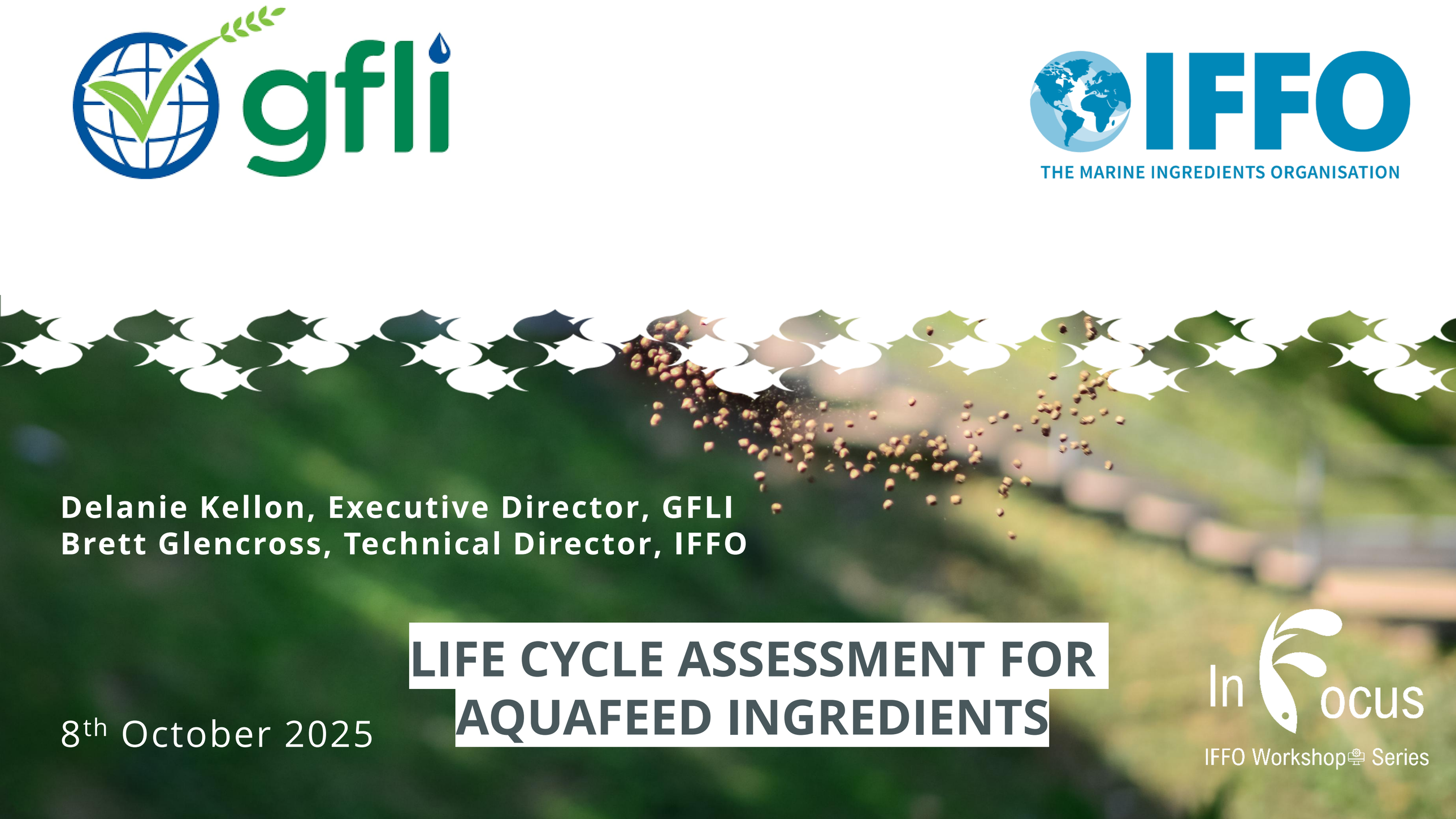


Delanie Kellon, Executive Director, GFLI
Brett Glencross, Technical Director, IFFO

LIFE CYCLE ASSESSMENT FOR AQUAFEED INGREDIENTS

8th October 2025

In Focus
IFFO Workshop Series

Global Metrics for Sustainable Feed

October 8, 2025

SUSTAINABLE FEED & FOOD PRODUCTION

IFFO InFocus Webinar

www.globalfeedlca.org

Independent non-profit institute with the purpose of:

- Providing a globally accessible, evolving animal feed ingredient Life Cycle Analysis (LCA) database;
- Supporting compliant, credible, and transparent environmental assessment of animal feed ingredients and their role in the environmental footprint of animal derived products; and
- Fostering continuous improvement of the environmental performance of animal derived products.

GFLI timeline

While the Institute was established in 2019, a long road came before...

2020 onwards
Publication of the database, member-based institute, data licensing

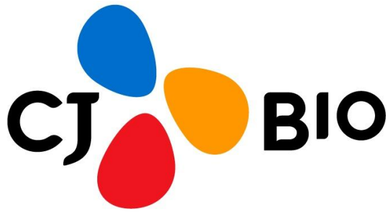
2019
GFLI founded as non-profit institute

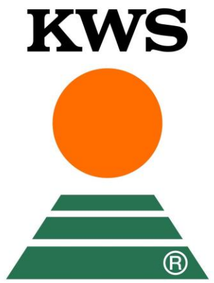
2016-2018
GFLI methodology created according to FAO-LEAP & EU PEFCR Feed

2015
GFLI established as a coalition project

2010-2015
Start of feed LCA research

GFLI Corporate Members





GFLI Association Members

FEFAC
Experts in Animal Nutrition

AFIA
American Feed Industry Association

Animal Nutrition Association of Canada
ANAC
Association de nutrition animale du Canada

SjømatNorge
Norwegian Seafood Federation

EuroFAC
La Représentation Européenne de la Nutrition Animale Française
EU French Feed Industry Representation

US SOY

Farm Carbon Toolkit

USSEC

SEGES INNOVATION

DVT
DEUTSCHER VERBAND TIERNAHRUNG E.V.

sindiraçoes
Sindicato Nacional da Indústria de Alimentação Animal

aic
agricultural industries confederation

Cool Farm

asc
ASC-AQUA.ORG
TM

Nevedi

U.S. GRAINS COUNCIL

IFFO
THE MARINE INGREDIENTS ORGANISATION

NARA
NORTH AMERICAN RENDERERS ASSOCIATION

DAKOFO
Danish Grain & Feed

IFIF
Feed the world

Join the GFLI!

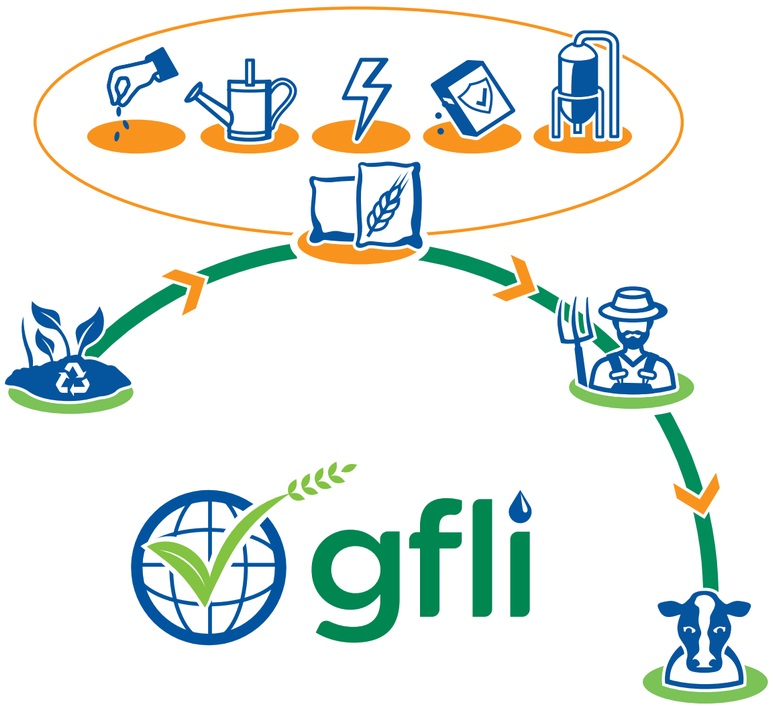
Interested in membership, providing or accessing data, or becoming a strategic partner? Let us help you meet your sustainability goals! Contact the GFLI Secretariat for more information at: info@globalfeedlca.org

47

MEMBERS

Check out our website!

What is the GFLI database?



- High-quality, comprehensive database of emissions using LCA metrics for more than **1,830 feed ingredients**.
- Methodology aligned with **FAO-LEAP** & **EU PEF Feed**
- System-boundary: **cradle-to-gate** of feed mill
- Full environmental footprint with **16+ impact categories** according to EF3.1 & ReCiPe Midpoint (H)
- Ingredient outputs are presented per **1 ton (1000 kg) of fresh weight**
- Datasets are based on statistics & **secondary** data sources, or **aggregated primary** data
- Data quality rating (**DQR**) metrics aligned with EU PEFCR Feed
- Three **allocation** methods: mass, economic, energy
- Three **formats** to accommodate different users: LCIA, system processes, unit process

Database users - feed companies

Leverage GFLI data as a parameter in feed formulation, innovate

Benchmark, deliver sustainability reports (Scope 3), coms & marketing

Database users – LCA practitioners research institutes, food companies

Integrate GFLI data in LCA studies or software tools

Define footprint of food production (both animal and plant-based products)

Database users – LCA practitioners research institutes, food companies

Identify opportunities for impact reduction (scenario analysis)

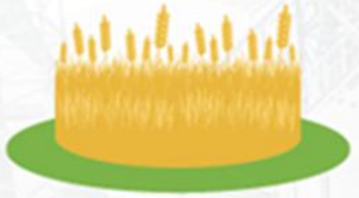
Communicate results and impact reductions

DATA COLLECTION REQUIREMENTS

FEFAC
Experts in Animal Nutrition

SCOPE

Feed Sourcing Stage



Environmental impacts of the sourced feed ingredients

Inbound Transport

Default distances available in the PEFCR Feed

Feed Manufacturer Stage

- Factory energy consumption
- Nutritional Analysis
- List of Feed Ingredients part of the feed composition

Outbound Transport

Livestock Farm Stage

- Emissions related to feed digestion

Animal Products

Red Meat PEFCR?

Egg PEFCR?

Poultry Meat PEFCR?

Marine Fish PEFCR?

Use of secondary data allowed

Company Specific Data Required

GFLI serves as a catalyst for the feed sector, and beyond…

Validation of environmental footprints of companies (branded data)

Compliant with national regulatory developments, voluntary schemes and certifications

High-quality database of secondary data

Recognition within and beyond the animal feed sector

Forms the basis for full supply chain alignment

High-quality database of secondary data

The GFLI database is accessible via the purchase of a license agreement. Other license types to respond to additional use cases will be available soon.

Commercial license

- Benchmarking
- Environmental parameters for compound feed production
- Improve internal processes
- Marketing and communication

Developer license

- Data integration in any tool

Research license

- Academic and other research and studies

Validate environmental footprints of companies

GFLI's 'Branded Data' methodology was developed to respond to the growing demand for primary data and many companies' interest in showcasing their own environmental footprint.

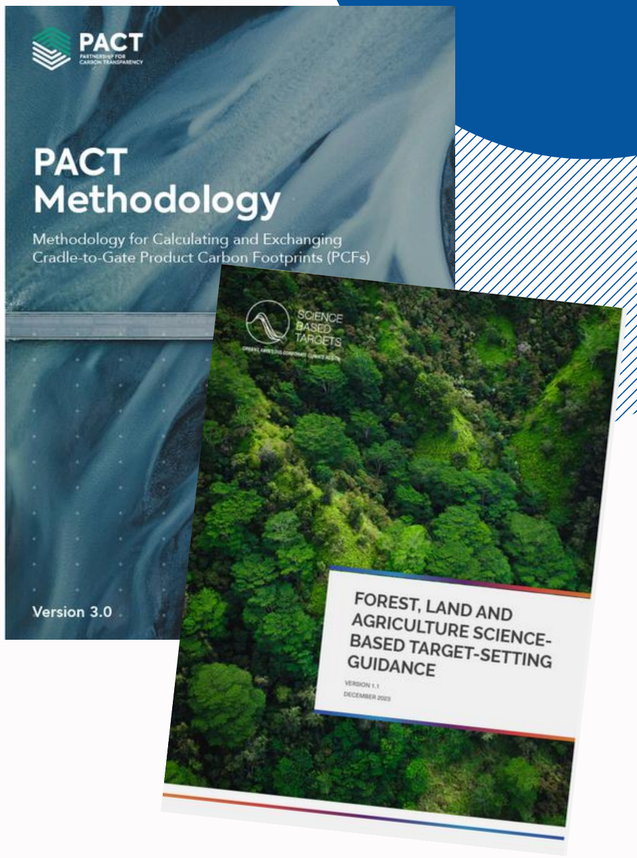
- Gives insight into a company's emissions in order to track sustainability over multiple years
- Allows for sustainability reporting through a recognized methodology
- Allows for comparison of a company-specific ingredient with the averages in the GFLI database
- Gives a company insights into its own supply chain so it can drive sustainability
- Marketing and communication purposes

Recognition within and beyond the animal feed sector

GFLI currently has 47 members, from large international feed companies to national feed associations and research institutes.

The GFLI database is utilized by more than 500 users through commercial licenses and developer license integration of the data into third-party tools.

Voluntary schemes, reporting and certifications



Latest developments:

- SBTI-FLAG compliant version of the GFLI database for corporate targets to reduce emissions
- Guidance for accepting higher tier approaches (yielding more precise data) in National Inventory Reports
- Involved in the OECD's development of a framework for measuring carbon footprints of Agri-Food Products
- Listed on the PACT website for compliant data exchange

Forms the basis for full supply chain alignment

With all previous steps, we've aimed to provide high quality data calculated in a transparent manner, and compliant with relevant methodologies in order to meet the needs for environmental footprints of feed (and food) ingredients calculated up to the feed company gate. But the data’s value extends far beyond this point in the chain.

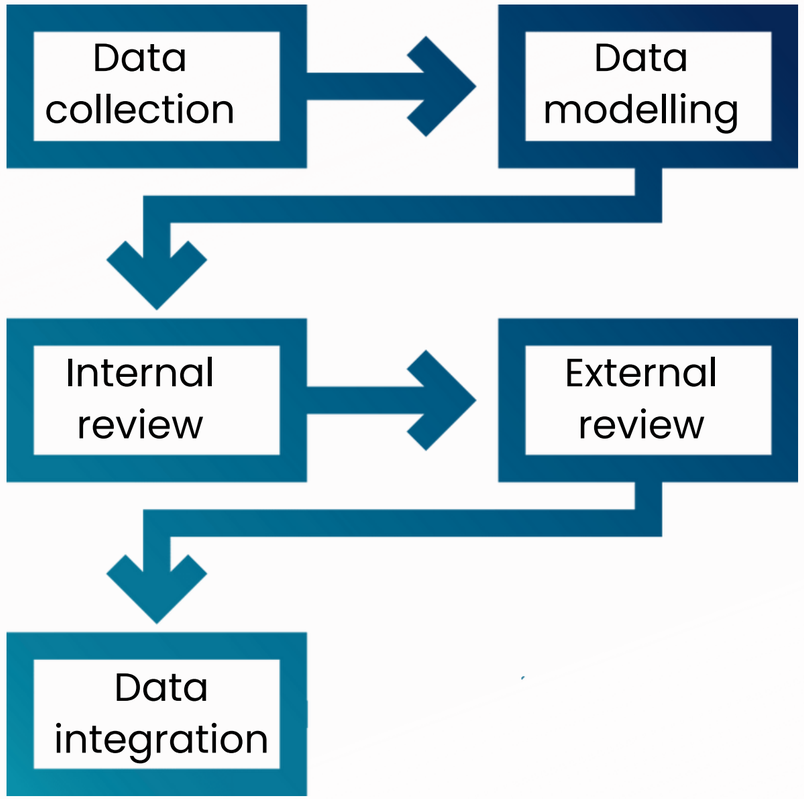
GFLI continues to strengthen partnerships with relevant organizations to ensure that the GFLI methodology and database are used as the basis for calculating feed (and food)-related emissions throughout the full supply chain (including plant-based foods and pet food).

