Special Issue of The International Journal of Life Cycle Assessment

Challenges and best practice in LCAs of seafood and other aquatic products

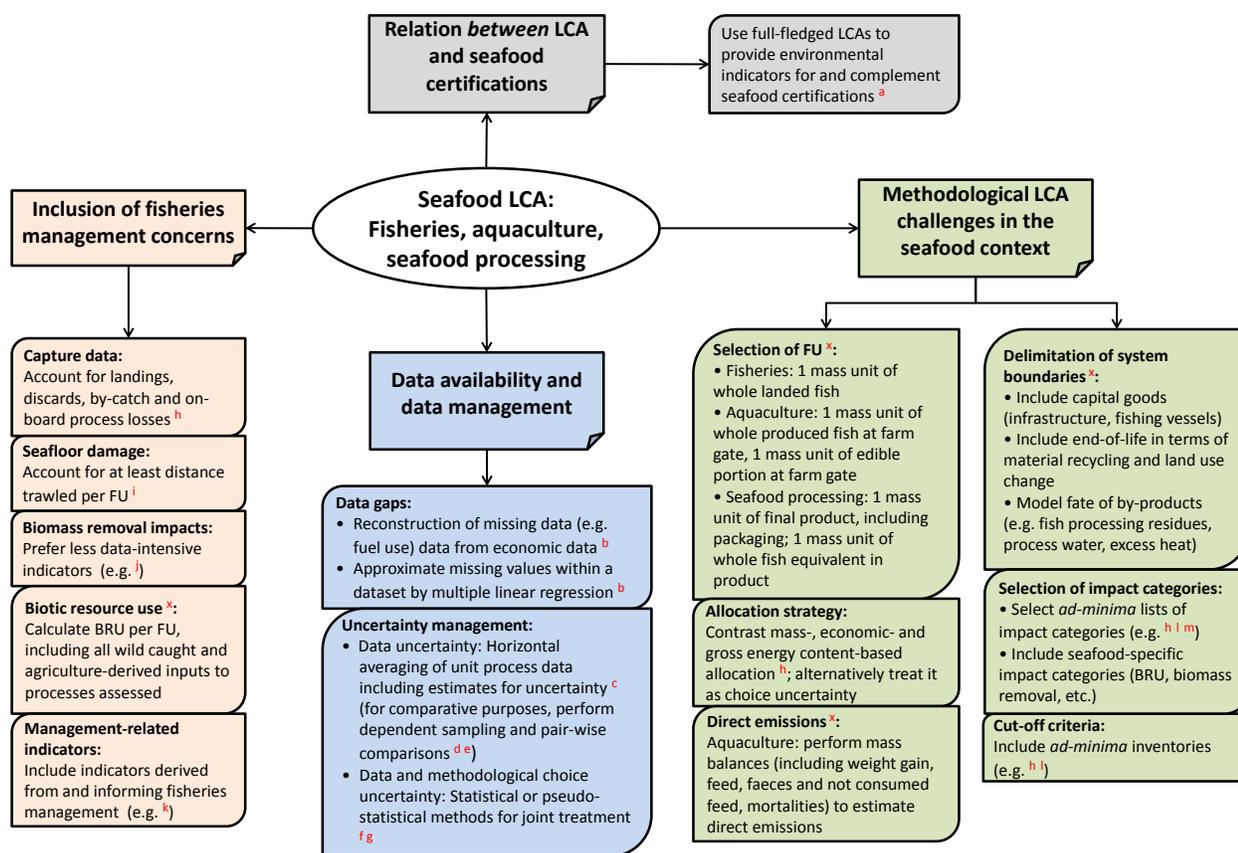Short title: Best practice in seafood LCA
Short title for submission: Special Issue: Seafood LCA

Call proposal

Given the increasing global demand for fish products both for direct human consumption and animal feed for agri- and aquaculture, alongside the fact that fishery catches have stagnated, it is relevant to study the environmental and ecological impacts associated with current seafood supply chains in order to optimise future ones. Globally, more than half of the seafood is produced in aquaculture, a proportion that will continue to increase as it is expected to become the main sector to meet the growing seafood demand. Seafood products often originate in diverse supply chains involving actors such as capture fisheries, feed producers, aquaculture farms, seafood processing plants, wholesalers, retailers and consumers around the world. Each actor contributes to the overall environmental profile of the products resulting in specific improvement options.

