

PROJECT REPORT

02 - 02



Rannsóknastofnun
fiskiðnaðarins

JANUARY 2002

**LCA OF FISHERIES AND
FISH PRODUCTS**

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<i>Titill / Title</i>	LCA of Fisheries and Fish Products		
<i>Höfundar / Authors</i>	Helga R. Eyjólfsdóttir (Rf), Berit Matson (SIK).		
<i>Skýrsla Rf / IFL report</i>	02-02	<i>Útgáfudagur / Date:</i>	January 2002
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<i>Styrktaraðilar / funding:</i>	Nordisk Ministerråd, Rf, SIK		
<i>Ágrip á íslensku:</i>	<p>Þessi skýrsla greinir frá niðurstöðum 1. norræna vinnufundar í samnorrænu verkefni um vistferilgreiningu sem haldinn var í Gautaborg, dagana 26-27. Febrúar 2001.</p> <p>Um var að ræða tveggja daga vinnufund (workshop). Markmið fundarins var að ræða aðferðafræði LCA fyrir fisk og fiskafurðir og uppbyggingu gagnabanka. Þátttakendur voru vísindamenn á norðurlöndum sem nýta vistferilgreiningu á einn eða annan hátt í sínu starfi/ námi.</p> <p>Kynnt voru þau verkefni um vistferilgreiningu á fisk og fiskafurðum sem eru í gangi á norðurlöndum með aðaláherslu á skilgreiningu viðmiðunareiningu og ferilgreiningu.</p> <p>Ákveðið var að setja upp heimasíðu og er slóð hennar: http://prosjekt.fish.sintef.no/LCAfishnet/</p> <p>Á henni er að finna yfirlit yfir áhugaverð LCA verkefni og útgefnar skýrslur</p>		
<i>Lykilorð á íslensku:</i>			
<i>Summary in English:</i>	<p>This report presents the outcome of the first workshop in a Nordic project on LCA of fisheries and fish products. The workshop was held in Gothenburg, Sweden 26.-27. February 2001.</p> <p>This was a two days workshop. The goal of the workshop was to discuss the methodology of LCA for fish and fish products and database format.</p> <p>The participants were scientists from the Nordic countries that use LCA in their work. They presented ongoing projects regarding LCA for fish and fish products with the focus on definition of functional unit and allocation.</p> <p>There were decided to set up a homepage, adress http://prosjekt.fish.sintef.no/LCAfishnet/</p> <p>There will be available a list of interesting projects and reports</p>		
<i>English keywords:</i>			

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1. INTRODUCTION

This workshop was organized as a joint start meeting for two network projects which have been funded by different programs within the Nordic Council of Ministers. The reason for starting them together is that they both concern the application of LCA in the seafood sector and some of the participants are members of both projects. However, the objectives of these two projects are quite different. The objective of the project “Network for environmental assessment of seafood products through LCA” is to strengthen the communication of environmental information between stakeholders in the Nordic fish sector and to create a forum for interactive communication. The objective of the second project, “Work forum; Life cycle assessment” is primarily to create a forum for researchers in the area LCA of seafood products, and is primarily dedicated to the development of LCA methodology for seafood. It was considered advantageous to hold a joint first meeting in order to co-ordinate the two network projects and benefit from each other as much as possible.

2. WORK PROGRAMME AND PARTICIPANTS

Workshop programme 26. February 2001

- 09:00 Coffee and registration
- 10:00 Introduction and presentation of the two network projects
Berit Mattsson and Helga Eyjolfsdottir
- 10:30 Presentation of National LCA fish projects:
Kristin Hassel, Norway
Mikkel Thrane and Jens Munk, Denmark
Helga Eyjólfsdóttir, Iceland
Friedrike Ziegler, Sweden
- 12:15 Lunch
- 13:15 More detailed planning of the project " Network for environmental assessment of the seafood products through LCA" , Berit Mattsson, Thomas Ohlsson and Friedrike Ziegler
- 15:00 Visit at the Swedish National Board of Fisheries, organised by Staffan Larsson.
Presentation of the Swedish fishery administration and the national environmental goals with relation to fishery.
- 17:00 Closing
- 19:00 Dinner at the restaurant Fiskekrogen in the city centre

Workshop programme 27 February 2001

- 09:00 Introduction and planning of the NARP project
Helga Eyjólfsdóttir
- 09:45 Coffee
- 10:15 Database format for LCA, Raul Carlson, CPM
Demonstration of the Swedish software LCAit 4, Lisa Person, CIT
Joint effort of Swedish industrial research institutes (IRIS) to establish a database format, Pär Olsson, SIK
- 12:00 Lunch
- 12:10 Lunch
- 13:00 Discussion on the following themes related to LCAs of fish products:
1. Definition of system boundaries, functional unit and allocation
2. Common database format for fish? Policy for trading of data
- 15:00 Coffee
- 15:30 Conclusion and planning of the next workshops
- 16:00 Closing

