the DNM;
3. Follow the data requirements indicated in Table 5-6;
4. Calculate/re-evaluate the DQR values (for each criterion + total) for the datasets of the most relevant processes and the new ones created.

*Table 5-6 Data Needs Matrix (DNM). The options described in the DNM are not listed in order of preference. *Disaggregated datasets shall be used.*

	Option	Most relevant processes	Other processes
Situation 1: process run by the company using the PEFCR	I	Provide company-specific data (as requested in the PEFCR) and create a company-specific dataset, in aggregated form (DQR≤1.5)[110] Calculate the DQR values (for each criterion + total)	
	II		Use default secondary dataset in PEFCR, in aggregated form (DQR≤3.0) Use the default DQR values
Situation 2: process not run by the company using the PEFCR but with access to	I	Provide company-specific data (as requested in the PEFCR) and create a company-specific dataset, in aggregated form (DQR≤1.5) Calculate the DQR values (for each criterion + total)	
	II	Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets (DQR≤3.0)* Re-evaluate the DQR criteria within the product specific context	

	≡		Use company-specific activitydata for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific EF compliant datasets (DQR≤4.0)* Use the default DQR values.
Situation 3: process not run by the company using the PEFCR and without access to company- specific information	I	Use default secondary data set in aggregated form (DQR≤3.0) Re-evaluate the DQR criteria within the product specific context	
	II		Use default secondary data set in aggregated form (DQR≤4.0) Use the default DQR values

5.6.1 Situation 1: The process is run by the company applying the PEFCR.

For each process in situation 1 there are two possible options:

1. The process is in the list of most relevant processes as specified in the PEFCR or is not in the list of most relevant process, but still the company wants to provide company-specific data (option 1);
2. The process is not in the list of most relevant processes and the company prefers to use a secondary dataset (option 2).

Situation 1/Option 1

For all processes run by the company and where the user of the PEFCR applies company-specific data. The DQR of the newly developed dataset shall be evaluated as described in section 5.5.

Situation 1/Option 2

For the non-most relevant processes only, if the user of the PEFCR decides to model the process without collecting company-specific data, then the user shall use the secondary dataset listed in the PEFCR together with its default DQR values listed here. If the default dataset to be used for the process is not listed in the PEFCR, the user of the PEFCR shall take the DQR values from the metadata of the original dataset.

Example: A fish farmer that uses generic data to cover the emissions of refrigerants from the harvesting plant will be in situation 1/option 2.

5.6.2 Situation 2: The process is not run by the company applying the PEFCR, but the company has access to (company-)specific information.

When a process is not run by the user of the PEFCR, but there is access to company-specific data, then there are three possible options:

1. The user of the PEFCR has access to extensive supplier-specific information and wants to create a new EF compliant dataset;
2. The company has some supplier-specific information and wants to make some minimum changes;
3. The process is not in the list of most relevant processes and the company wants to make some minimum changes.

Situation 2/Option 1

For all processes not run by the company and where the user of the PEFCR applies company-specific data, the DQR of the newly developed dataset shall be evaluated as described in section 5.5.

Situation 2/Option 2

The user of the PEFCR shall use company-specific activity data for transport and shall substitute the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets, starting from the default secondary dataset provided in the PEFCR.

Please note that the PEFCR lists all dataset names together with the UUID of their aggregated dataset. For this situation, the disaggregated version of the dataset is required.

The user of the PEFCR shall make the DQR context specific by re-evaluating TeR and TiR using Table 5-6. The criteria GeR shall be lowered by 30%[22] and the criteria P shall keep the original value.

Situation 2/Option 3

The user of the PEFCR shall apply company-specific activity data for transport and shall substitute the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets, starting from the default secondary dataset provided in the PEFCR.

Please note that the PEFCR lists all dataset names together with the UUID of their aggregated dataset. For this situation, the disaggregated version of the dataset is required.

In this case, the user of the PEFCR shall use the default DQR values. If the default dataset to be used for the process is not listed in the PEFCR, the user of the PEFCR shall take the DQR values from the original dataset.

5.6.3 Situation 3

If a process is not run by the company using the PEFCR and the company does not have access to company-specific data, there are two possible options:

[22] In situation 2, option 2 it is proposed to lower the parameter GeR by 30% to incentivise the use of company-specific information and reward the efforts of the company in increasing the geographic representativeness of a secondary dataset through the substitution of the electricity mixes and of the distance and means of transportation.

1. It is in the list of most relevant processes (situation 3, option 1);
2. It is not in the list of most relevant processes (situation 3, option 2).

Situation 3/Option 1

In this case, the user of the PEFCR shall make the DQR values of the dataset used context specific by re-evaluating TeR, TiR and GeR. The criteria P shall keep the original value.

Situation 3/Option 2

For the non-most relevant processes, the user of the PEFCR shall apply the corresponding secondary dataset listed in the PEFCR together with its DQR values.
If the default dataset to be used for the process is not listed in the PEFCR, the user of the PEFCR shall take the DQR values from the original dataset.

5.7 Which datasets to use?

According to section A.4.4.2 of the PEF Method [1], whenever a dataset needed to calculate the PEF profile is not among those listed in this PEFCR, then the user shall choose data from among the following options (in hierarchical order):

- Use an EF compliant[23] dataset available on one of the nodes of the Life Cycle Data Network http://eplca.jrc.ec.europa.eu/LCDN/
- Use an EF compliant dataset available in a free or commercial source.
- Use another EF compliant dataset considered to be a good proxy. In such case this information shall be included in the "limitations" section of the PEF report.
- Use an ILCD entry level (EL) compliant dataset. These datasets shall be included in the "limitations" section of the PEF report. A maximum of 10% of the total environmental impact may be derived from ILCD-EL compliant datasets (calculated cumulatively from lowest to largest contribution to the total EF profile).
- If no EF compliant or ILCD-EL compliant proxy is available, it shall be excluded from the PEF study. This shall be clearly stated in the PEF report as a data gap and validated by the PEF study and PEF report verifiers.

5.8 Naming of elementary flows

Elementary flows shall be identified by their UUID that can be found here:
https://eplca.jrc.ec.europa.eu/EF-node/elementaryFlowList.xhtml

5.9 Allocation rules

Allocation refers to, "partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems" (ISO 14040:2006). The general rule for allocation is that economic allocation shall be used when allocation cannot be avoided. The TS chose to use economic allocation to ensure consistency with the use of economic allocation required for various aspects of animal

[23] Compliant with quality requirements and coherence in terms of Methodology, Documentation, and Nomenclature, for the two compliance systems allowed (ILCD entry level and PEF/OEF). https://eplca.jrc.ec.europa.eu/permalink/Guide_EF_DATA.pdf .

husbandry (European Commission, 2021) and with the requirement of economic allocation by the PEFCR for Feed for Food Producing Animals [3].

The rules for allocation are set according to section 4.5 in the PEF Method [1]. **The first allocation rule** is that wherever possible, allocation shall be avoided by dividing the unit process to be allocated into sub-processes and collecting the input and output data related to these sub-processes; system expansion with substitution shall be avoided because it can lead to arbitrary choices.

Table 5-7 presents different stages/processes where allocation is necessary and the allocation rules to use. The reason that there are some exceptions from the general rule of economic allocation is that the Technical Secretariat considers that the general PEF rule provides very good instruction on how to handle allocation for important processes such as transport.

Fish flows that have no positive economic value for the operator shall not be attributed any of the environmental footprint up to the point of allocation. For example, fish that is lost or just a waste flow, with no economic value for the producer, shall not be attributed any of the environmental footprint up to the point of allocation.

Section 5.10 on how fish waste flows shall be handled also includes instructions on when allocation can be used and when the CFF (Circular Footprint Formula) shall be used.