Help GFLI become the global standard for feed LCA emissions data and bring us in contact with downstream partners and relevant organizations to further align!

DATA GENERATION

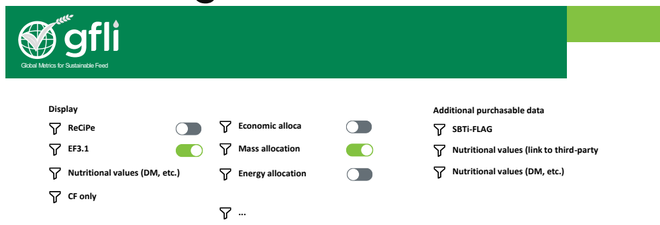
How is data added to the GFLI database?

- LCA data from various sources contributed by data providers
- Data providers: research institutes, universities, associations, companies, a consortium of entities
- Goal: collect and model data per GFLI Methodology to fill gaps, improve existing datasets, or improve methodology (i.e. regionalized modelling)
- Branded data: product-specific data
- Internal and external reviews ensure high quality and transparency
- Process description: transparency re: data sources and details about data collection and modelling.

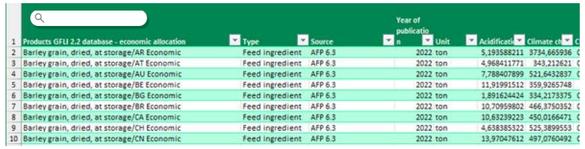


In progress...

Launching our IT-framework



2026



	Products GFLI 2.2 database - economic allocation	Type	Source	Year of publication	Unit	Acidificat	Climate ch
2	Barley grain, dried, at storage/AR Economic	Feed ingredient	AFP 6.3	2022	ton	5,193588211	3734,665936
3	Barley grain, dried, at storage/AT Economic	Feed ingredient	AFP 6.3	2022	ton	4,968411771	343,2126211
4	Barley grain, dried, at storage/AU Economic	Feed ingredient	AFP 6.3	2022	ton	7,788407899	521,6432837
5	Barley grain, dried, at storage/BE Economic	Feed ingredient	AFP 6.3	2022	ton	11,91991512	359,9265748
6	Barley grain, dried, at storage/BG Economic	Feed ingredient	AFP 6.3	2022	ton	1,891624424	334,2173375
7	Barley grain, dried, at storage/BR Economic	Feed ingredient	AFP 6.3	2022	ton	10,70959802	466,3750352
8	Barley grain, dried, at storage/CA Economic	Feed ingredient	AFP 6.3	2022	ton	10,63239223	450,0166471
9	Barley grain, dried, at storage/CH Economic	Feed ingredient	AFP 6.3	2022	ton	4,638385322	525,3899553
10	Barley grain, dried, at storage/CN Economic	Feed ingredient	AFP 6.3	2022	ton	13,97047612	497,0760492

2025

AKTUELT

Charting New Waters: Building the First PEF-Compliant Generator for Fisheries and Feed ingredients

POSTED ON 20. MAY 2025 BY TRINE SIRNES

In a major leap forward for environmental transparency in the seafood sector, a new collaboration is underway between GFLI (Global Feed LCA Institute), Sjømat Norge, and LCA.no. Their joint project, funded by FHF (The Norwegian Seafood Research Fund), aims to deliver a cutting-edge, cloud-based tool for environmental data generation — the first of its kind to comply with both GFLI standards and the EU's Product Environmental Footprint (PEF) methodology.

2026

Inclusion of New Primary Data!
Inclusion and update of marine ingredient data based on new primary data derived values.

IFFO
THE MARINE INGREDIENTS ORGANISATION

2026

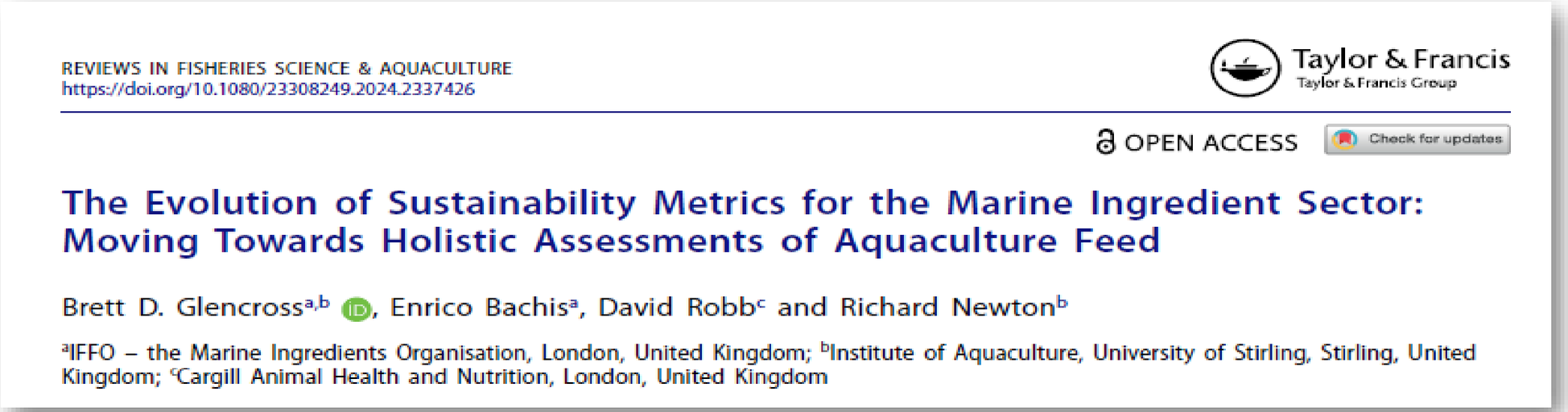
Publication of Marine data generator tool!
Automated data modelling for PEF (Marine Fish PEFCR) and GFLI-compliant marine-based data creation.

2027

Extension of generator tool!
Expanding the tool for cultivated & processed ingredients, as well as multiple additional features.

You Can Only Manage What You Measure

met-ric (me-trik)
: a standard of measurement
: of or relating to (such) an art, process, or science of measuring
“no metric exists that can be applied directly to happiness”
—Scientific Monthly



REVIEWS IN FISHERIES SCIENCE & AQUACULTURE
https://doi.org/10.1080/23308249.2024.2337426

Taylor & Francis
Taylor & Francis Group

OPEN ACCESS Check for updates

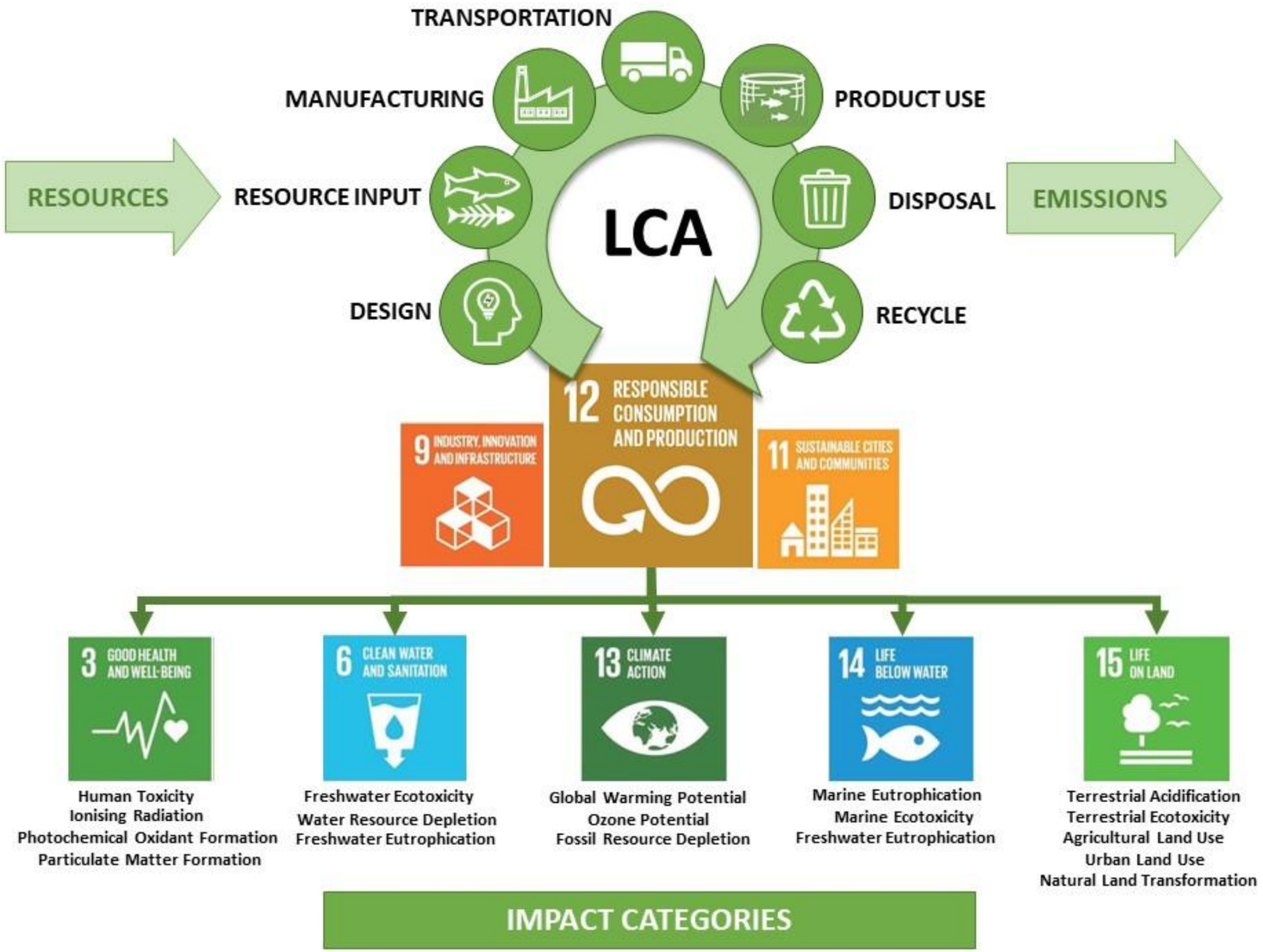
The Evolution of Sustainability Metrics for the Marine Ingredient Sector: Moving Towards Holistic Assessments of Aquaculture Feed

Brett D. Glencross[a,b], Enrico Bachis[a], David Robb[c] and Richard Newton[b]

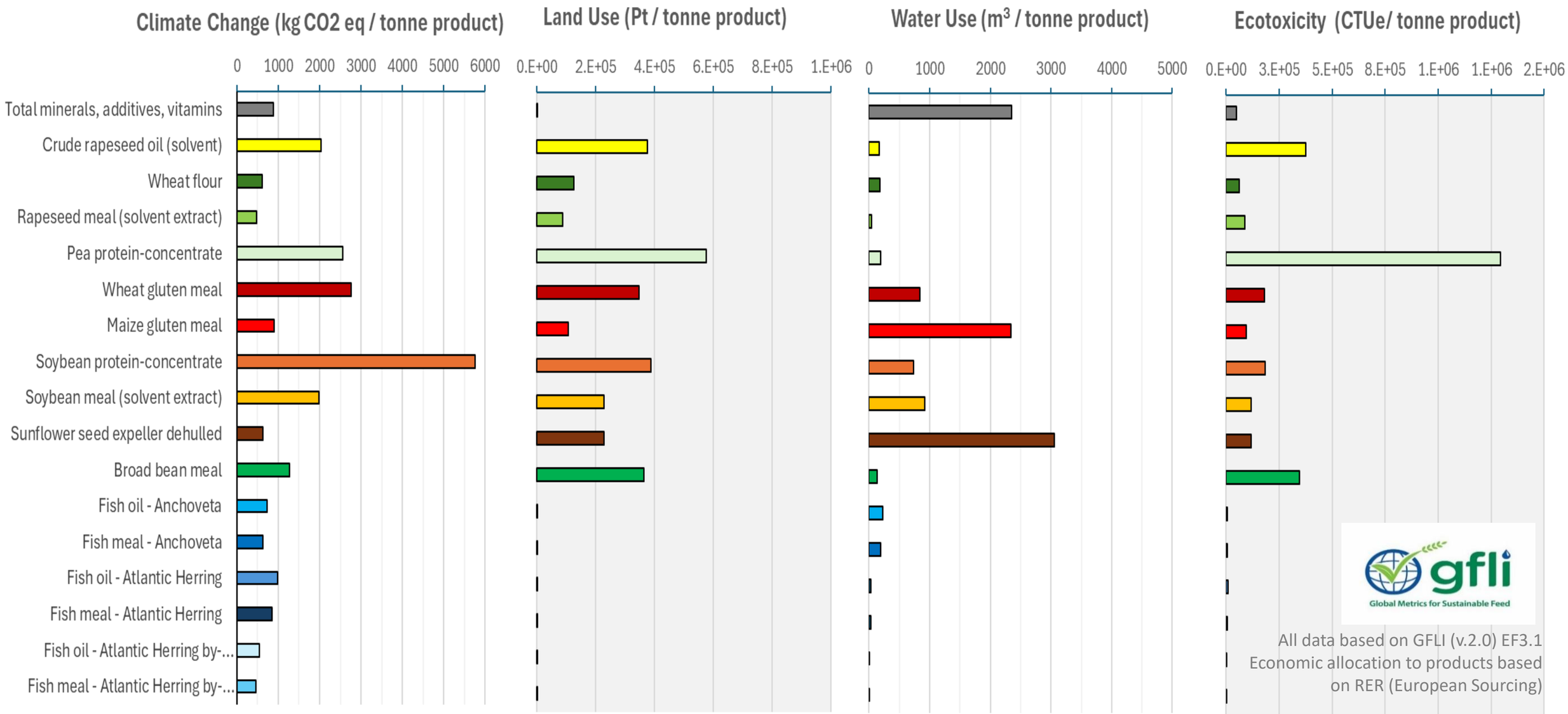
[a]IFFO – the Marine Ingredients Organisation, London, United Kingdom; [b]Institute of Aquaculture, University of Stirling, Stirling, United Kingdom; [c]Cargill Animal Health and Nutrition, London, United Kingdom

“ *We need to move toward **a more transparent assessment process** as this will better support aquaculture to move forward by being able to **assess the sustainability of the use of all feed ingredient resources** on an equivalent basis.”*