To quantify environmental impacts throughout product supply chains, LCA has been applied to seafood production systems over the past 15 years, and the body of scientific literature is growing rapidly. Although substantial methodological improvements have been achieved over the years, certain challenges remain. To avoid these constraints, we would like to point out a number of remaining issues that if addressed would improve the utility of seafood LCA studies greatly:

- Address in full all requirements for goal and scope in ISO 14044, including justifying specific methodological choices such as system boundaries, functional unit, co-product allocation strategy, choice of impact assessment methods, inclusion or exclusion of infrastructure and other capital goods;
- Contrast allocation strategies (see bullet point on uncertainty);
- Present data that enables reproducibility of results, namely inventories, data sources, assumptions, choices, including their justification (either in the study or as supplementary online files);
- Perform statistical treatment of data, when multiple samples (vessels, farms, plants) are considered (and when not, discuss representativity of the results);
- Conduct sensitivity and uncertainty analyses, and discuss various sources of uncertainty in the aggregate LCA model and how it may influence results and conclusions (where a sensitivity analysis should be conducted for allocation, as prescribed by ISO 14044);
- Ensure that any comparisons of results with those of other studies are done in a meaningful way (e.g. considering study design differences);
- Describe in detail the modelling of recycling activities;
- Assess relevant biological impacts such as sustainable use of fish stocks when studying capture fisheries and seafloor impacts when the fishing gear used has seafloor contact.
- Explore the potential role of LCA in seafood certification schemes.
- Other recommendations, as shown in the figure below.

Relation *between* LCA and seafood certifications

Use full-fledged LCAs to provide environmental indicators for and complement seafood certifications [a]

Seafood LCA: Fisheries, aquaculture, seafood processing

Inclusion of fisheries management concerns

Methodological LCA challenges in the seafood context

Capture data:
Account for landings, discards, by-catch and on-board process losses [h]

Seafloor damage:
Account for at least distance trawled per FU [i]

Biomass removal impacts:
Prefer less data-intensive indicators (e.g. [j])

Biotic resource use [x]:
Calculate BRU per FU, including all wild caught and agriculture-derived inputs to processes assessed

Management-related indicators:
Include indicators derived from and informing fisheries management (e.g. [k])

Data availability and data management

Data gaps:
• Reconstruction of missing data (e.g. fuel use) data from economic data [b]
• Approximate missing values within a dataset by multiple linear regression [b]

Uncertainty management:
• Data uncertainty: Horizontal averaging of unit process data including estimates for uncertainty [c] (for comparative purposes, perform dependent sampling and pair-wise comparisons [d e])
• Data and methodological choice uncertainty: Statistical or pseudo-statistical methods for joint treatment [f g]

Selection of FU [x]:
• Fisheries: 1 mass unit of whole landed fish
• Aquaculture: 1 mass unit of whole produced fish at farm gate, 1 mass unit of edible portion at farm gate
• Seafood processing: 1 mass unit of final product, including packaging; 1 mass unit of whole fish equivalent in product

Allocation strategy:
Contrast mass-, economic- and gross energy content-based allocation [h]; alternatively treat it as choice uncertainty

Direct emissions [x]:
Aquaculture: perform mass balances (including weight gain, feed, faeces and not consumed feed, mortalities) to estimate direct emissions

Delimitation of system boundaries [x]:
• Include capital goods (infrastructure, fishing vessels)
• Include end-of-life in terms of material recycling and land use change
• Model fate of by-products (e.g. fish processing residues, process water, excess heat)

Selection of impact categories:
• Select *ad-minima* lists of impact categories (e.g. [h l m])
• Include seafood-specific impact categories (BRU, biomass removal, etc.)