Table 5-7 Allocation rules

Process/stage	Allocation rule
Fishing, allocation of fishing effort between products landed.	Economic allocation
Aquaculture fish farm, allocation of products for human consumption and other products.	
Feed production.	
Preparation, allocation between main products and by-products.	
Transport	Allocation according to section 4.4.3.1 of the PEF Method [1].

If the applicant multi-functional processes are **not** listed in *Table 5-7*, allocation shall be done according to the hierarchy presented in section 4.5 of the PEF Method [1]:

1) wherever possible, allocation should be avoided by dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes; system expansion should be avoided because it can lead to arbitrary choices. System expansion by substitution should be avoided because it entails arbitrary choices leading to high uncertainty.
2) where allocation cannot be avoided and subdivision cannot be applied, the inputs and outputs of the system shall be partitioned between its different products in a way that reflects relevant underlying physical relationships between them.
3) Allocation based on some other relationship may be possible. For example, economic allocation refers to allocating inputs and outputs associated with multi-functional processes to the co-product outputs in proportion to their relative market values.

5.9.1 Economic allocation rules

The allocation factor for each co-product shall be calculated based on the value ratio between the different co-products at the stage where the allocation is done. It shall be documented how this is achieved. The basic principle is that the allocation factor shall reflect the value of the co-product flow for the producer and thus these values are mandatory company-specific data.

The data that is used to set the economic allocation factor shall be representative for the last 3-year average.

One way of determining the economic allocation factor is to use the market price of the co-product. Since it is the value ratio between the co-products that are relevant it does not matter which currency this ratio is defined in, but the values that are used for each co-product shall be representative for the same market/situation and time-period. When there is no market price, it can be an intermediate product, the value ratio can be set based on the company's assessment of their profitability and value creation. Even though at the point of allocation one of the co-products might be an intermediate product it will in the end be sold and thus it can be given a value relative to the other co-products. How these allocation factors are set shall be clearly documented.

Equation (2) presents how the economic allocation factor (AF) to "product *a*" shall be calculated using the market price or in other ways defined economic value ratio (V_a and V_b) and mass yield of "co-products a and b" (M_a and M_b).

Both the unit value (V_a and V_b) and the mass yield (M_a and M_b in equation) shall be documented.

$$Allocation\ factor\ (AF)\ for\ product\ a: A_a = \frac{M_a * V_a}{(M_a * V_a + M_b * V_b)} \qquad \textit{Equation 2}$$

The following figure and equation present a generic example of how economic allocation is done at stage/process X among the co-products *a* and *b*. The example uses the carbon footprint (CF) with the reference substance CO_2-equivalents (CO_2e) as an example, but the principle is the same for all impact categories of the complete PEF:

$$CF_a\left(\frac{kgCO2e}{kg\ product\ a}\right) = \frac{CF_{TOT} * A_a}{M_a} = \frac{CF_{TOT} * \frac{M_a * V_a}{(M_a * V_a + M_b * V_b)}}{M_a}$$

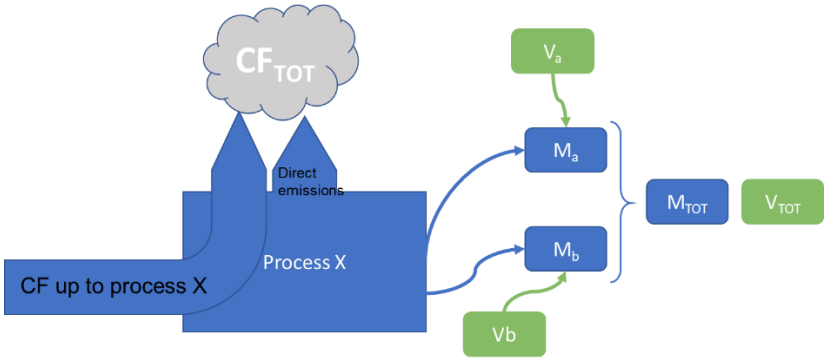

Figure 5-1 Example of economic allocation, the illustration uses the carbon footprint (CF) as an example of impact

5.9.2 Allocation - farmed products

The PEF up to the stage where fish leaves the fish farm shall be allocated among **all products with a documented commercial value**. The value that is used for each product shall reflect the value for the fish farmer.

Aquaculture can include the output of products other than fish (e.g. utilization of sludge to grow vegetable in aquaponics). If these products present an income to the producer, they can be attributed a share of the environmental footprint by applying economic allocation.

If product-specific yields and values are not available, all shall be allocated to the product for which the PEF profile is calculated.

A flow chart with mass flows and values per flow shall be included in the report, including the fate of each flow.

5.9.3 Allocation - wild products

The fishery can include the process of catching the fish and onboard preparation of the fish. Preparation ranges from the simple process of bleeding the fish to a complete fillet factory with freezing and meal/oil production.

The following rules apply for allocation of the fishery:

1. If possible, allocation should be avoided (e.g. only products that are prepared onboard carry the impacts from preparation).

The following rules are valid for the case where such measurements/data are not available:

2. The complete activity of the fishing vessel shall be allocated among the products that are landed and have a commercial value. Outputs with no value shall not be assigned any of the fishing activity.
3. The value assigned to each product shall reflect the value of the product as is at landing.

If product-specific yields and values are not available, all shall be allocated to the product for which the PEF profile is calculated.

A flow chart including all mass flows and values per flow shall be included in the report, including the fate of each flow. The flow chart shall include all flows so that the mass balance can be controlled.

5.9.4 Allocation - onshore preparation

This applies for both fished and farmed products.

If product-specific yields and values are not available, all shall be allocated to the product for which the PEF profile is calculated.

A flow chart with mass flows and values per flow shall be included in the report, including the fate of each flow.

5.10 End-of-life, waste handling and recycling

"End of life" includes the process from when the mass is discarded and ends when the product is returned to nature as a waste product or enters another product's life cycle (i.e. as a recycled input). The inventory data file presents default data for the application of the CF formula on fish and other relevant waste flows for marine fish systems.

The CF formula (section 5.10.2) shall be applied for all waste flows. The waste handling of products used during the manufacturing, distribution, retail, use, or after use stage shall be included. These processes/flows shall be modelled and reported at the life cycle stage where the waste occurs.

To separate between products and waste flows the following distinction shall be used:

- "Products" are mass flows that represent an income to the producer (quantified by market price) : value > 0. Products are handled according to the allocation rules (section 5.9).
- "Waste" are mass flows that represent a zero income or expenses to the producer: value ≤ 0.

Waste flows will include fish and other materials. These flows shall be modelled and included at the life cycle stage where they occur following the instructions for the use of the end-of-life formula.

Figure 5-2 illustrates how fish/biomass from a marine fish farm shall be handled.

The following processes shall be taken into consideration:

- Collection and transport to end of life treatment facilities;
- Sorting and other types of processing;
- Storing, including emissions from degradation during storing;
- Wastewater of products used/dissolved in or with water;
- Composting or other organic waste-treatment methods;
- Incineration and disposal of bottom ash; and
- Landfilling and landfill operation and maintenance.