Life Cycle Assessment



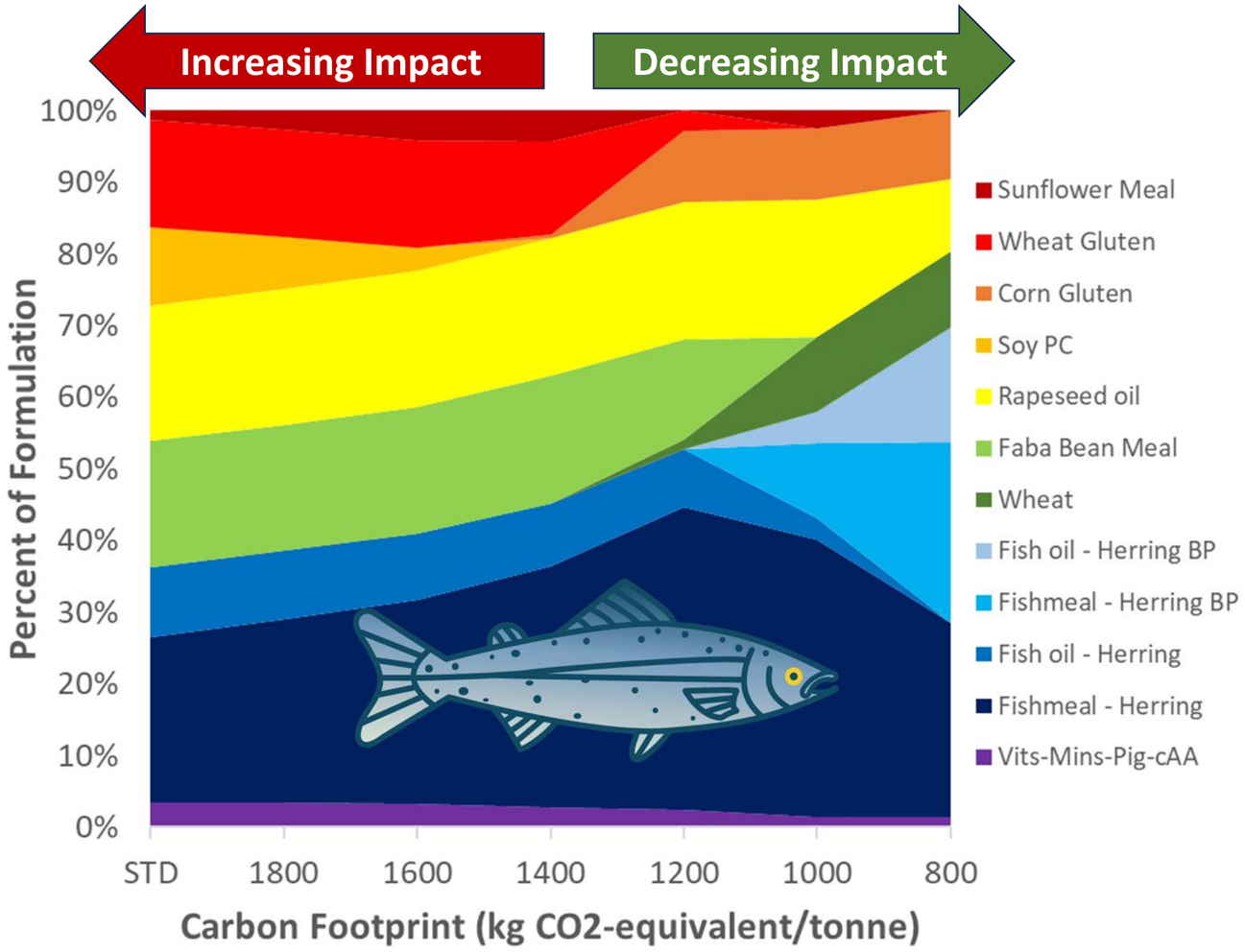
Something HIGH in one Impact Category…



gfli
Global Metrics for Sustainable Feed

All data based on GFLI (v.2.0) EF3.1
Economic allocation to products based on RER (European Sourcing)

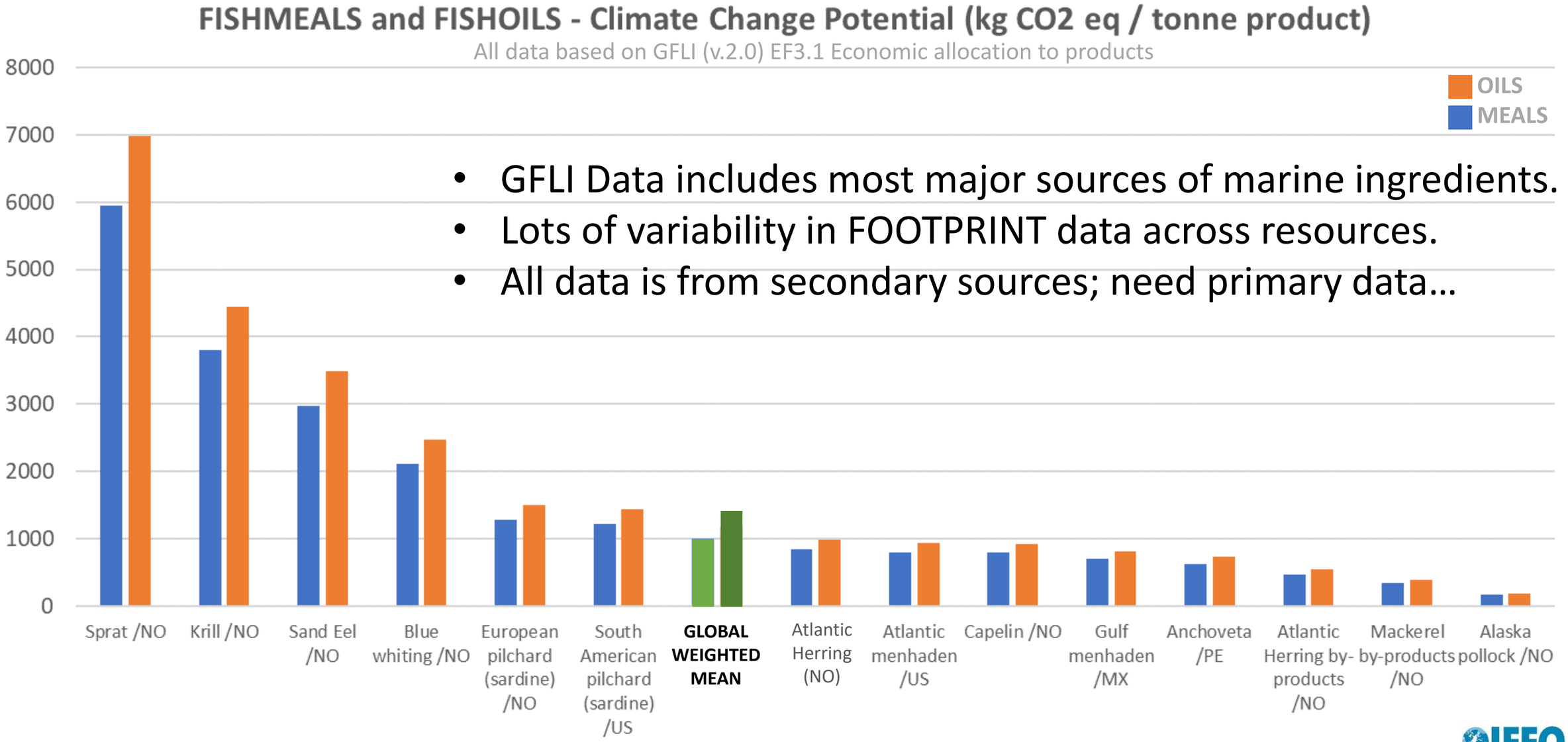
Using LCA Data as a Formulation Constraint



- LCA data can be **used in formulation** databases like any other parameter.
- A standard (STD) North Atlantic salmon feed (DP36%:DE20kJ/g) has a Carbon Footprint (CF) of about **1978 kg CO2.eq / tonne feed**.
- Formulating on CF has some **clear effects on ingredient preference**.
- **Primary data** from ingredient suppliers is increasingly being sought by the feed producers as values **can vary markedly**.

Glencross et al. (2025)doi.org/10.1080/23308249.2025.2552166

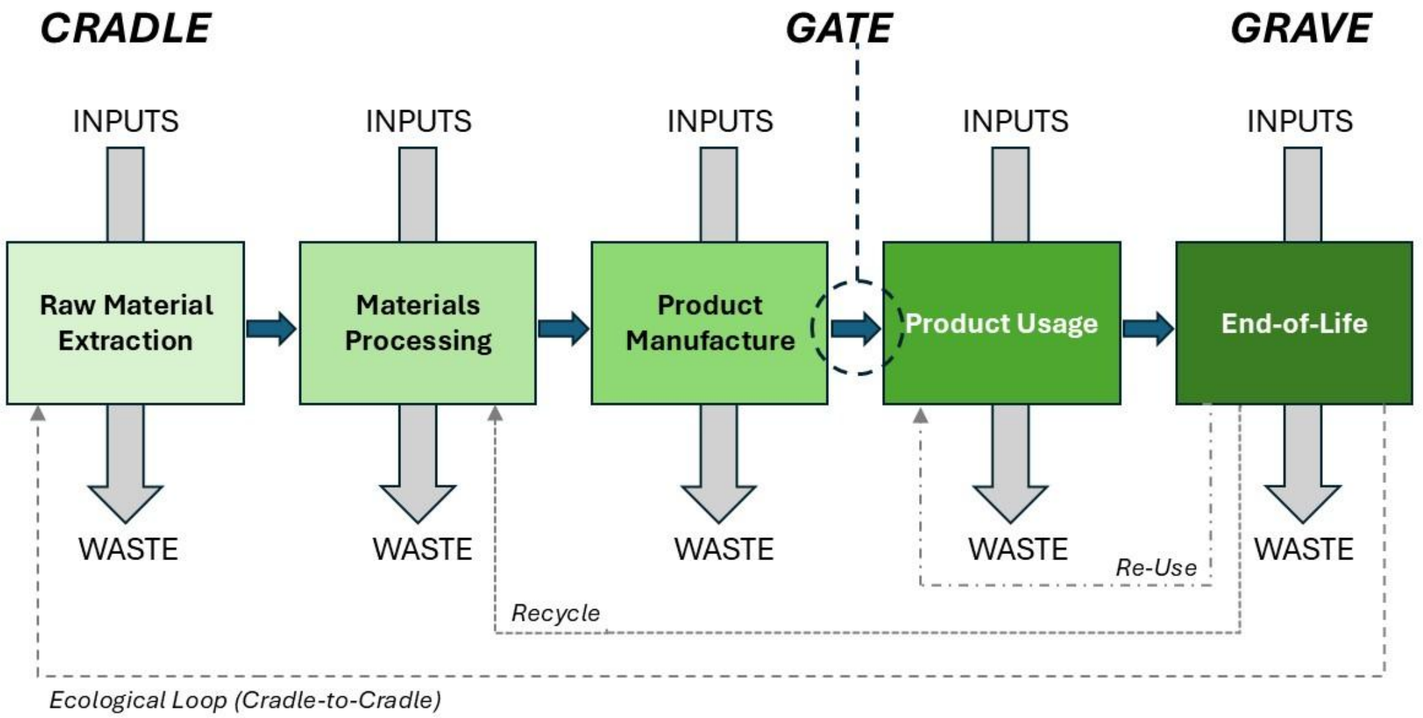
Existing GFLI Data on Marine Ingredients



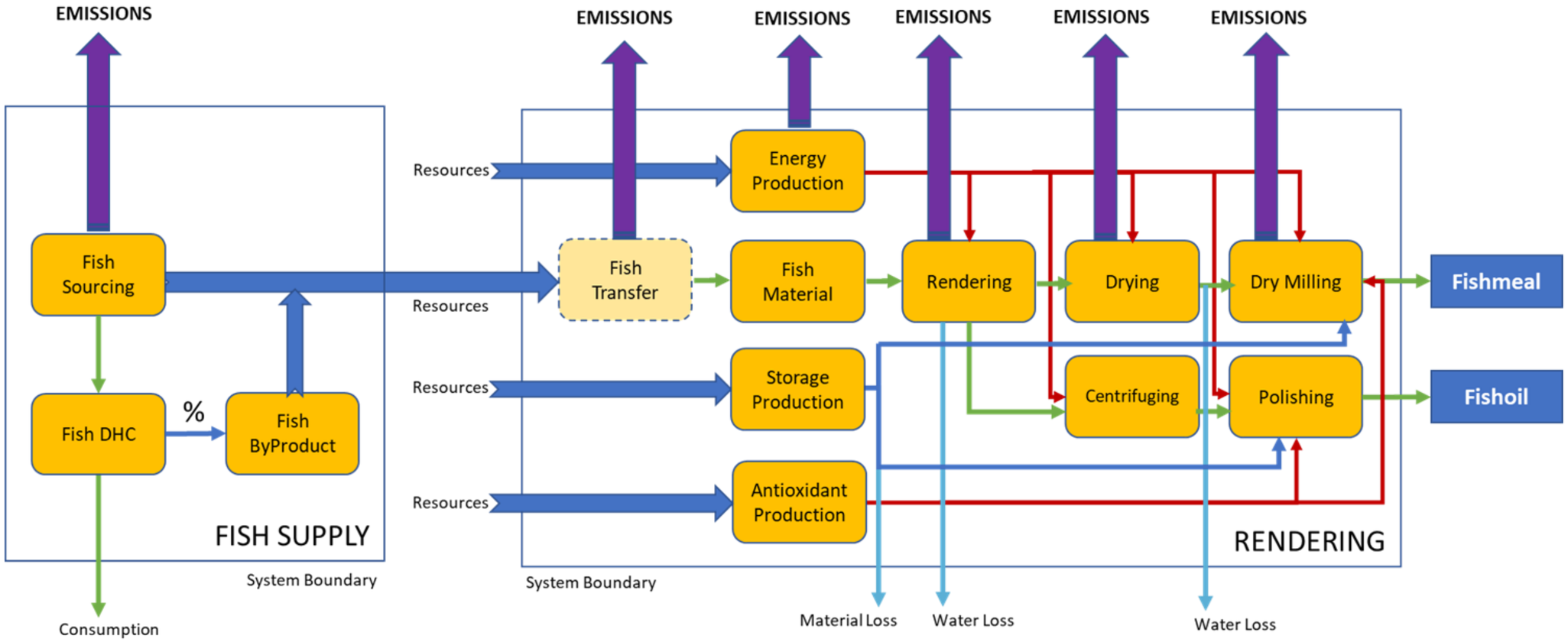
- GFLI Data includes most major sources of marine ingredients.
- Lots of variability in FOOTPRINT data across resources.
- All data is from secondary sources; need primary data…

Assessing Marine Ingredient Impacts…

- Environmental impacts do not just occur on the production unit
  - Raw material extraction (capture)
  - Processing
  - Distribution
  - Consumption/Use
  - Waste disposal
- Defining the extent (boundaries) of your system is critical.
- We are focussing on a CRADLE-to-GATE analysis of Marine Ingredient Production.