Cut-off criteria:
Include *ad-minima* inventories (e.g. [h l])

[a] Jonell et al. (2013) [b] Fréon et al. (2014) [c] Henriksson et al . (2013) [d] Henriksson et al .(2015a) [e] Henriksson et al. (2015b) [f] Andrianandraina et al. (2015) [g] Mendoza et al. (2015) [h] Vázquez-Rowe et al. (2012) [i] Nilsson and Ziegler (2007) [j] Langlois et al. (2014) [k] Shin and Shannon (2010) [l] Henriksson et al. (2012) [m] EC (2013, PEF) [x] Anchoveta Supply Chains project (http://anchoveta-sc.wikispaces.com)

Figure 1. Graphical representation of the main challenges in seafood LCA**.**

Based on these concerns, this special issue aims at presenting recent methodological developments and applications of novel methods promoting more holistic and robust outcomes. Submissions should contribute to improving the soundness of future LCA studies on seafood and other aquatic supply chains based on any type of aquatic organisms. We especially welcome the following types of contributions:

- Case studies from productions systems currently underrepresented in published LCA literature.
- Case studies from countries/regions currently underrepresented in published LCA literature.
- Development or application of new methods (e.g. with regard to uncertainty analysis or biotic impact assessment).
- Well-grounded syntheses of published seafood LCAs.
- Scenarios studies modelling alternative future development.

How to submit

Manuscripts should be original, written in English, and previously unpublished. The suggested length per article is up to 6 000 words excluding references – resulting in about 10 pages in the journal. Ancillary data relevant to articles can be posted on the journal's web site in the form of supporting information. Submission implies that the manuscript has not been submitted for

publication elsewhere and that it will not be submitted elsewhere while the review process is underway.

All papers are subject to peer-review by at least two experts. When submitting your paper, you will be asked for suggested names of reviewers.

Papers should be submitted electronically via https://www.editorialmanager.com/jlca/. Please indicate that this is a submission for the "Seafood LCA" issue on the author checklist during the submission process. Details about the preparation of the manuscript can be obtained from the journal's Web page.

Contact information

Please submit articles for this special issue by January 31, 2017. The Guest Editors for this issue are:

- Ian Vázquez-Rowe, Editor of Ocean Resources and Marine Conservation at the INTJLCA, Peruvian LCA Network, Department of Engineering, Pontificia Universidad Católica del Perú, ian.vazquez@pucp.pe
  Key areas of study: industrial ecology; fisheries LCA; Latin America; Peru; Spain; discards; certification schemes; combination of LCA with management methods (i.e., DEA; Operational Research); consequential LCA.

- Friederike Ziegler, SP Technical Research Institute of Sweden, Food and Bioscience/RISE Research Institutes of Sweden, friederike.ziegler@sp.se, friederike.ziegler@ri.se
  Key areas of study: fisheries management; fisheries, LCA; Sweden; Scandinavia; marine biotic resources; fuel use intensity, aquaculture, salmon farming.

- Angel Avadí, CIRAD French International Center for Agricultural Research for Development, angel.avadi@cirad.fr
  Key areas of study: fisheries LCA; Peru; Ecuador; Latin America; France; statistical analysis; aquaculture, agriculture.

- Patrik Henriksson, Stockholm Resilience Centre, Stockholm University and WorldFish, patrik.henriksson@beijer.kva.se
  Key areas of study: aquaculture LCA; Asia; uncertainty analysis.

Chronogram

Deadline for submissions: January 31, 2017

Tentative date of publication: mid 2017 (accepted papers will be published online immediately, until the Special Issue is completed)