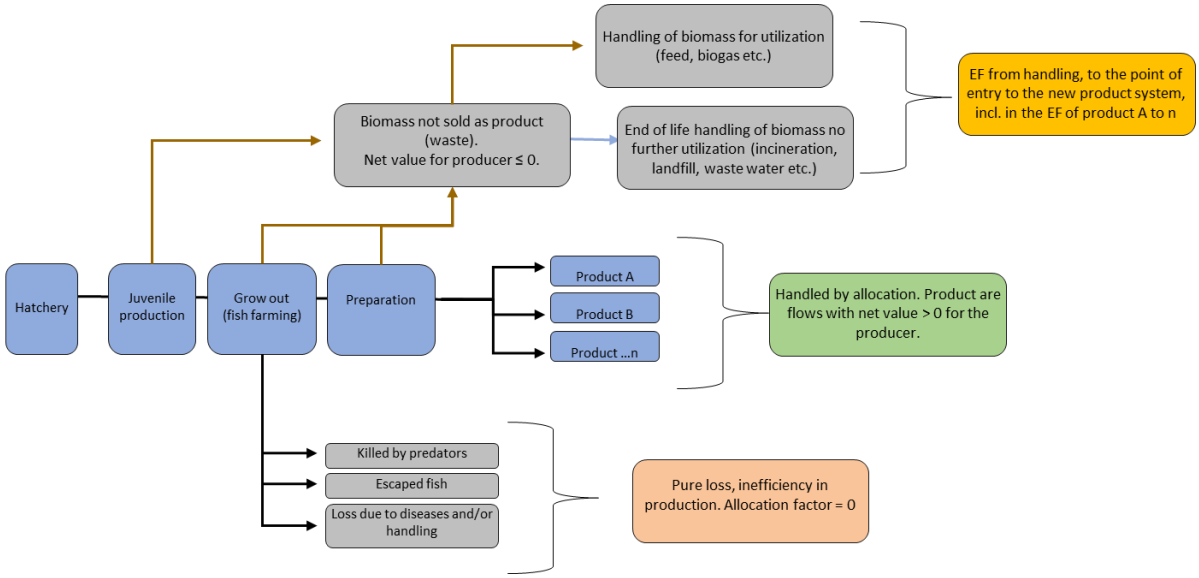

Figure 5-2 Illustration of biomass flows in marine aquaculture and handling of products and waste

5.10.1 Fish biomass and sludge carbon and energy content

Waste handling of fish biomass and sludge shall be included. If information regarding the waste treatment is available this shall be used. Annex C[24] of the PEF method (sheet R3 data MunicipalWaste), showing the share of treatment methods for municipal waste per country, or data in the sheet "**Fish and sludge CFF data**" of the "Marine Fish PEFCR Inventory Data" file (see also the Excel file, "Marine Fish PEFCR Feed emission mass balance model") shall be used if specific data are not available.

5.10.2 Circular Footprint Formula (End of life formula)

The end-of-life stage shall be modelled using the Circular Footprint Formula (CFF) from section 4.4.8 of the PEF Method [1]. The Circular Footprint Formula is an equation that incorporates the full life cycle of a product and material and energy recovery, final disposal and how burdens and benefits are shared among the actors in the life cycle.

Users of the PEF Method shall report all the parameters used. Default values for some parameters (A, R1, R2, R3 and Qs/Qp for packaging) are available in Annex C of the PEF Method [1]. This list is periodically reviewed and updated by the European Commission; therefore, users shall use the most updated values, and shall refer to the version of Annex C they are using. Annex C is available at https://eplca.jrc.ec.europa.eu/

The sheet "**Fish and sludge CFF data**" in the inventory data file presents the parameters that shall be used **if primary data is not available**. For waste flows that are not listed here, section 4.4.8 of the PEF Method [1] shall be used.

The following presents the CFF:

$$CFF = material + energy + disposal$$

24 https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Feplca.jrc.ec.europa.eu%2Fpermalink%2FAnnex_C_V2.1_May2020.xlsx&wdOrigin=BROWSELINK

$$Material: (1 - R_1)E_v + R_1\left(AE_{rec} + (1 - A)E_V \frac{Q_{Sin}}{Q_p}\right) + (1 - A)R_2\left(E_{recEoL} - E^*_V \frac{Q_{Sout}}{Q_p}\right)$$

$$Energy: (1 - B)R_3 * \left(E_{ER} - LHV * X_{ER,heat} * E_{SE,heat} - LHV * X_{ER,elec} * E_{SE,elec}\right)$$

$$Disposal: (1 - R_2 - R_3)E_D$$

$$\boldsymbol{CFF\ with\ "cut\ off\ approach": (1 - R_1)E_v + R_1E_{rec} + R_3E_{ER} + (1 - R_2 - R_3)E_D}$$

Parameters of the CFF

A: allocation factor of burdens and credits between supplier and user of recycled materials.

B: allocation factor of energy recovery processes. It applies both to burdens and credits.

Q_{sin}: quality of the ingoing secondary material, i.e. the quality of the recycled material at the point of substitution.

Q_{sout}: quality of the outgoing secondary material, i.e. the quality of the recyclable material at the point of substitution.

Q_p: quality of the primary material, i.e. quality of the virgin material.

R_1: it is the proportion of material in the input to the production that has been recycled from a previous system.

R_2: it is the proportion of the material in the product that will be recycled (or reused) in a subsequent system. R2 shall therefore take into account the inefficiencies in the collection and recycling (or reuse) processes. R2 shall be measured at the output of the recycling plant.

R_3: it is the proportion of the material in the product that is used for energy recovery at EoL.

$E_{recycled}$ (E_{rec}): specific emissions and resources consumed (per functional unit) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.

$E_{recyclingEoL}$ (E_{recEoL}): specific emissions and resources consumed (per functional unit) arising from the recycling process at EoL, including collection, sorting and transportation process.

E_v: specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material.

E^*_v: specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials.

E_{ER}: specific emissions and resources consumed (per functional unit) arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, etc.).

$E_{SE,heat}$ and $E_{SE,elec}$: specific emissions and resources consumed (per functional unit) that would have arisen from the specific substituted energy source, heat and electricity respectively.

E_D: specific emissions and resources consumed (per functional unit) arising from disposal of waste material at the EoL of the analysed product, without energy recovery.

$X_{ER,heat}$ and $X_{ER,elec}$: the efficiency of the energy recovery process for both heat and electricity.

LHV: lower heating value of the material in the product that is used for energy recovery.

5.11 Electricity modelling

The use of electricity shall be included following the requirements of section B.5.8 of the PEF Method [1].

5.12 Climate change modelling

The impact category climate change shall be modelled according to section B.5.9 of the PEF Method [1].

5.13 Capital goods – infrastructure and equipment

Infrastructure and equipment shall be included for the following:

- Fishing vessel (wild fish)
- Fishing gear(s) (wild fish)
- Infrastructure and equipment for sea water farming stage (farmed fish)
- Infrastructure for juvenile production stage (farmed fish)

All life-cycle stages shall be included: production, transport, maintenance/replacement, and end-of-life handling. Default data from the EF3.1 database and proxies can be used when specific data are not available.

5.14 Biogenic methane

A simplified approach can be used, see "Feed emission model" and the sheet "**Fish and sludge CFF data**" in the "Marine Fish PEFCR Inventory Data" file. Only the emission 'methane (biogenic)' is modelled, while no further biogenic emissions and uptakes from atmosphere are included. If methane emissions can be both fossil or biogenic, the release of biogenic methane shall be modelled first and then the remaining fossil methane.

Biogenic methane emissions shall be considered for at least:

Farmed products:

- Biogenic methane from anaerobic degradation of sludge. This includes both sludge that is built up under the sea cage fish farms and sludge that is collected and stored (e.g. from land-based farms).
- Biogenic methane from anaerobic degradation of fish waste.

Wild products:

- Biogenic methane from anaerobic degradation of fish waste. Section 5.10.1 references default values for the calculation of potential biogenic carbon emission from fish biomass and sludge.

6 Life Cycle Stages (Data collection instructions)

This chapter presents the different processes/data that shall or should be included for each life cycle stage. While this PEFCR tries to cover all major flows and activities that are included in the life cycle of unprocessed marine fish, it is still up to the integrity of the conductor of the PEF to explore this system and make sure that the PEF includes the major

flows and activities, and that the resulting PEF gives a responsible and honest understanding of the PEF profile of the product.