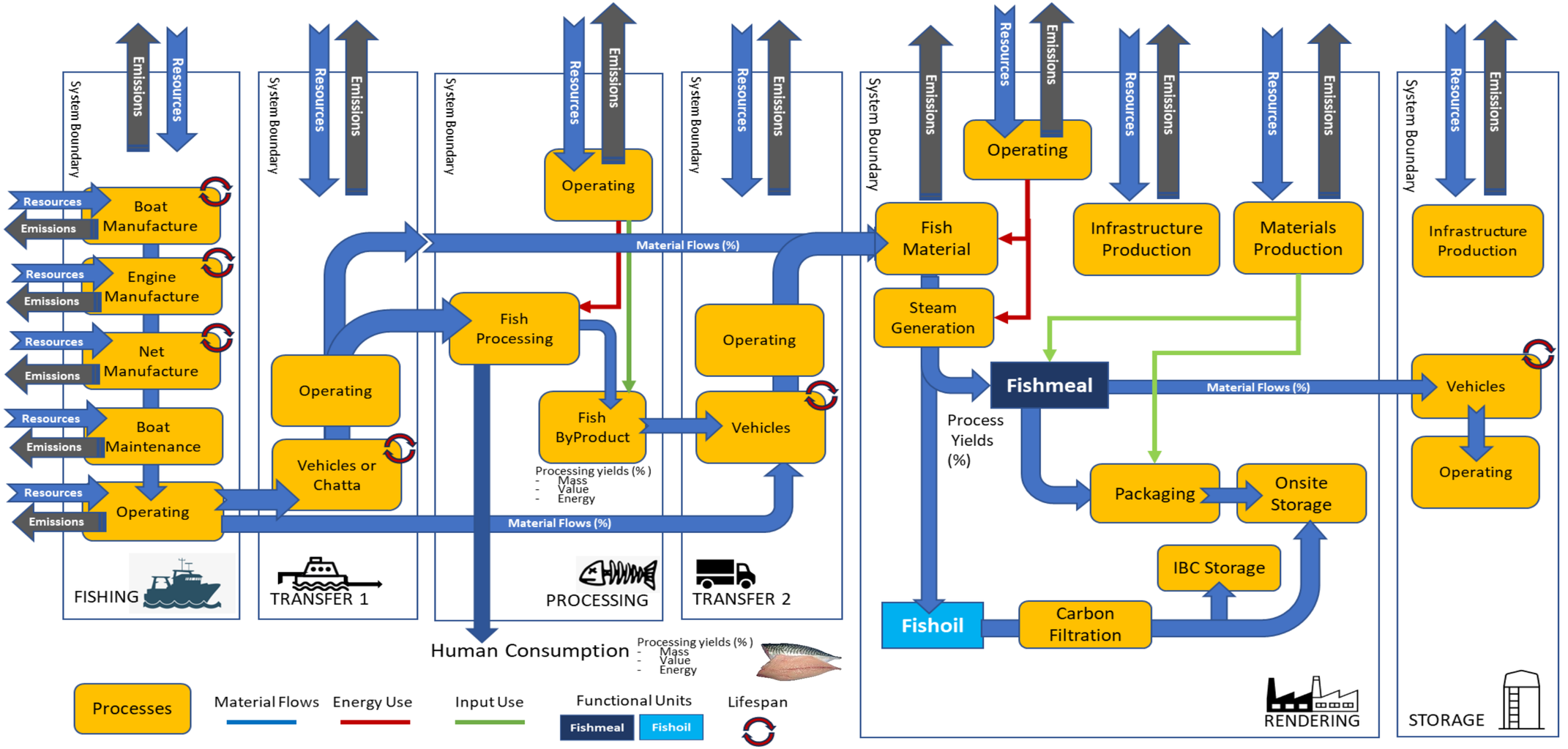


Step 1- Mapping the System Boundaries and Flows

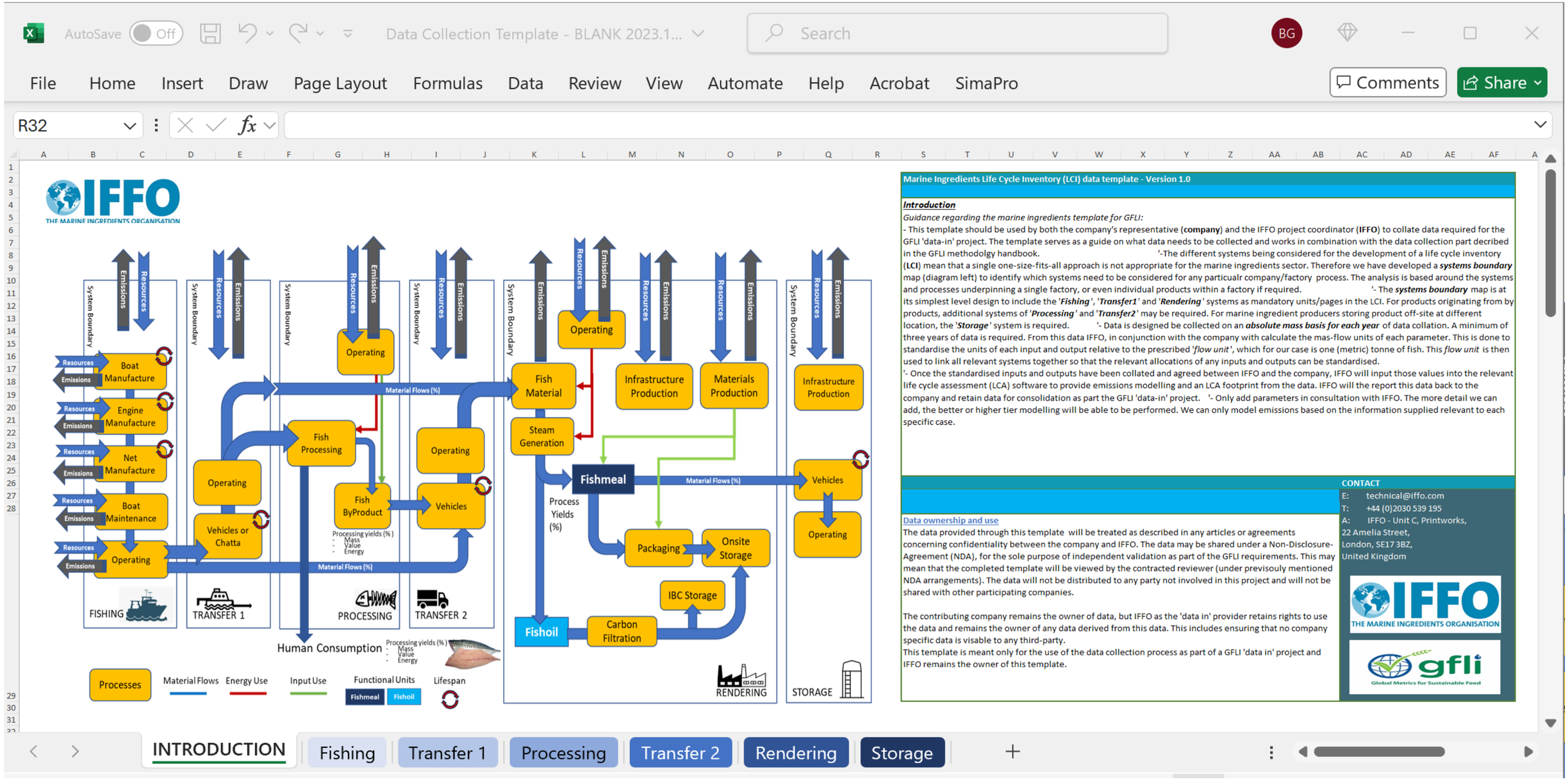


Agri-footprint ecoinvent gfli Global Metrics for Sustainable Feed

Step 1.x - Mapping the System Boundaries and Flows



Collecting Primary Data

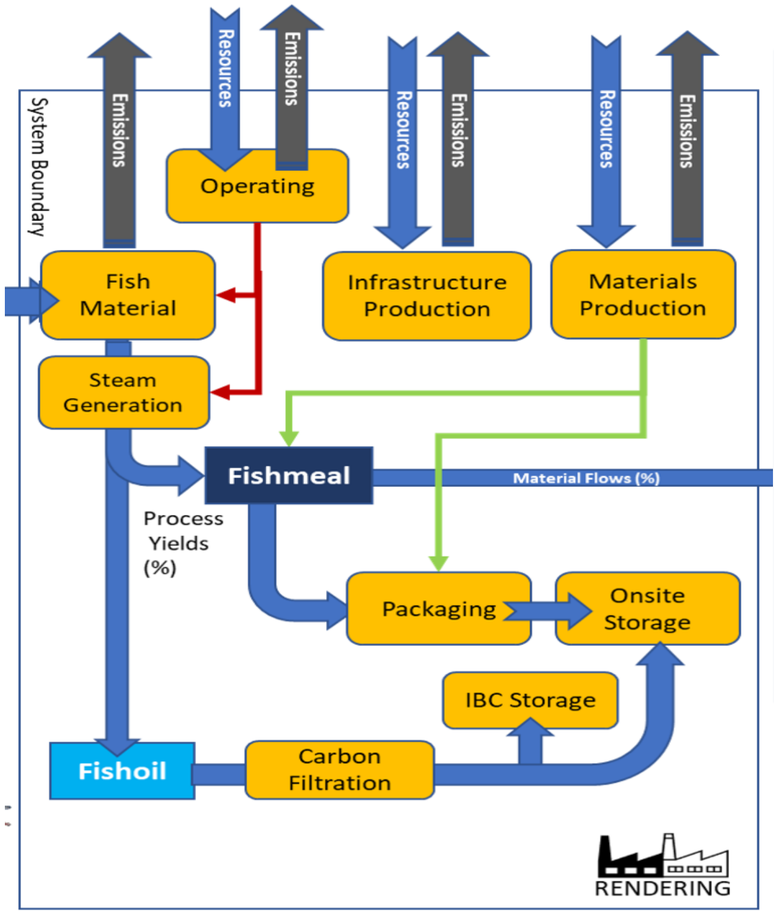


Data Collection: EXAMPLE - Rendering

LIFECYCLE INVENTORY - RENDERING

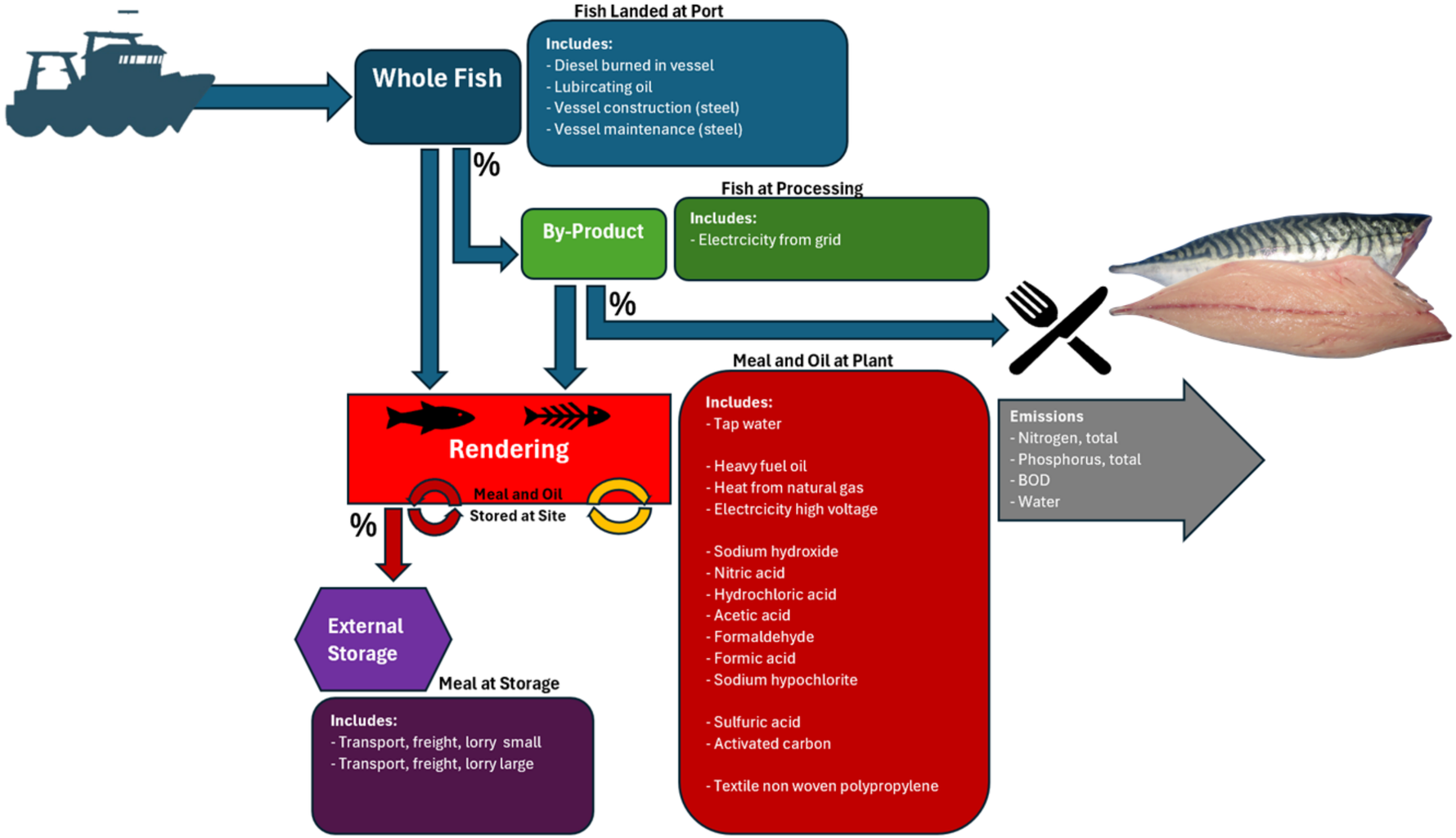
Data that is critical for the LCI to work
Data that would allow a more thorough analysis
Data that would allow us to expand the assessment
<-- PRIORITIES ON THE DATA REQUIRED

INPUTS			2018	2019	2020	2021	2022	MEAN	Data Source ID (drop down)	Comments
FISH MATERIAL - INPUT	MATERIAL	per ANNUM								
1 Species 1		tonnes						#DIV/0!		
2 Species 2		tonnes						#DIV/0!		
3 Species 3		tonnes						#DIV/0!		
4 Species 4		tonnes						#DIV/0!		
5 Species 5		tonnes						#DIV/0!		
TOTAL		tonnes	0	0	0	0	0	0		
OUTPUTS										
Fishmeal 1		tonnes						#DIV/0!		
Fishmeal 2		tonnes						#DIV/0!		
Fishmeal 3		tonnes						#DIV/0!		
Fishmeal 4		tonnes						#DIV/0!		
Fishmeal 5		tonnes						#DIV/0!		
as linked to input materials		TOTAL	0	0	0	0	0	0		
Fish oil 1		tonnes						#DIV/0!		
Fish oil 2		tonnes						#DIV/0!		
Fish oil 3		tonnes						#DIV/0!		
Fish oil 4		tonnes						#DIV/0!		
Fish oil 5		tonnes						#DIV/0!		
as linked to input materials		TOTAL	0	0	0	0	0	0		
DISCHARGES		per ANNUM								
Waste Water Discharge		m3						#DIV/0!		
Total Nitrogen Discharge		kg						#DIV/0!		
Total Phosphorus Discharge		kg						#DIV/0!		
BOD/COD Discharge		kg						#DIV/0!		
Mineral Oil Waste		kg						#DIV/0!		
Other Hazardous Waste		kg						#DIV/0!		
		other						#DIV/0!		
OPERATIONAL INPUTS		per ANNUM								
Freshwater		m3						#DIV/0!		
Heavy fuel oil (burned in furnace)		UNITS - drop down list						#DIV/0!		
Gas (burned in furnace)		UNITS - drop down list						#DIV/0!		
Diesel (generators)		UNITS - drop down list						#DIV/0!		
Electricity use		MWh						#DIV/0!		
- electricity source 1		percent						#DIV/0!		
- electricity source 2		percent						#DIV/0!		
- electricity source 3		percent						#DIV/0!		
CHEMICAL USE		per ANNUM								
Sodium hydroxide		kg						#DIV/0!		
Sodium chloride		kg						#DIV/0!		
Nitric acid		kg						#DIV/0!		
Sulphuric acid		kg						#DIV/0!		