Figure 6-1 presents the different stages, processes, and flows that shall be taken into consideration when performing a PEF of a wild marine fish product.

Figure 6-2 presents the different stages, processes, and flows that shall be taken into consideration when performing a PEF of a farmed marine fish product.

This chapter refers to an Excel file that presents a data collection sheet and the default data that shall be used to include the different inputs and outputs. This file, the Excel file “Marine Fish PEFCR Inventory Data” is referred to as the “inventory data file”.

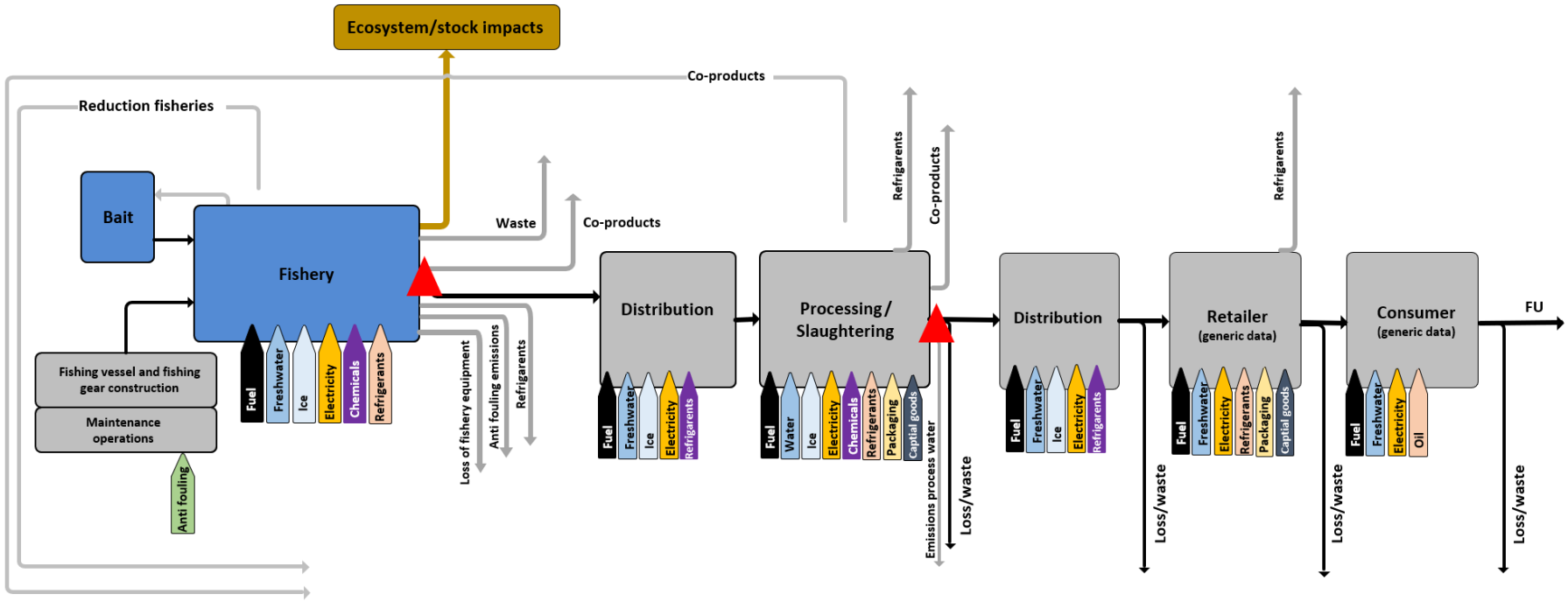

Figure 6-1 Wild product flow chart with important flows indicated; the red triangle indicates an important point of allocation.

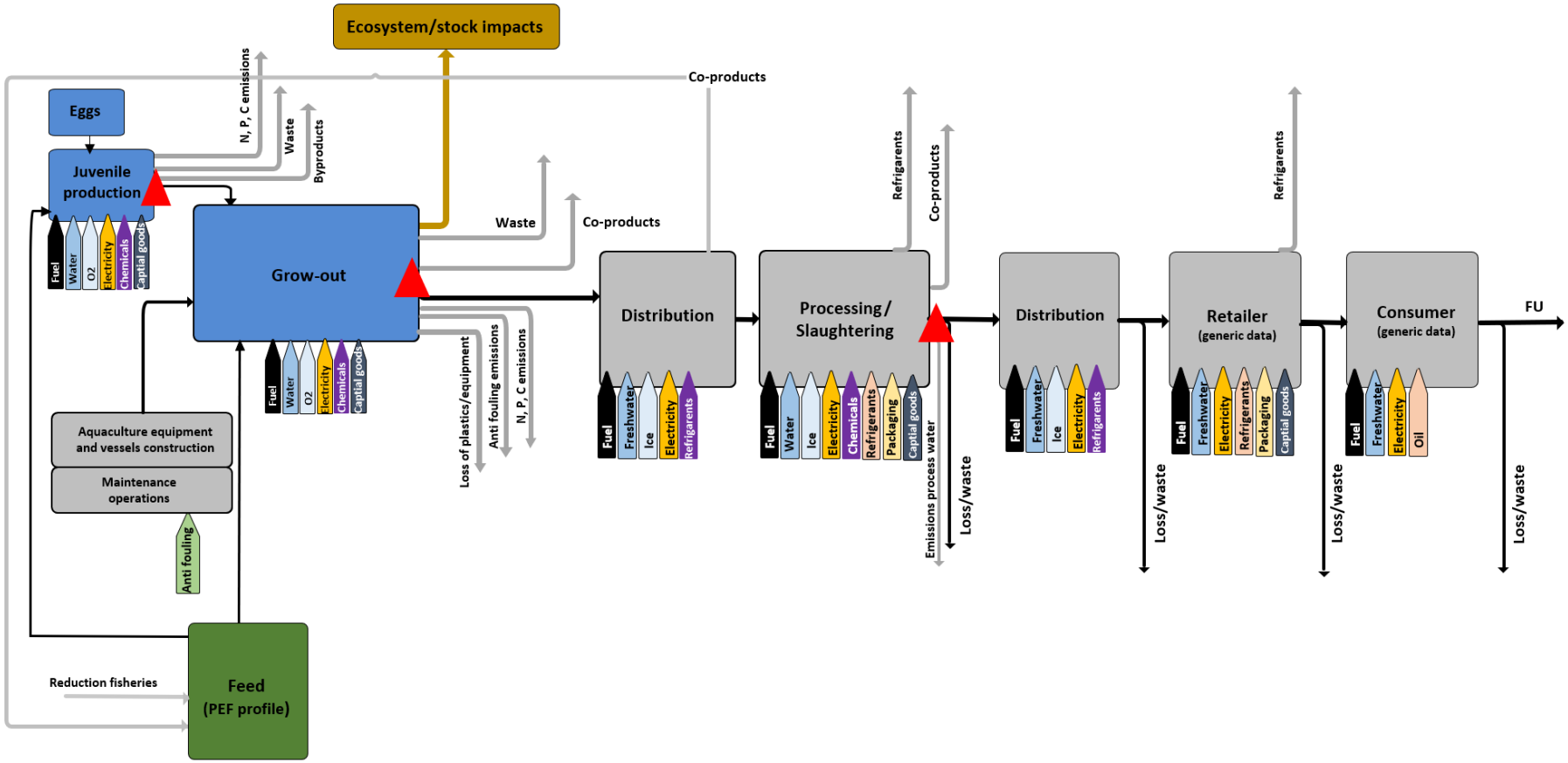

Figure 6-2 Farmed product flow chart with important flows indicated; the red triangle indicates an important point of allocation.