Rationalising Things to the Key Data Elements

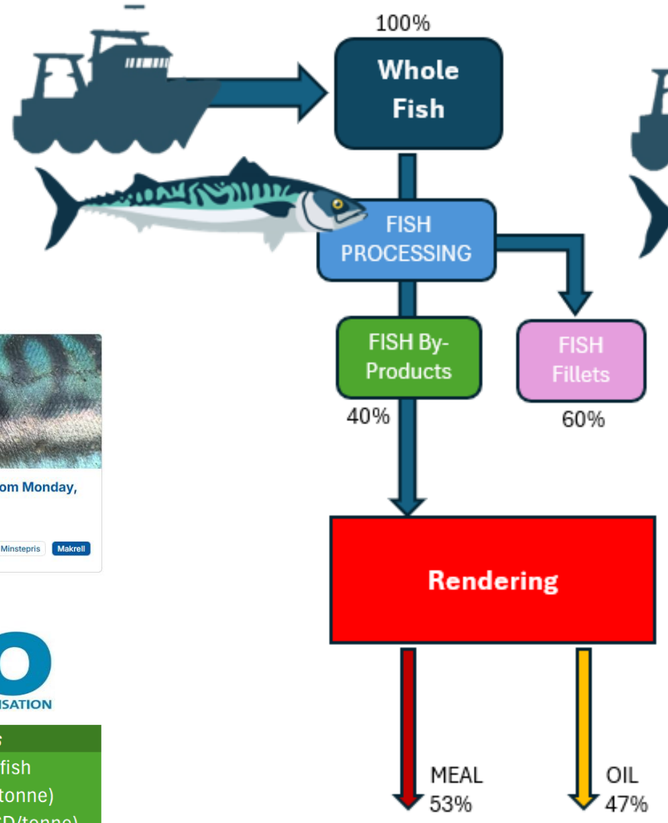
KEY DATA ELEMENTS BY SYSTEM



Calculating MASS, ECONOMIC and ENERGY Allocations

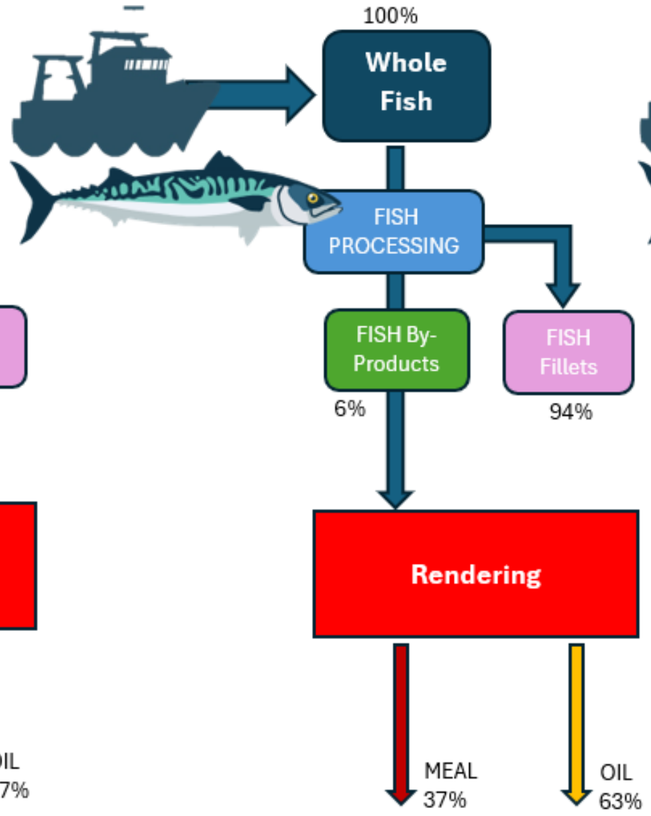
kg

MASS ALLOCATION



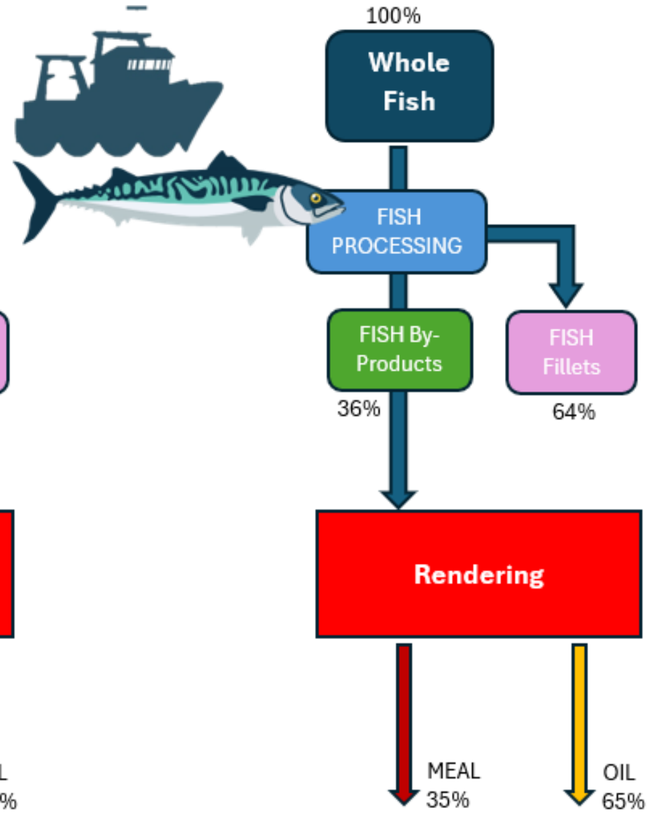
$

ECONOMIC ALLOCATION

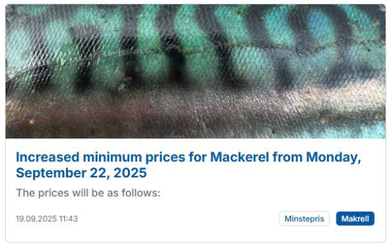


kJ

ENERGY ALLOCATION



NORGES SILDESALGSLAG



Increased minimum prices for Mackerel from Monday, September 22, 2025

The prices will be as follows:

19.09.2025 11:43 Minstepris Makrell

IFFO
THE MARINE INGREDIENTS ORGANISATION

5yr lagging values	
$643	Yield per tonne of fish
$1,652	Prime Meal (USD/tonne)
$3,128	Aquagrade Oil (USD/tonne)
7.6	*energy densities*
3.7	19 meal (kJ/g)
3.9	39 oil (kJ/g)

Standardising DATA to a FLOW UNIT (1 tonne of fish)

ATLANTIC MACKEREL CASE EXAMPLE

LIFECYCLE INVENTORY - FISHING

FISH MATERIAL - CATCH	MATERIAL	per ANNUM	######	MEAN
Atlantic mackerel (Purse seine)	whole fish	tonnes		100,000
TOTAL				100,000

Atlantic mackerel	Fuel Use Intensity	L/ tonne	100
Atlantic mackerel	Fuel Use Intensity	MJ/tonne	3,800

PROCESSING INPUTS

	Units	######	MEAN
FISH - INPUTS	Value (NOK) per Tonne		17000
Atlantic mackerel	tonnes per ANNUM		100,000
Electricity use	KWh		216

FISH BY-PRODUCT OUTPUTS		
Atlantic mackerel	tonnes	60,000
MASS allocation of by-product	%	40.0%
ECONOMIC allocation of by-product	%	6.3%
BP Value per Tonne (NOK)		4000
Fillet Value per Tonne (NOK)		40000
Total Value per Tonne of Fish (NOK)		25600

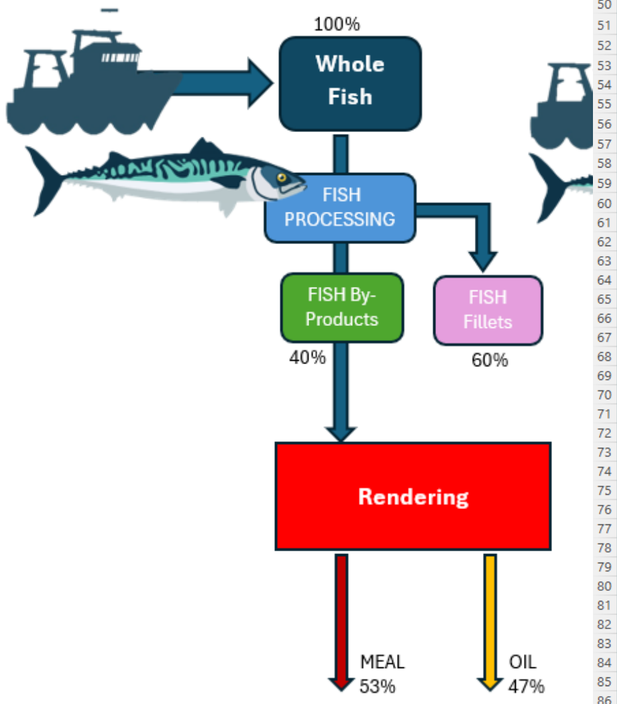
RENDERING INPUTS

FISH MATERIAL - INPUT	MATERIAL	per ANNUM	######	MEAN
Atlantic mackerel	By-Products	tonnes		60,000
TOTAL		tonnes		60,000

OUTPUTS			
Fishmeal 1	tonnes		12,000
as linked to input materials	TOTAL		12,000
Fish oil 1	tonnes		6,000
as linked to input materials	TOTAL		6,000
TOTAL OUTPUTS	tonnes		18,000

kg

MASS ALLOCATION



5yr lagging values

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3.9	39 oil (kJ/g)

RENDERING INPUTS

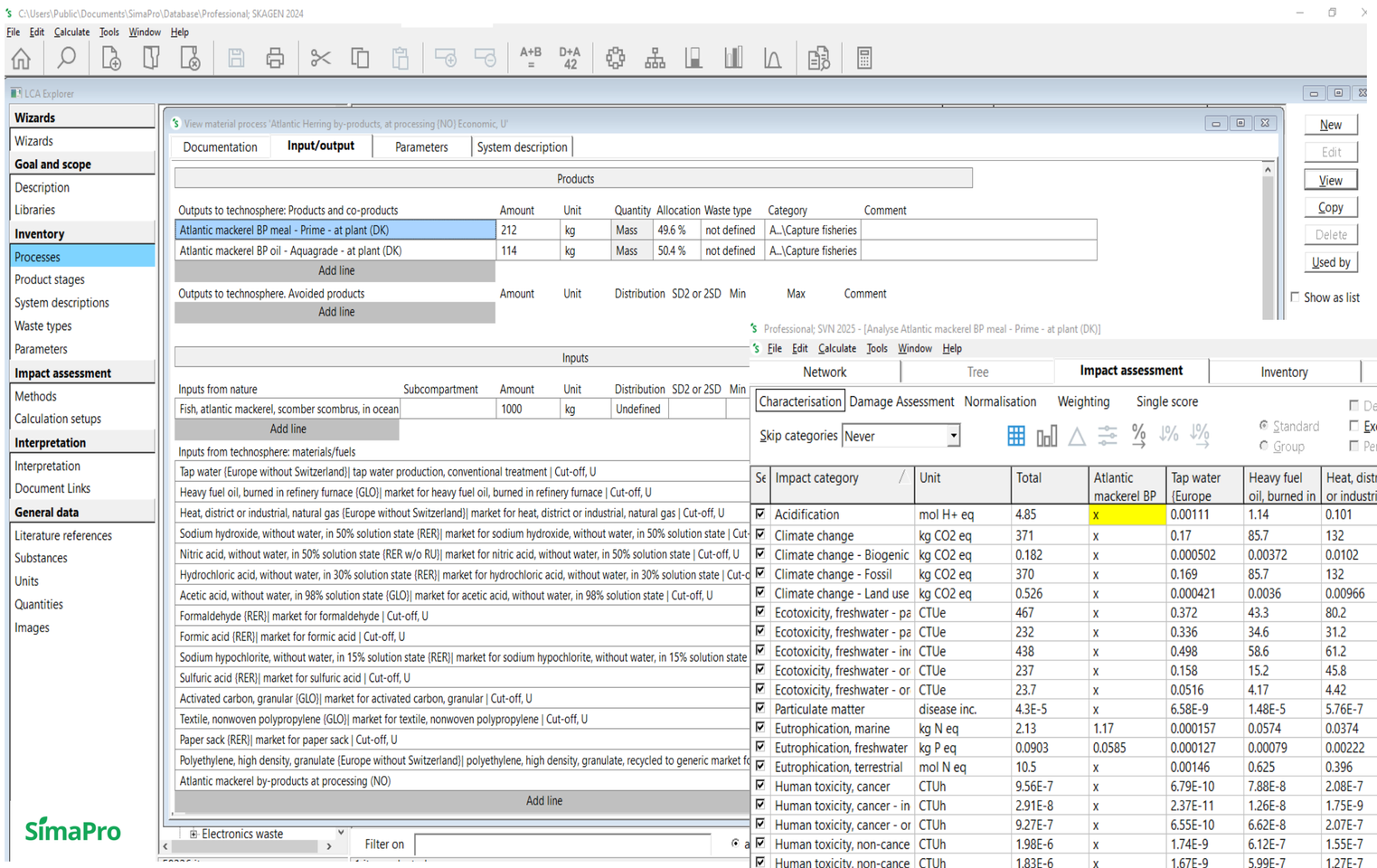
FISH MATERIAL - INPUT	MATERIAL	per ANNUM	######	MEAN
Atlantic mackerel	By-Products	tonnes		60,000
TOTAL		tonnes		60,000

OUTPUTS			Per Tonne Fish	
Fishmeal 1	tonnes	12,000		
as linked to input materials	TOTAL	12,000	200	kg
Fish oil 1	tonnes	6,000		
as linked to input materials	TOTAL	6,000	100	kg
TOTAL OUTPUTS	tonnes	18,000	300	kg

20.0%	Yield - Meal
10.0%	Yield - Oil
67%	Mass balance - meal
33%	Mass balance - Oil
51%	Econ balance - Meal
49%	Econ balance - Oil
49%	Energy balance - Meal
51%	Energy balance - Oil

DISCHARGES	per ANNUM			
Waste Water Discharge	m3	1,200,000	20.000	m3
Total Nitrogen Discharge	kg	30,000	0.500	kg
Total Phosphorus Discharge	kg	1,500	0.025	kg
BOD/COD Discharge	kg	60,000	1.000	kg
OPERATIONAL INPUTS	**per ANNUM**			
Freshwater	m3	20,000	0.333	m3
Heavy fuel oil (burned in furnace)	MJ	20,000,000	333.333	MJ
Gas (burned in furnace)	MJ	60,000,000	1000.000	MJ
Diesel (generators)	UNITS - drop down list			
Electricity use	MWh	3,000,000	50.000	MWh
Grid Mix	percent	100%		percent
CHEMICAL USE	**per ANNUM**			
Sodium hydroxide	kg	60,000	1.000	kg
Nitric acid	kg	30,000	0.500	kg
Hydrochloric acid	kg	30,000	0.500	kg
Acetic acid	kg	15,000	0.250	kg
Formalin	kg	30,000	0.500	kg
Bactericide (Virkon/Formic Acid)	kg	1,800	0.030	kg
Sodium Hypochlorite	kg	24,000	0.400	kg
Antioxidant Product	kg	6,000	0.100	kg
Antioxidant Type	drop down list -->	S S S S S S		
ODOUR AND CONTAMINANT MANAGEMENT				
Activated carbon (cleaning)	kg	3,000	0.050	kg
Sulphuric acid	kg	30,000	0.5000	kg
PACKAGING	**per ANNUM**			
Bags (amount)	kg	12,000	0.200	kg
Bags	material type	PP		
IBCs (oil)	number	240	0.004	number

Interfacing with SimaPro

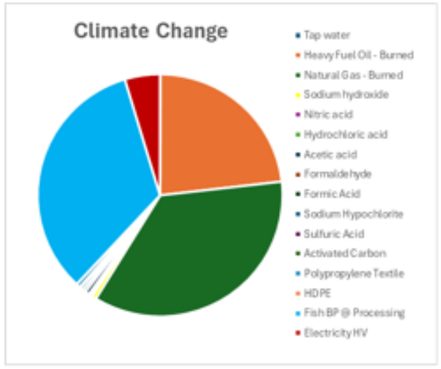


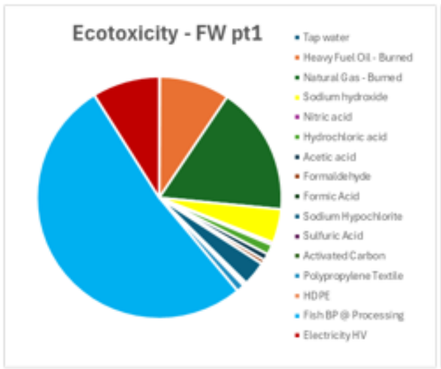
Se	Impact category	Unit	Total	Atlantic mackerel BP	Tap water (Europe	Heavy fuel oil, burned in	Heat, district or industrial,	Sodium hydroxide,	Nitric acid, without	Hydrochloric acid, without	Acetic acid, without	Formaldehyd (RER)|	Formic acid (RER)|	Sodium hypochlorite,	Sulfuric acid (RER)|	Activated carbon,	Textile, nonwoven	Polyet high d
☑	Acidification	mol H+ eq	4.85	x	0.00111	1.14	0.101	0.00965	0.0106	0.00544	0.00762	0.00325	0.000828	0.00684	0.0156	0.0027	0.00776	2.42E-
☑	Climate change	kg CO2 eq	371	x	0.17	85.7	132	2.08	1.21	0.755	1.93	1.43	0.194	1.48	0.145	0.391	2	0.0069
☑	Climate change - Biogenic	kg CO2 eq	0.182	x	0.000502	0.00372	0.0102	0.00512	0.00032	0.0012	0.0009	0.000573	0.000169	0.00364	0.000407	7.25E-5	0.00101	0.0002
☑	Climate change - Fossil	kg CO2 eq	370	x	0.169	85.7	132	2.08	1.21	0.753	1.93	1.43	0.193	1.47	0.144	0.391	2	0.0067
☑	Climate change - Land use	kg CO2 eq	0.526	x	0.000421	0.0036	0.00966	0.0034	0.000248	0.000917	0.00135	0.00057	0.000215	0.00241	0.00013	0.00016	0.0013	7.28E-
☑	Ecotoxicity, freshwater - pa	CTUe	467	x	0.372	43.3	80.2	21	1.72	6.21	4.14	2.51	0.283	15	1.6	0.79	4.85	0.0273
☑	Ecotoxicity, freshwater - pa	CTUe	232	x	0.336	34.6	31.2	5.18	1.17	4.25	13	1.59	0.241	3.69	0.998	0.148	13	0.0111
☑	Ecotoxicity, freshwater - in	CTUe	438	x	0.498	58.6	61.2	23.7	2.17	6.96	15.6	2.62	0.374	16.9	1.44	0.809	16.1	0.0262
☑	Ecotoxicity, freshwater - or	CTUe	237	x	0.158	15.2	45.8	2.02	0.671	0.906	1.24	1.35	0.121	1.43	1.13	0.111	1.46	0.0114
☑	Ecotoxicity, freshwater - or	CTUe	23.7	x	0.0516	4.17	4.42	0.504	0.0506	2.6	0.233	0.138	0.0294	0.358	0.0172	0.0177	0.285	0.0008
☑	Particulate matter	disease inc.	4.3E-5	x	6.58E-9	1.48E-5	5.76E-7	7.71E-8	5.33E-8	3.87E-8	9.28E-8	2.34E-8	6.11E-9	5.43E-8	9.97E-8	3.68E-8	9E-8	3.57E-
☑	Eutrophication, marine	kg N eq	2.13	1.17	0.000157	0.0574	0.0374	0.00205	0.000851	0.000629	0.00146	0.000884	0.00014	0.00145	0.000171	0.000389	0.00162	7.65E-
☑	Eutrophication, freshwater	kg P eq	0.0903	0.0585	0.000127	0.00079	0.00222	0.0015	0.000112	0.000384	0.000542	0.000186	7.9E-5	0.00107	5.97E-5	0.000157	0.000488	2.08E-
☑	Eutrophication, terrestrial	mol N eq	10.5	x	0.00146	0.625	0.396	0.0184	0.0432	0.00626	0.015	0.00924	0.0014	0.013	0.00186	0.00401	0.017	6.45E-
☑	Human toxicity, cancer	CTUh	9.56E-7	x	6.79E-10	7.88E-8	2.08E-7	2.43E-8	3.02E-9	6.01E-9	4.03E-9	6.64E-9	5.25E-10	1.72E-8	5.01E-9	3.88E-10	5.71E-9	4.99E-
☑	Human toxicity, cancer - in	CTUh	2.91E-8	x	2.37E-11	1.26E-8	1.75E-9	3.42E-10	9.96E-11	1.29E-10	1.46E-10	1.11E-10	1.86E-11	2.43E-10	4.57E-11	2.73E-11	1.79E-10	9.87E-
☑	Human toxicity, cancer - or	CTUh	9.27E-7	x	6.55E-10	6.62E-8	2.07E-7	2.39E-8	2.92E-9	5.88E-9	3.89E-9	6.53E-9	5.07E-10	1.7E-8	4.97E-9	3.6E-10	5.54E-9	4.89E-
☑	Human toxicity, non-cance	CTUh	1.98E-6	x	1.74E-9	6.12E-7	1.55E-7	2.88E-8	8.48E-9	1.16E-8	4.68E-8	9.66E-9	1.54E-9	2.04E-8	5.04E-9	2.51E-9	1.49E-8	7.26E-
☑	Human toxicity, non-cance	CTUh	1.83E-6	x	1.67E-9	5.99E-7	1.27E-7	2.72E-8	7.83E-9	1.04E-8	1.13E-8	8.59E-9	1.41E-9	1.93E-8	4.79E-9	2.42E-9	1.37E-8	6.81E-
☑	Human toxicity, non-cance	CTUh	1.48E-7	x	6.87E-11	1.39E-8	2.81E-8	1.62E-9	6.52E-10	1.21E-9	3.55E-8	1.06E-9	1.34E-10	1.14E-9	2.46E-10	9.04E-11	1.25E-9	4.55E-
☑	Ionising radiation	kBq U-235 eq	14.3	x	0.0865	0.218	0.741	0.571	0.0264	0.151	0.132	0.0784	0.0422	0.406	0.0174	0.0155	0.103	0.0011
☑	Land use	Pt	1.13E3	x	0.812	60	32	10	1.96	3.28	4.63	2.76	0.765	7.08	1.06	0.754	5.8	0.0532
☑	Ozone depletion	kg CFC11 eq	9.49E-6	x	3.03E-9	1.15E-6	5.56E-6	1.21E-7	2.56E-8	1.19E-7	3.6E-8	1.27E-7	6.24E-9	8.6E-8	2.4E-9	2.15E-9	4.77E-8	9.63E-
☑	Photochemical ozone form	kg NMVOC eq	3.18	x	0.000496	0.333	0.251	0.00591	0.00287	0.00234	0.00723	0.00663	0.000709	0.00416	0.00157	0.00123	0.00844	2.38E-
☑	Resource use, fossils	MJ	5.33E3	x	3.51	1.07E3	2.1E3	34.3	14.7	12.8	36.6	49.1	4.32	24.3	2.15	4.63	44.5	0.0889
☑	Resource use, minerals and	kg Sb eq	0.000847	x	1.04E-6	8.72E-6	4.48E-5	3.09E-5	1.19E-5	1.31E-5	8.35E-6	1.02E-5	1.07E-6	2.2E-5	5.07E-6	1.89E-7	1.3E-5	4.33E-
☑	Water use	m3 depriv.	-1.96E3	-2.01E3	33.6	0.835	4.46	0.747	0.527	0.476	1	0.155	0.5	0.531	1.01	0.0255	0.501	0.0011

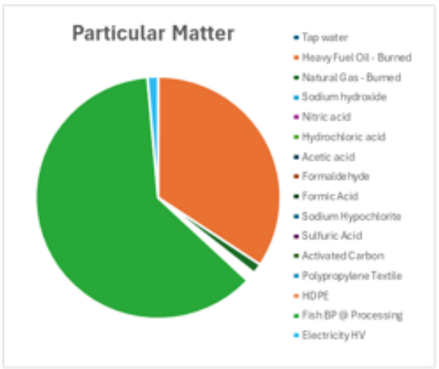
Summarising the Data from SimaPro

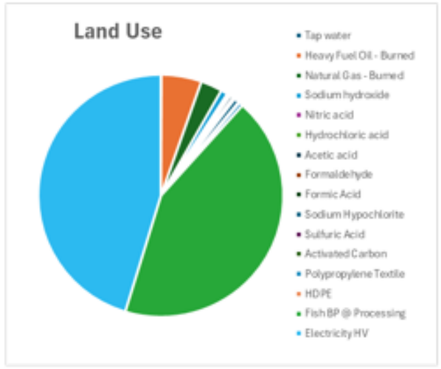
Calculation:	Economic Allocation method applied (value of meal/oil, and value of BP/Fillet)						
Results:	Impact assessment						
Product:	**1000 kg Atlantic Mackerel - Prime MEAL or Aquagrade OIL- at plant (NO)**						
Method:	**Environmental Footprint 3.1 (adapted) V1.01 / EF 3.1 normalization and weighting set**						
Indicator:	Characterisation						
Skip categories:	Never						
Exclude infrastructure processes:	No						
Exclude long-term emissions:	No						
Allocation method:		ECONOMIC	ECONOMIC		ECONOMIC	ECONOMIC	Mass
Impact category	**Unit**	**MEAL**	**OIL**		**A.Mackerel BP**	**Fillet**	**A.Mackerel**
Acidification	mol H+ eq	4.85E+00	9.16E+00		1.48E+00	1.46E+01	9.24E+00
Climate change	**kg CO2 eq**	**3.71E+02**	**7.00E+02**		**5.30E+01**	**5.25E+02**	**3.05E+02**
Climate change - Biogenic	kg CO2 eq	1.82E-01	3.44E-01		3.30E-02	3.27E-01	6.75E-02
Climate change - Fossil	kg CO2 eq	3.70E+02	6.99E+02		5.28E+01	5.23E+02	3.04E+02
Climate change - Land use and LU char	kg CO2 eq	5.26E-01	9.95E-01		1.81E-01	1.80E+00	1.01E+00
Ecotoxicity, freshwater - inorganics	CTUe	4.67E+02	8.83E+02		1.04E+02	1.03E+03	5.84E+02
Ecotoxicity, freshwater - organics - p.1	CTUe	2.32E+02	4.38E+02		4.29E+01	4.25E+02	2.32E+02
Ecotoxicity, freshwater - organics - p.2	CTUe	4.38E+02	8.28E+02		7.84E+01	7.78E+02	4.10E+02
Ecotoxicity, freshwater - part 1	CTUe	2.37E+02	4.48E+02		6.42E+01	6.37E+02	3.79E+02
Ecotoxicity, freshwater - part 2	CTUe	2.37E+01	4.48E+01		4.33E+00	4.29E+01	2.62E+01
Eutrophication, freshwater	kg P eq	4.30E-05	8.13E-05		1.13E-05	1.12E-04	7.09E-05
Eutrophication, marine	kg N eq	2.13E+00	4.03E+00		3.58E-01	3.55E+00	2.24E+00
Eutrophication, terrestrial	mol N eq	9.03E-02	1.71E-01		5.68E-03	5.63E-02	1.61E-02
Human toxicity, cancer	CTUh	1.05E+01	1.99E+01		3.92E+00	3.88E+01	2.45E+01
Human toxicity, cancer - inorganics	CTUh	9.56E-07	1.81E-06		2.25E-07	2.23E-06	1.30E-06
Human toxicity, cancer - organics	CTUh	2.91E-08	5.51E-08		4.75E-09	4.71E-08	2.59E-08
Human toxicity, non-cancer	CTUh	9.27E-07	1.75E-06		2.21E-07	2.19E-06	1.28E-06
Human toxicity, non-cancer - inorgani	CTUh	1.98E-06	3.73E-06		3.57E-07	3.54E-06	1.86E-06
Human toxicity, non-cancer - organics	CTUh	1.83E-06	3.45E-06		3.33E-07	3.31E-06	1.72E-06
Ionising radiation	kBq U-235 eq	1.48E-07	2.81E-07		2.40E-08	2.38E-07	1.39E-07
Land use	Pt	1.43E+01	2.70E+01		2.18E+00	2.16E+01	1.64E+00
Ozone depletion	kg CFC11 eq	1.13E+03	2.13E+03		2.08E+02	2.06E+03	3.76E+02
Particulate matter	disease inc.	9.49E-06	1.79E-05		8.13E-07	8.06E-06	4.60E-06
Photochemical ozone formation	kg NMVOC eq	3.18E+00	6.02E+00		1.07E+00	1.06E+01	6.71E+00
Resource use, fossils	MJ	5.33E+03	1.01E+04		7.03E+02	6.97E+03	3.94E+03
Resource use, minerals and metals	kg Sb eq	8.47E-04	1.60E-03		2.42E-04	2.40E-03	1.33E-03
Water use	m3 depriv.	-1.96E+03	-3.69E+03		2.86E+00	2.84E+01	1.16E+01

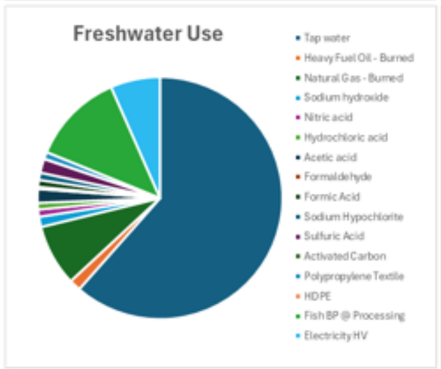
Attributional Analysis of the Primary LCA Data…