6.1 Fishing

Fishing includes all activities that the fishing vessel goes through to be able to deliver fish to shore. Table 6-1 presents an example of activities that are part of the fishing activity.

The sheet **"Fishing"** in the inventory data file lists the activities and direct elementary flows that shall be quantified and the default datasets for the sub-processes linked to the activity data within this process.

Primary data for transport of fishing vessel and catch to and from fishing ground can in many cases not be available and can for many companies fall below situation 2 (option 1 or 2) or situation 3 (option 1) according to the Data Needs Matrix (DNM, section 5.6). Data sampling/modelling shall be done according to section 5.2 to ensure a stratified sample.

The following methods can be used for modelling fuel use of vessels:

1) Modelling based on estimated hours in operation, fuel use and catch. The modelling may be done based on the following components:
    a. Estimated hours per vessel;
    b. Estimated hours in different operational modes; and
    c. Fuel/electricity use in different modes distinguished by type of vessel and gear used.

    The practitioner shall ensure a stratified sample, which accounts for variations in gear, seasonality, vessels etc.

2) Modelling based on datasets for fuel/electricity use per kg catch as explained in section 5.7.

The DQR shall be adjusted accordingly as described in section 5.7.

Sections 3.9 and 3.10 state additional information that shall be reported for this stage.

If the fishery includes on-board preparation this shall be included according to section 6.3.6.

Table 6-1 Activities that are part of fishing (non-exhaustive list).

Transport of fishing vessel and catch to and from fishing ground
Maintenance operations and transport of fishing vessel to maintenance
Catching of fish
Onboard preparation of fish
Onboard refrigeration and ice production
Harbour activities and onshore ice production

6.1.1.1 Handling of mixed catch and mixed gear

Fisheries can include landing of many different species and/or fishing with different gears during the period of data collection. The data shall be collected for a period that will cover several seasons.

Data to model the fishery shall be collected so that they are as specific as possible for the product that is studied. The DQR shall reflect this precision. If the product that is analysed is

the result of fisheries using different gears the data should be collected per trip. To allocate the fishing effort among the landings of each trip, section 5.9.3 presents the allocation rules.

If multiple vessels are used simultaneously (pair trawling) the total fuel use and total catch of all vessels shall be accounted for.

6.2 Feed input

The feed intensity and the feed EF is part of the mandatory company-specific data (section 5.3). The feed shall be included with its environmental footprint calculated according to the PEFCR Feed for food-producing animals [3]. The DQR score for the feed shall also be calculated.

These instructions apply for all feed that is used. When several different types of feed are used their contributions shall be weighted according to the share of the total mass of feed that is used up to the point of harvest.

6.3 Manufacturing

6.3.1 Transport of inputs to manufacturing

Transport from raw material acquisition to the preparation and transport of inputs to farming shall be included according to section 4.4.3 of the PEF Method [1].

The sheet **"Transport and distribution"** in the inventory Excel file presents the transports that shall be included and the default data to be used if primary data are not available.

6.3.2 Aquaculture: Juvenile production

This stage covers juvenile production in land-based systems, but the requirements are also relevant for full grow out of fish in land-based systems. This stage includes all activities and inputs that are necessary to operate the plant. Water input to the land-based system shall be included in the PEF. The source of raw water (surface water, ground water, desalination), as well as energy use and other inputs required for potential treatment and supply of water to the plant shall be included.

The output and handling of sludge shall be included until this stage. If the sludge presents an income to the producer of juveniles, this shall be included as a product using economic allocation.

The sheet **"Juvenile production"** in the inventory data file lists the activities and direct elementary flows that shall be quantified and the default datasets for the sub-processes linked to the activity data within this process.

It is important to note that juvenile production can include the production of small juveniles that have reached only a small percentage of their harvest weight (e.g. salmon juveniles of 100 g that are grown out to 4-5 kg at harvest), as well as fish that are brought up to a considerable percentage of their final harvest weight. However, regarding for example

salmon, operators may choose to postpone placing the fish into the sea by feeding them in onshore sites keeping them in water with increasing salinity until a weight of up to 1 kg. Nevertheless, the completion of smoltification marks the end of the juvenile stage and the start of the grow out stage.

For some species and aquaculture production systems, juveniles are acquired by catching wild juveniles that are placed in sea cages for grow out. In these cases, the data regarding juveniles shall be included according to section 6.1 Fishing.

6.3.3 Aquaculture: Grow-out of fish contained in seawater

The growing of fish in sea water includes the system from when juvenile fish are released into the fish farm and until they are ready for harvest. The fish are kept in open or covered enclosed structures (e.g. open net-pens, cages, etc.) The grow-out here includes all activities that are necessary to keep the fish farm operating and to handle the fish. For example, this includes the different vessels that are used, as well as those operated by sub-contractors, see Table 6-2.

The sheet **"Farming grow out"** in the inventory data file lists the activities and direct elementary flows that shall be quantified and the default datasets for the sub-processes linked to the activity data within this process.

Section 3.10 states additional information that shall be reported for this stage.

Table 6-2 Activities that are considered part of the grow out of fish in marine sea cages (non-exhaustive list).

Feeding and all handling of feed
Maintenance operations of fish cages, mooring systems and all other equipment
Transport of fish
Handling of fish such as grading and veterinary treatment
Use of cleaner fish including breeding, feeding and disposal
Transport of personnel and materials between land and fish farm
Energy used by equipment on the fish farm (e.g. generators, pumps, communication and monitoring systems, lighting and monitoring, oxygen production, cleaning systems and facilities for the operators).

6.3.3.1 Cleaner fish

Some operators are using various species of marine cleaner fish as a measure to control ectoparasites by introducing a certain number of these fish into the cages. The quantity of cleaner fish used, their feed, and the disposal or onward sale of the fish shall be documented.

6.3.4 Direct emissions to water

During the feeding of fish, nutrients are emitted from feed spills, faeces, and individual dead fish before they are removed from the cage. Emissions to water of nitrogen, phosphorus, carbon from the salmon cage shall be included. The Excel file "Marine Fish PEFCR Feed Emission Mass Balance model" presents a model of a feeding mass balance that shall be used to calculate these emissions based on the content of the feed, feeding efficiency and retention in the fish. Note that this model estimates emissions per unit of on-growth and

must be implemented in the analysis with respect to the mass balance considering mortality etc.

If other representative values are available (direct measurements from the company or literature values representing actual measurements in representative conditions), these can be used.

The subsequent potential degradation of carbon to methane emissions and nitrogen to N_2O is highly uncertain and depends on the specific conditions. Potential emissions shall at minimum be included based on factors in the feed emission model which is currently the best available data. Methane emissions are set to zero (based on Yuan et al. (2019) [4]), as anaerobic conditions are not likely occurring. While N2O-N/kg N input is set to 0,018 based on Hu et al. (2012) [5].

Carbon emissions from respiration shall not be included.

6.3.5 Aquaculture sludge handling

If sludge is collected, this handling shall be included. This shall include the energy used to process the sludge, emissions of biogenic methane from the sludge, and transport of the sludge to EoL handling.

Sludge consists of feed loss and faeces, containing nutrients, organic matter, and metals. Collection of sludge will lead to a reduction of carbon, nitrogen and phosphorus bound to particles, which shall be accounted for in the modelling of emissions to water.

6.3.6 Preparation

Preparation includes transformation of the fish such as gutting, filleting, freezing, etc., and this process shall be included using company-specific data. See section 3.1 for more information on the difference between preparation and processing. For fished products, preparation can happen both on the fishing vessel and on shore. For preparation on the fishing vessel, this process shall be included in the data for the fishery as stated in section 6.1.

The sheet **"Preparation"** in the inventory data file lists the activities and direct elementary flows that shall be quantified and the default datasets for the sub-processes linked to the activity data within this process.

The source of raw water (surface water, ground water, desalination), as well as energy use and other inputs required for potential treatment and supply of water to the plant shall be included.

Emissions to water shall be included and the treatment methods applied shall be described. The following parameters shall be included in the quantification of the emissions to water: the total organic carbon (TOC), the chemical oxygen demand (COD), the total nitrogen (TN), the total phosphorus (TP), the total suspended solids (TSS) and the biochemical oxygen demand (BOD).

6.3.7 Waste from manufacturing

Waste generated during manufacturing (i.e. both fish and other materials) shall be included in the modelling. The waste handling shall be modelled using the Circular Footprint Formula (section 5.10).

6.4 Distribution stages

The distribution stage shall include the transport activity, packaging and product loss and waste handling.

6.4.1 Transport and storing of the marine fish product

Fish is distributed in many ways from the point where it is landed to final consumption.

The following distribution processes shall be included (non-exhaustive list):

- Transports from landing to preparation
- Transports from preparation to retailer
- Storage and distribution hubs
- Transport to consumer

Systems may include numerous iterations of sequences of preparation and storage and all transport of fish shall be included.

In general, these distribution processes shall be included according to section 4.4.3.5 of the PEF Method [1]. The sheet **"Transport and distribution"** in the inventory data file presents the transport and distribution activities that shall be included and default datasets.

Transport of the fish before it is landed shall be included in the fishing or farming stages.

All storage during distributions shall be included. If company-specific data is not available, the sheet "**Retail and use**" in the inventory data file presents data that can be used to include the storage. The same data can be used for chilled storage in distribution, at retailer and consumer.

6.4.2 Packaging production and waste handling

Packaging shall be included with production of materials, transport, and end-of-life handling (waste handling) according to the CFF formula (section 5.10.2). Packaging used in all distribution stages shall be included (transport and consumer packaging).

The sheet **"Packaging"** in the inventory data file presents data that can be used for the production of different packaging materials if primary data is not available (the full PEF profile of the product-specific packaging). The mass of the different materials in the packaging shall be explicitly documented as well as the parameters used in the CFF calculation for the packaging material.

6.4.3 Waste at distribution

The waste of products during distribution and retail shall be included in the modelling. (Waste refers to all fish biomass that leaves the value chain without a value for the producer.) Waste handling shall be included according to section 5.10.

6.5 Retailer and consumer

The retailer and the consumer stage shall be included. The sheet "**Retail and use**" in the inventory data file presents the data that shall be included and default data that can be used if primary data are not available. The following processes shall be included:

- Chilled storage at retailer;
- Transport from retailer to consumer; and
- Use phase at consumer.

The default data for the retailer stage are based on data from the Retail OEFSR[25] and the consumer stage based on data from PEF Annex II, part D [1].

Waste at retailer and consumer stage shall be included. If primary data is not available, default data shall be used. The food waste will be the combination of default loss rates and yield data. Default data are default loss rates per type of product from PEF Annex II, part F [1]. Waste handling shall be included according to section 5.10. See inventory file for default data.

6.6 End-of-life fish consumer product

Waste handling of the fish products that are not consumed and their packaging materials shall be included according to section 5.10.

According to PEF Annex II, part F, if primary data on waste handling is not available, the food losses at the distribution centre, during transport, at retail place, and at home shall be modelled as: 50% trashed (i.e. incinerated and landfilled), 25% composted and 25% anaerobically digested.

7 PEF results

7.1 Benchmark values

The Excel file "Marine Fish PEF-RP Results" presents the complete hotspot analysis and benchmark results (available at www.marinefishpefcr.eu/resources).

7.2 PEF profile

The user of the PEFCR shall calculate the PEF profile of its product in compliance with all requirements included in this PEFCR. **The impact assessment method that shall be used is presented in section 3.8.** The following information shall be included in the PEF report:

- full life cycle inventory;
  - characterised results in absolute values for all impact categories (as a table);
  - normalised results in absolute values for all impact categories (as a table);
  - weighted results in absolute values for all impact categories (as a table);

[25] Retail OEFSR: https://wayback.archive-it.org/org-1495/20221006222603mp_/https:/ec.europa.eu/environment/eussd/smgp/pdf/OEFSR-Retail_15052018.pdf

- the aggregated single overall score in absolute values;
  - the stock sustainability assessment and the indicator of the impact on the seabed (section 3.10);
- other additional environmental information (section 3.10) and additional technical information (section 3.9); and
- the contribution from "GWP – land use change" shall be reported separately[26], and results shall be reported including and excluding its contribution.
- the contribution from potential CH_4 and N_2O emissions from sludge, waste and accumulation of feed losses, faeces, etc. underneath open farming systems shall be reported separately[27], and results shall be reported including and excluding its contribution.

Together with the PEF report, the user of the PEFCR shall develop an aggregated EF compliant dataset of its product in scope. This dataset shall be made available to the European Commission. The disaggregated version may remain confidential or be shared with the European Commission.

8 VERIFICATION

A PEF study carried out in compliance with this PEFCR shall be verified according to section B.8. of the PEF Method [1].

9 REFERENCES

[1] European Commission, "Commission recommendation (EU) 2021/2279 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations," 15 December. 2021. https://eur-lex.europa.eu/eli/reco/2021/2279/oj/eng

[2] S. Fazio, L. Zampori, A. de Schryver, O. Kusche, L. Thellier, and E. Diaconu, *Guide for EF compliant data sets (Version 2.0)*. 2020.

[3] European Commission, "PEFCR Feed for food producing animals version 4.1 April 2018," no. April. 2018.

[4] Yuan, J., Xiang, J., Liu, D. *et al.* Rapid growth in greenhouse gas emissions from the adoption of industrial-scale aquaculture. *Nat. Clim. Chang.* 9, 318–322 (2019). https://doi.org/10.1038/s41558-019-0425-9

[5] Hu, Z., Lee, J.W., Chandran, K. *et al. Environmental Science & Technology* **2012** *46* (12), 6470-6480. https://pubs.acs.org/doi/10.1021/es300110x

[26] As the contribution from GWP – land use change to GWP – total is typically larger than 5 % the subcategory shall be reported separately as according to the PEF Method section A.4.2.8.3.

[27] The reporting of these emissions shall be done separately due to the current uncertainty and the difficulty of measuring.

10 ANNEXES

10.1 Annex 1: Review Panel

LCA expert, **Dr. Angel Avadí** graduated in Computer Systems Engineering in 2002, from the Catholic University of Guayaquil (Ecuador). He obtained in 2006 a MSc in e-Business (International University of Japan), in 2008 a MSc. in International Cooperation Policy (Ritsumeikan Asia Pacific University - Japan), and in 2010 a MEng. in International Material Flow Management (University of Applied Science Trier - Germany). Between 2011 and 2014, he worked on his PhD thesis (University of Montpellier - France) focused on the sustainability of value chains associated with Peruvian fisheries, including aquaculture. Since 2015, he is a researcher at the French Agricultural Research Centre for International Development (CIRAD). He has contributed to various projects focused on seafood systems, including a project funded by Sustainable Recycling Industries (SRI) during which he provided dozens of LCI datasets to ecoinvent (2018); and two European Value Chain Analysis for Development (VCA4D) projects focused on Zambian aquaculture (2018) and Gambian fisheries and aquaculture (2020). Angel has contributed dozens of life cycle inventory datasets to the French AGRIBALYSE agricultural LCA database. Angel has also reviewed projects and methodological guidelines focused on seafood systems, such as VCA4D projects on Cambodian aquaculture (2017) and Malian inland fisheries (2020), as well as several project proposals submitted to the German Research Foundation (2017) and the Research Council of Norway (2020). He has published 35 scientific papers to date, with nine additional pieces currently under review.