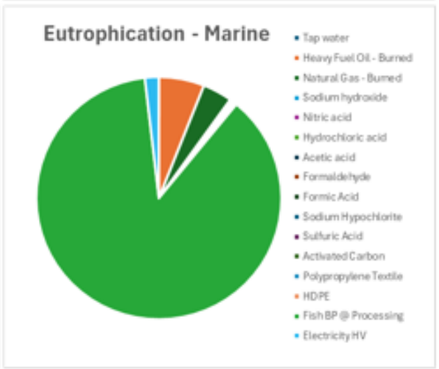


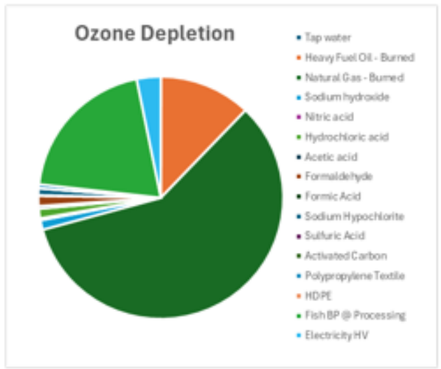


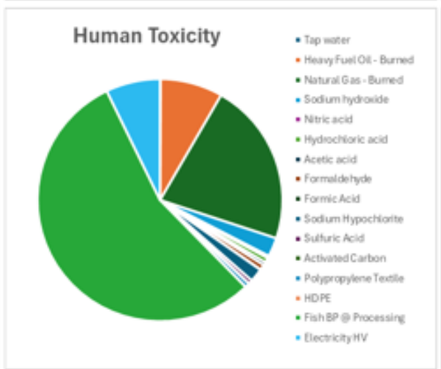


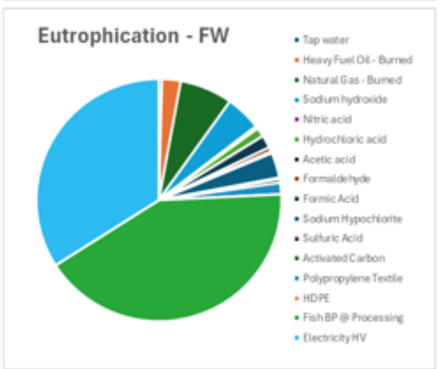




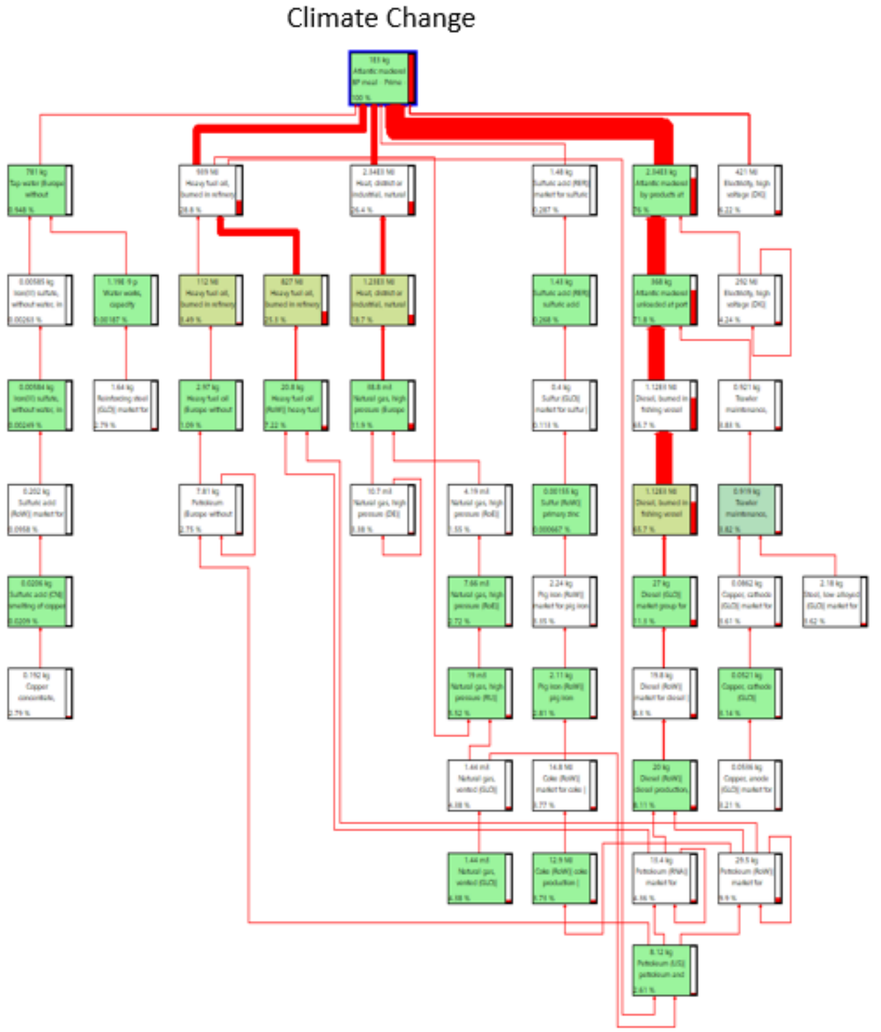




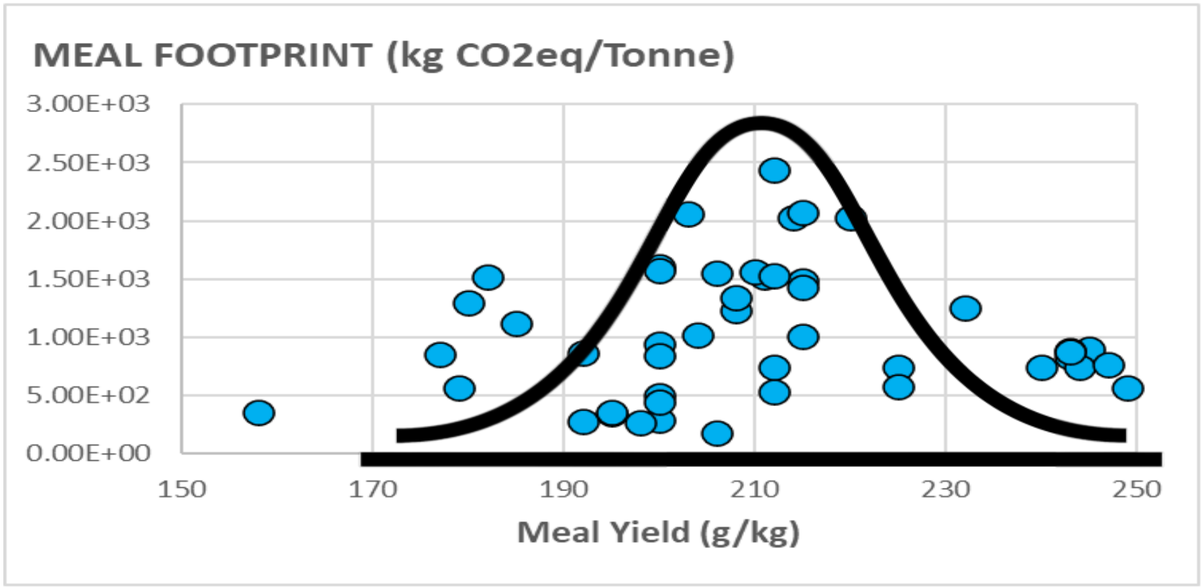


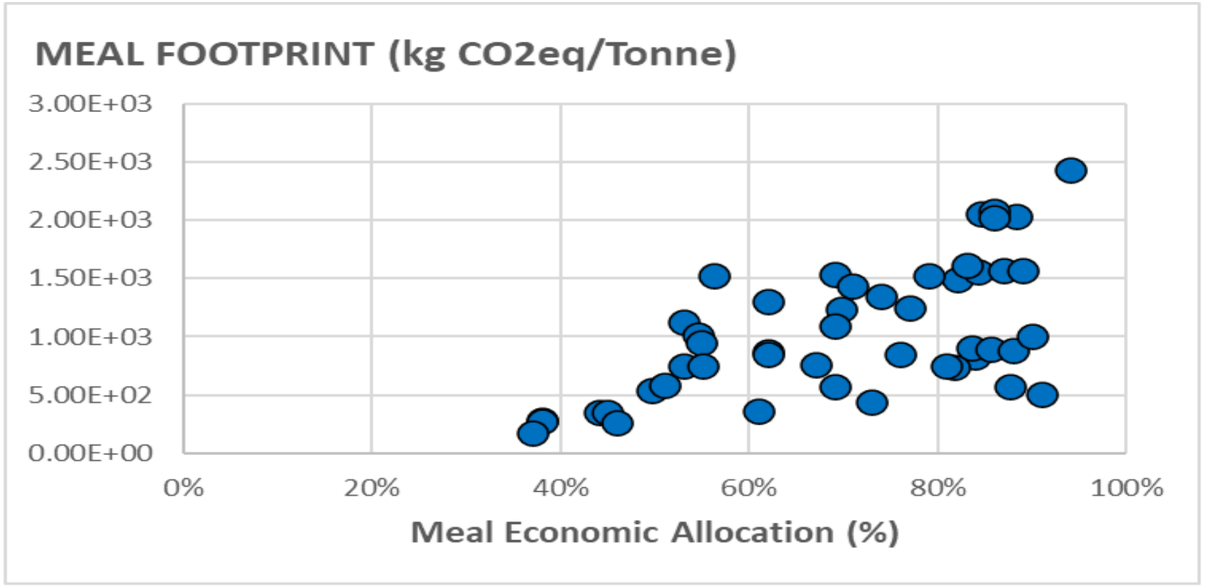


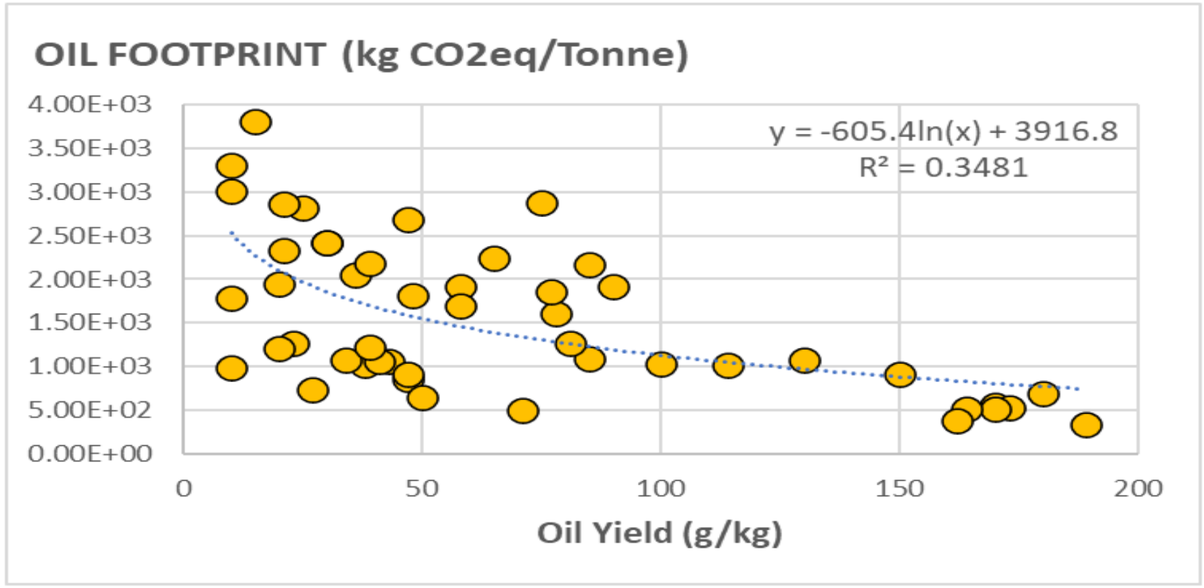
Fishmeal Component Contributions

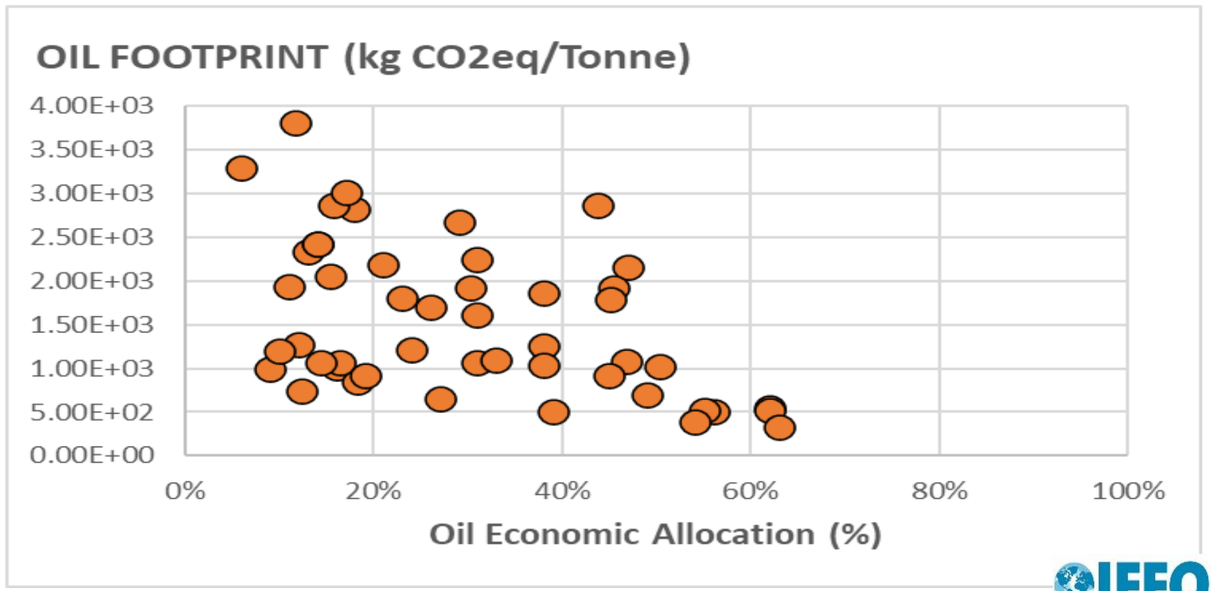


Understanding Marine Ingredient Footprints

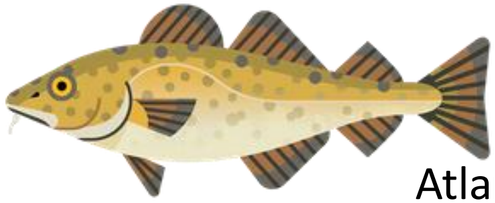








Fishing Methods Have Different Impacts…



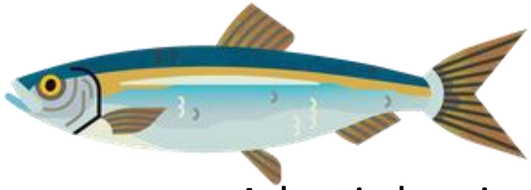
Atlantic cod

Blue whiting

Anchoveta

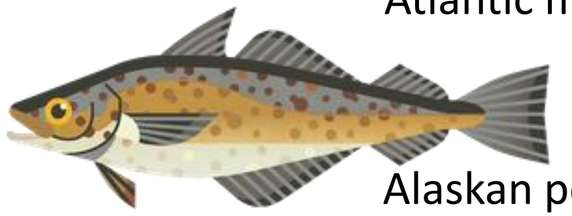
Atlantic haddock

Atlantic mackerel

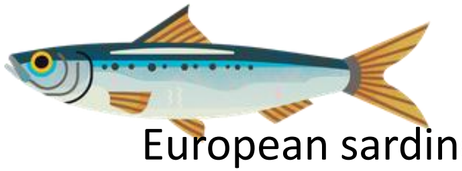


Atlantic herring

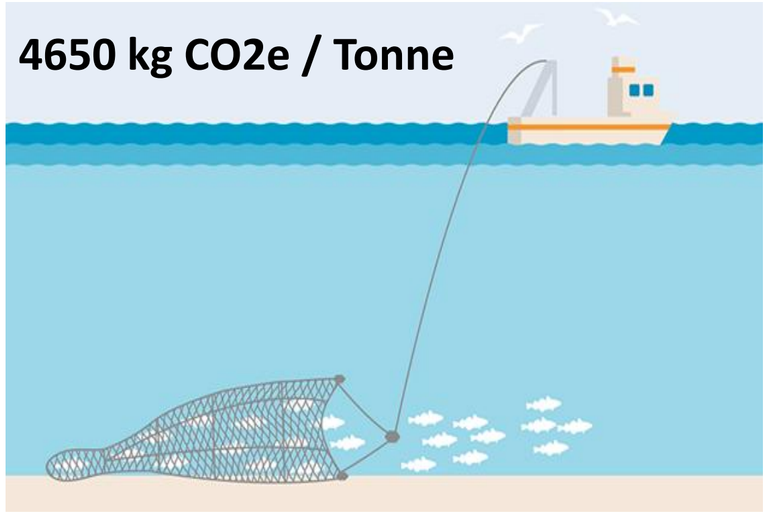
Hake

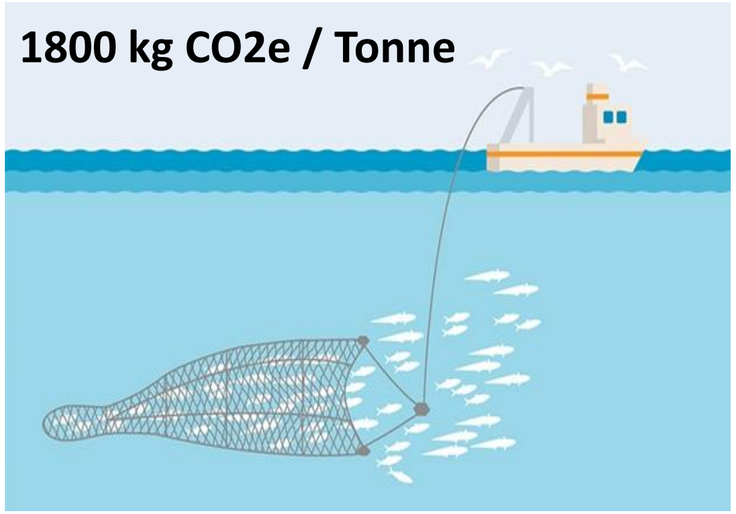


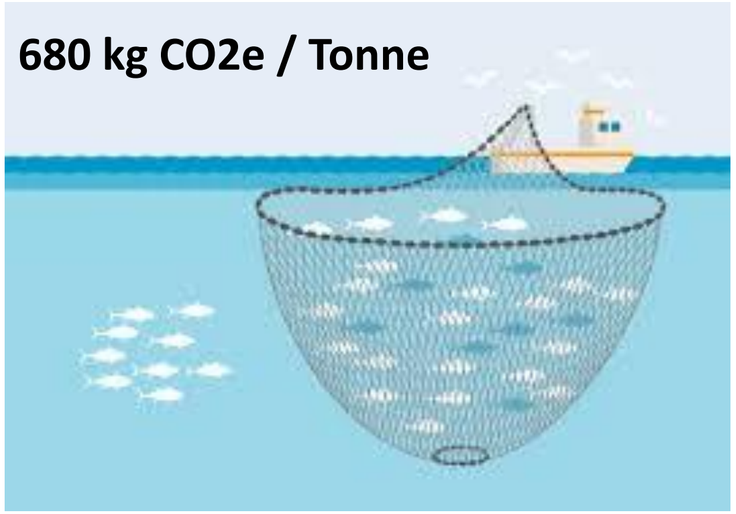
Alaskan pollock



European sardine

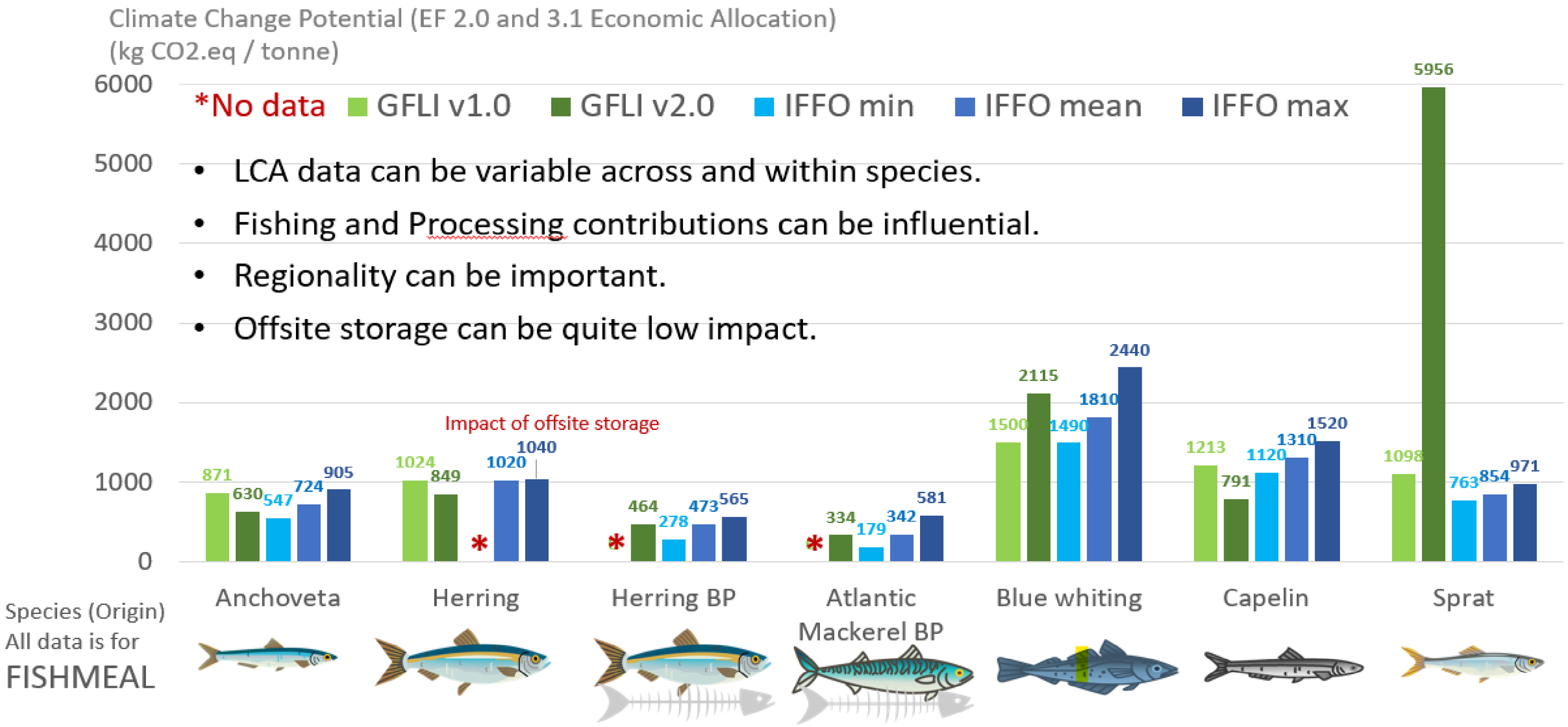




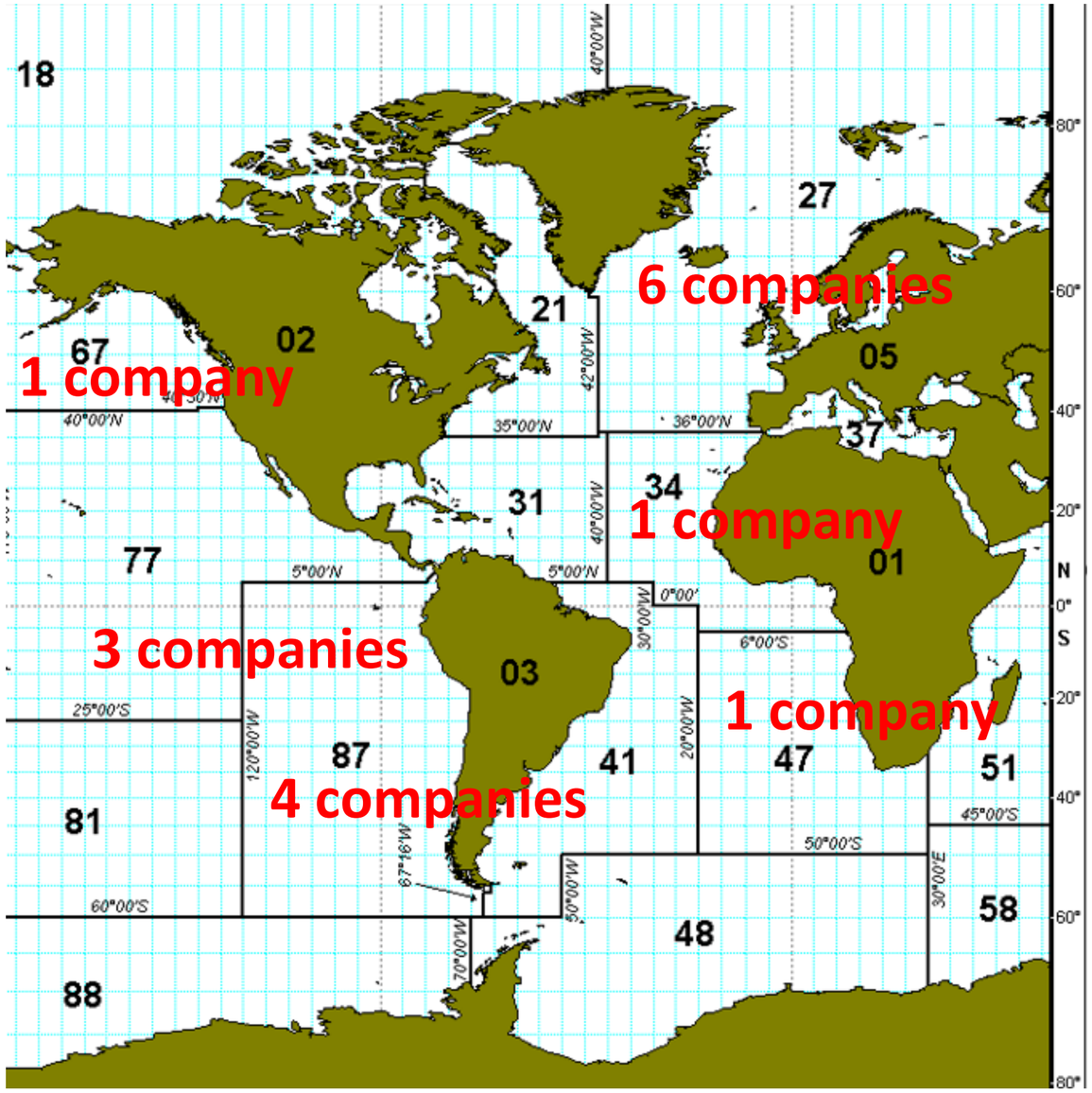


Hilborn et al 2023. ICES Journal of Marine Science. https://doi.org/10.1093/icesjms/fsad115

Progress with Primary Data: Some Examples



Marine Ingredient Footprint Progress…



- We have completed LCIA on 53 different products across the global industry…
- This comprises 13 different types of fishmeals and fish oils.
- Reports detailing the footprint of each product have already been delivered to all participants who have provided data.
- We are currently working with GFLI to progress the audit stage to update the Database in 2026.
- Need to review some of the data input assessments (**Fishery Data**).
- Still always more we can do…

Resources

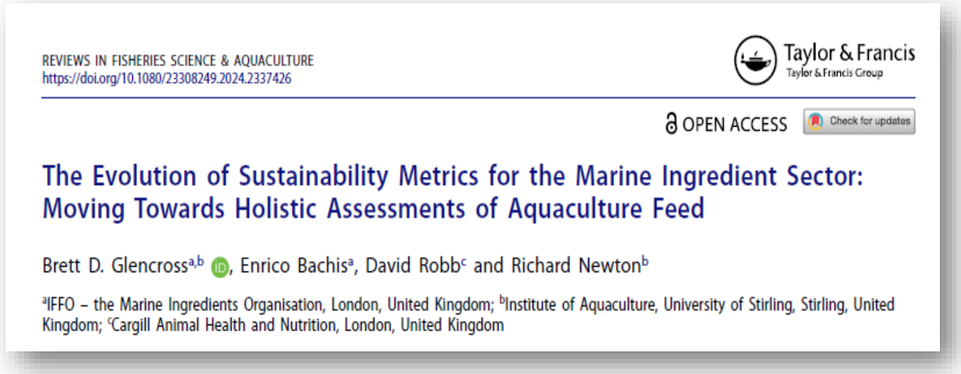
Relevant documents

- **Methodology for regional/sectoral data-in projects**: https://globalfeedlca.org/wp-content/uploads/2023/01/GFLI-Methodology-and-Project-Guidelines.V2.pdf
- **Procedures for a data-in project**: https://globalfeedlca.org/wp-content/uploads/2023/01/GFLI-Procedures-for-Data-in-Projects.V2.pdf
- **Methodology + procedures of branded data**: https://globalfeedlca.org/wp-content/uploads/2023/10/GFLI-Branded-Data-Methodology-and-procedures.V1-20231016-1.pdf
- **LCIA guidance document** (how to read the GFLI database): https://globalfeedlca.org/wp-content/uploads/2023/11/GFLI-LCIA-Guidance-Document-version-2.1-20231127.pdf

Overviews

- **Overview of available datasets in V2.2 database**: https://globalfeedlca.org/wp-content/uploads/2023/10/Overview-of-datasets-in-GFLI-database.pdf
- **Fee structure for database access**: https://globalfeedlca.org/wp-content/uploads/2023/12/Fee-structure-20231220.pdf
- **GFLI leaflet**: https://globalfeedlca.org/wp-content/uploads/2024/09/GFLI-Leaflet.onlineversion.pdf

More Resources



Relevant documents

- Glencross, B., Bachis, E., Robb, D., & Newton, R. (2024). The evolution of sustainability metrics for the marine ingredient sector: moving towards holistic assessments of aquaculture feed. Reviews in Fisheries Science & Aquaculture, 32(4), 545-561. https://doi.org/10.1080/23308249.2024.2337426
- Glencross, B., Ling, X., Gatlin, D., Kaushik, S., Øverland, M., Newton, R., & Valente, L. M. (2024). A SWOT analysis of the use of marine, grain, terrestrial-animal and novel protein ingredients in aquaculture feeds. Reviews in Fisheries Science & Aquaculture, 32(3), 396-434. https://doi.org/10.1080/23308249.2024.2315049
- Glencross, B., Bachis, E., Betancor, M. B., Calder, P., Liland, N., Newton, R., & Ruyter, B. (2025). Omega-3 futures in aquaculture: exploring the supply and demands for long-chain Omega-3 essential fatty acids by aquaculture species. Reviews in Fisheries Science & Aquaculture, 33(2), 167-216. https://doi.org/10.1080/23308249.2024.2388563
- Glencross, B., Bureau, D., Øverland, M., Simon, C., Valente, L. M., Gracey, E., & Zatti, K. (2025). Toward Applying a Circularity Framework Against the Use of Aquaculture Feed Ingredients. Reviews in Fisheries Science & Aquaculture, 1-14. https://doi.org/10.1080/23308249.2025.2552166

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