LCA expert, **Dr. Ian Vázquez-Rowe** graduated in Biology in 2006 at the University of Texas at Arlington. He then continued his graduate studies in Environmental Engineering at the University of Santiago de Compostela – USC (2006-2008), with a short Erasmus period at the University La Sapienza in Rome where he developed his master thesis. In October 2008 he initiated his research career at USC, where he obtained his PhD in Chemical Engineering in July 2012. Currently, Dr. Vázquez-Rowe is an Associate Professor at the Department of Engineering at the Pontificia Universidad Católica del Perú. He has participated in numerous research projects at a European, Spanish, Galician, Luxembourgish and Peruvian level, as well as recent projects with UN Environment. Dr. Vázquez-Rowe has published over 110 articles in international journals. Currently, he is also the editor for Ocean Resources and Marine Conservation at the International Journal of Life Cycle Assessment and for Journal of Environmental Management. One of his main research lines has been linked to analyse the environmental sustainability of seafood products, mainly from wild fisheries. He has contributed to various projects focused on seafood systems, including a project funded by Sustainable Recycling Industries (SRI) during which he provided dozens of LCI datasets to ecoinvent (2018), together with Ángel Avadí. More recently, he has started working on the environmental impacts related to the dissipative release of plastic fragments to the ocean and the associated effects on human health and (ocean) ecosystem quality. Since 2019 he co-chairs the Marine impacts in Life Cycle Assessment (MarILCA) projects, which aims at establishing novel characterization factors and impact categories to compute environmental impacts and damages associated to marine plastics in Life Cycle Impact Assessment.

Industry expert, **Tom Maidment** graduated with a MEng degree in Automotive Engineering with Sustainability from the University of Warwick (UK) in 2017 and became a Chartered Engineer in 2022 with the Institution of Engineering and Technology. Mr. Maidment currently works for Hilton Foods as Group Product Sustainability Senior Manager (since 2021) and is an Associate at Oxford Net Zero (since 2023). Prior to this he worked at Jaguar Land Rover (2014-2021) on Environmental Lifecycle Assessment and before that in a number of product development roles and was Technical Director of E.Mission (2018-2023), a business which he founded to improve public understanding of the carbon footprint of food. During his career Tom has worked on a number of lifecycle assessment related projects across sectors including completing a lifecycle assessment for the production of insect derived livestock feed, developing a tool which used natural language processing to automatically calculate the carbon footprint of online recipes and supporting Seafish in the development of a carbon measurement tool.

10.2 Annex 2: Description of how the representative product was developed

The PEF study of the representative products (section 3.4) are documented in the report, "Marine Fish PEF-RP Report" (available at www.marinefishpefcr.eu/resources).

10.3 Annex 3: Default datasets

The inventory data file presents the relevant default datasets (available at www.marinefishpefcr.eu/resources).

10.4 Annex 4: Public Review Reports

The following review reports (Excel files) provide comments received and responses from the TS (available at www.marinefishpefcr.eu/resources):

1) Review Reports for 1st Draft PEFCR and PEF-RP (August-October 2021)

2) Review Report for 2nd Draft PEFCR and PEF-RP (July-August 2024)

3) Review Report for Final Draft PEFCR and PEF-RP (October 2024)

10.5 Annex 5: Section 3.1.8 of the STECF report *Marketing standards: review of fishery criteria and underlying methodologies* (EWG 22-12)

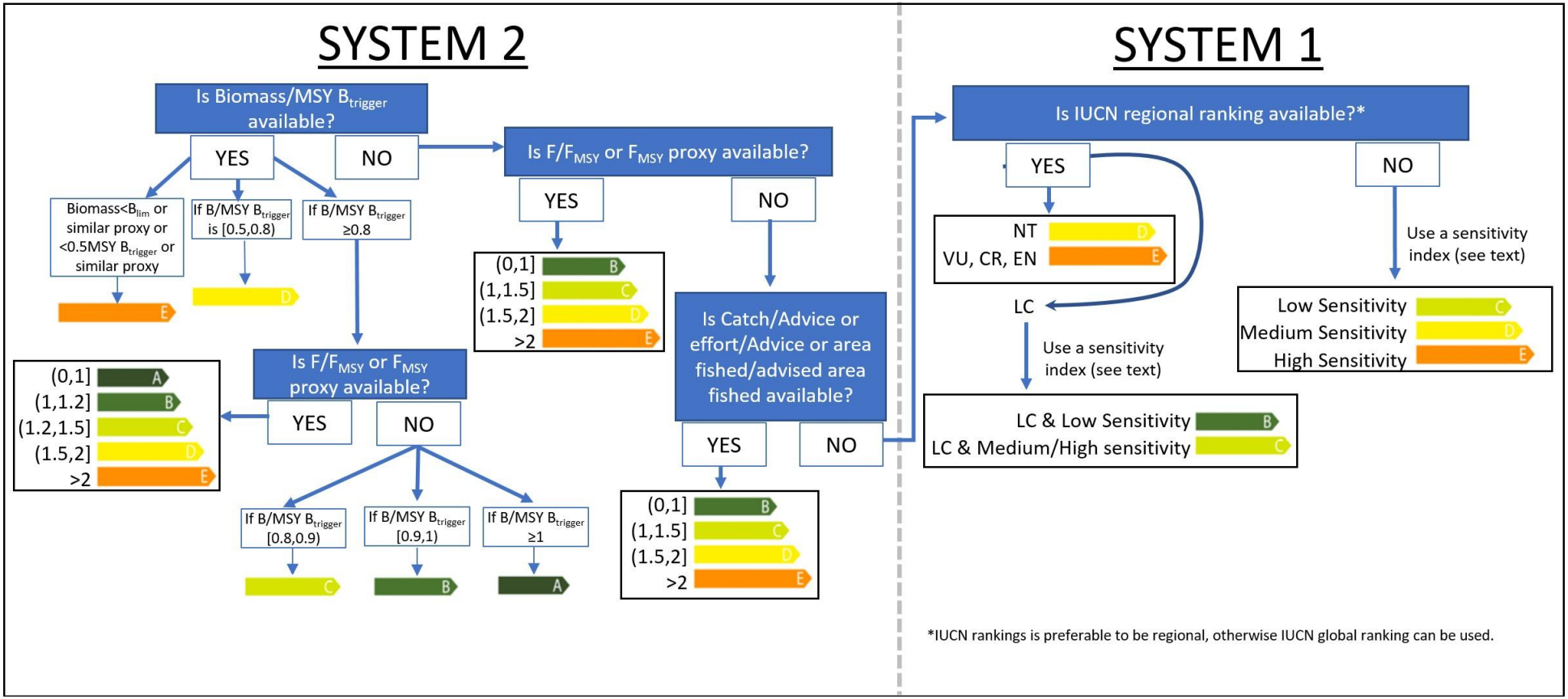

Figure 2. Decision tree to evaluate sustainability level according to fishing pressure (LC: Least Concerned; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered). See text for the description of System 2 (steps 1 and 2) and System 1 (step3). The specific limits between the grades B/C/D should be further analysed (see text on step 2).

Step 1 (system 2). The grading of a stock will be based only on Table 6 in the case the evaluation of F/F_{MSY} or proxies (e.g., short-lived species) are not available. If F/F_{MSY} or proxies are available, the stock will be graded according to step 1 and step 2. However, in the case the stock is graded as D or E according to Table 6 (step 1), step 2 is not considered.

It is important to stress that, while B_{lim} and MSY $B_{trigger}$ are only used by ICES (see as example: https://sid.ices.dk/Default.aspx), other RFMOs use similar indicators to identify overfished stocks and management action is to be taken to reduce fishing pressure (e.g., in the US, 0.5 B/BMSY can be used depending on the stock, https://www.fisheries.noaa.gov/national/sustainable- fisheries/status-stocks-2020#the-science-behind-stock-status).

Table 6. Grading systemaccording to biomass in step 1 (System2). The specific limits between the grades B/C/D should be further analysed (see text on step 2).

Grade	Biomass / MSY $B_{trigger}$ (or proxies) average over 6 years
A	Biomass / MSY $B_{trigger}$ (or proxies) greater than or equal to 1*
B	Biomass / MSY $B_{trigger}$ (or proxies) in the interval [0.9-1)*
C	Biomass / MSY $B_{trigger}$ (or proxies) in the interval [0.8-0.9)*
D	Biomass / MSY $B_{trigger}$ (or proxies) in the interval [0.5-0.8)
E	Biomass $< B_{lim}$ (or proxies)** or Biomass < 0.5 MSY $B_{trigger}$ (or proxies)

* Use this grade only when stocks have no estimate of F/F_{MSY} or proxies (e.g. short- lived species). When F/FMSY is available, use ranking from step 2.

** In the case Biomass < B_{lim}, ranking according to MSY $B_{trigger}$ should not occur.

Step 2 (system2). This step grades F/F_{MSY} or catch/advice according to Table 7 (see as example: https://sid.ices.dk/Default.aspx).

Table 7. Grading system according to exploitation level in step 2 (System2). The specific limits between the grades B/C/D should be further analysed (see text on step 2).

Grade	Biomass / MSY $B_{trigger}$ (or proxies) available and above 0.8, F/F_{MSY} (or proxies) average over 6 years available	Biomass / MSY $B_{trigger}$ (or proxies) not available and F/F_{MSY} (or proxies) average over 6 years available	Biomass / MSY $B_{trigger}$ (or proxies) not available and F/F_{MSY} (or proxies) average over 6 years not available Catch / Catch Advice or Effort / Effort Advice or area fished / advised area fished average over 6 years available
A	(0, 1]	-	-
B	(1, 1.2]	(0, 1]	(0, 1]
C	(1.2, 1.5]	(1, 1.5]	(1, 1.5]
D	(1.5-2]	(1.5-2]	(1.5-2]
E	> 2	> 2	> 2

It uses catch/advice only when F/F_{MSY} is not available. Grade A can only be attained for stocks when B / MSY $B_{trigger}$, or a proxy for this, is available. The specific limits between the grades B/C/D presented both in Tables 6 and 7 should be further evaluated in the future to ensure an even distribution of the three categories. In general, the equal distribution of stocks within the three groups would indicate appropriate levels for the grading efficiency, however this topic should be further discussed and analysed in a dedicated meeting using real data.

Would it be the case of adding here as STEP 3 the situation where the approach of the worst assessment level should be applied? (system1). If yes, it could be:

Step 3 (system 1). The evaluation is being carried out under system 1 when there is no available grading according to biomass and fishing mortality for the stock used or the information on the specific area is lacking.

In this case, if the wide marine region is known and assessments for other stocks of the same species occurring in the region are available, the worst assessment level is assigned.

Step 4 (system 1). The fourth option can be applied when there is no available grading according to biomass and fishing mortality for any stock of the considered species in the wide marine region, but an IUCN ranking and sensitivity analyses for the species (e.g., fishbase.org, sealifebase.org, etc.) are available.

If available, the IUCN ranking at regional level (regional as defined in IUCN website) is important to consider to score a stock under system 1, otherwise the global ranking can be used. The process will follow the suggestion provided in Table 8.

Table 8. Grading system according to system 1 based on sensitivity to fishing pressure. Data Deficient (DD), Not Evaluated (NE) or Not Applicable (NA).

Grade	IUCN ranking	Sensitivity ranking for NE, NA and DD stock or species
A	-	-
B	LC (low sensitivity)	-
C	LC (medium or high sensitivity)	Low sensitivity
D	NT	Medium sensitivity
E	VU, EN, CR	High sensitivity

Appendix 1 PEF study template

The PEF study template as provided in Annex II (part E) of the PEF guidance (European Commission, 2021).

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Appendix 2 Validation statement

Product Environmental Footprint Category Rules for Unprocessed Marine Fish Products

Review panel members:

Category	Name	Affiliation
Industry expert	Tom Maidment	Hilton Foods
LCA expert	Angel Avadí	CIRAD
LCA expert	Ian Vázquez-Rowe	PUCP

The members of the Review Panel confirm not to have conflicts of interest with respect to concerned products and any involvement in previous work (PEFCR development, Technical Secretariat membership, consultancy work carried out for the user of the PEF method) during the last three years.

The objective of this validation is to check whether the Product Environmental Footprint Category Rules for Unprocessed Marine Fish has been developed in compliance with the most updated version of the PEF method (2021) and that the information and data included in the study are reliable, credible, and correct.

The Review Panel members consider that:

- The Marine Fish PEFCR has been developed in accordance with the latest PEF guidance (2021).
- The data collection requirements (i.e. for company specific and secondary datasets) are appropriate.
- The hotspot analysis is applied, and reported upon, correctly.
- The identified LCA data and additional technical and environmental information give descriptions of the significant technical and environmental impacts associated with this product.
- The PEFCR gives suggestions for improvements and limitations of the PEFCR study itself and the studies on two representative products.
- The comments given on the draft PEFCR were seriously considered and worked on, leading to changes in the documents or explanations.
- Overall, the Technical Secretariat of the Marine Fish PEFCR has addressed the concerns raised by the Review Panel with clear and sufficient responses.

Points of attention and/or limitations of the PEFCR are as follows:

- We fully support TS's recommendation for the addition of impact categories for marine ecotoxicity, biotic impacts, and plastic pollution to the PEF method.

- As stated in the PEFCR, biodiversity impact cannot yet be fully taken into account, so we support the PEFCR's inclusion of biotic and seabed impact indicators under additional environmental information. It is important to improve this in the future. We recommend that the TS and EF Team discuss the results of a consultancy done for the JRC on the inclusion of biotic stock depletion and seabed damage. We also recommend that the TS and EF Team look into the recently published GLAM method (https://www.lifecycleinitiative.org/activities/life-cycle-assessment-data-and-methods/global-guidance-for-life-cycle-impact-assessment-indicators-and-methods-glam/). This could be a way to further improve the Marine Fish PEFCR, as ocean-related indicators are critical in the understanding of these systems, even if historically understudied. In fact, GLAM has included a first impact category on plastic pollution that could be eventually incorporated to the Marine Fish PEFCR.

- EF background data does not currently support accurate company-specific modelling of fuel. This should be addressed as soon as possible. For example, the promotion of "Diesel combustion in construction machine {GLO}" instead of a process representing diesel burned in a marine engine seems problematic, and easy to improve if the right datasets are included in the EF database.

- In a revised version of the PEF-RP, enough data should be gathered from around the EU to calculate EU-specific datasets (e.g. regarding annual catch, which is currently based on data from the Norwegian fishing fleet).

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- It would be helpful to include more information regarding the composition of the feed. While we understand that the assessment of feed impacts corresponds to another PEFCR, the lack of information on its composition is a setback to interpreting the results. Although tables 36 and 37 of the PEF-RP provide the composition of the feeds that were considered, it would be relevant to include the breakdown of impacts of each item, to detect whether there could be any inconsistencies.

- Considering that the benchmark is now largely based on non-existent, virtual products, the benchmark will improve over time as more studies have been performed and more high-quality data becomes available. As insights develop and the benchmark is improved, the Marine Fish PEFCR should adapt to the emerging benchmark accordingly.