Participants:

Jens Munk	DTI
Tommas Leth	DTI
Mikkel Thrane	Aalborg University
Halla Jónsdóttir	IceTec
Kristin Hassel	SINTEF
Helga R. Eyjólfsdóttir	IFL
Friederike Ziegler	SIK
Berit Mattsson	SIK
Thomas Ohlsson	SIK

Invited speakers:

Raul Carlson	CPM
Lisa Person	CIT
Pär Olsson	SIK
Staffan Larsson	National Board of Fisheries
Anita Tullrot	National Board of Fisheries
Bengt Kåmark	National Board of Fisheries

3. 26. FEBRUARY 2001: NETWORK FOR ENVIRONMENTAL ASSESSMENT OF SEAFOOD PRODUCTS THROUGH LCA

After coffee and registration, Berit Mattsson and Helga R. Eyjólfsdóttir, the co-ordinators of the two projects presented them with regard to planned contents and participants (App. 1,2 and 3). The participants then presented their national LCA projects.

Norway (App.4): At SINTEF, a project is on-going that concerns LCA from the designer's point of view. It is called "The fishing vessel –a part of the production chain," and studies the fishing vessel with a life-cycle perspective. Since fuel is the biggest operational cost during the life-time of a fishing vessel, the fishing company or the fisherman who owns and/or runs it becomes more independent of world market fuel

prizes if energy-efficiency is already taken into account during the construction phase of a vessel. The constructor can identify “problem areas” and try out alternative solutions which will conserve both money and the environment at an early stage.

Denmark (App. 5 and 6): At Aalborg University, a Ph.D. project is being carried out which concerns LCA for some common fish species consumed in Denmark. Screening methods will be developed for four different seafood products as a basis for environmental product development and eco-labelling. The Danish Technological Institute (DTI) is participating in a national project on “Life cycle aspects of basic food.” One part of this project concerns marine products in particular, a case study about fish meal.

Iceland (App.7): The IFL and IceTec are currently working on a national project concerning the life cycle assessment of cod produced and manufactured aboard trawlers. The project will go on for two years.

Sweden (App.8): At SIK, there is an ongoing project called “Environmental assessment of seafood products with a life-cycle perspective,” aimed at methodological development to include marine environmental impact in LCA. A case study about the Swedish cod fishery in 1999 is currently being prepared and the emissions from fuel combustion in this fishery are being modelled.

After lunch the participants discussed more detailed planning of the project “Network for environmental assessment of seafood products through LCA.”

- *Workshops.* We have revised the plan for workshops from the project application. The next workshop will be held in Denmark, preliminary days were set on the 6-8th of August 2001. The issues to be included there are:
 - Discards /Fishing gear
 - Trawling effects on the seafloor
 - By-catch allocation problem
 - Fuel consumption /engine /emissions
 - Stock impact

- Toxic effects of anti-fouling paints

- *Invited speakers.* Yvonne Walther from the Swedish National Board of Fisheries (NBF) was suggested as an expert on discard surveys and P-O Larsson (also from NBF) as an expert on fishing gear and stock effects. It was decided that everyone should consider possible speakers who could contribute to the workshop and check in their countries for whom we should invite.

- *Grant program.* Representatives from all of the participating institutes showed interest in the program which would offer an opportunity to visit another participating institute for a period of time (from a week to several weeks) in order to exchange methods and results and eventually, in some cases, even work together.

- *Web page.* The participants agreed that this has to be divided into two parts. An open web page with general information, links to the institutes, definition of LCA and its relation to fish, list of ongoing projects, list of previous publications and the opportunity for the industry to ask questions. The other part would be an interactive web page which can be accessed with a password. Kristin Hassel has some experience of designing webpages and will examine if it is possible for her to assume the responsibility of constructing and maintaining the page. Another option would be to use a conference system, called First Class, which e.g. is used at SIK.

The day was concluded with a visit to the Swedish National Board of Fisheries, organised by Staffan Larsson. Several presentations were made regarding the Swedish fishery administration, the national environmental goals with relation to fishery as well as the current status of the development of an eco-labelling scheme for seafood.

4. 27. FEBRUARY 2001, WORK FORUM, LIFE CYCLE ASSESSMENT

Helga started by introducing the NARP project and the objective of it and gave an overview of planned activities. The next workshop will be held in Iceland in 2002 in co-operation with the other networks. One idea is that the third workshop could be held in Norway and Kristin will look into that.

After coffee break, some invited lecturers presented database formats from different points of view. These were Raul Carlson from CPM, Lisa Person from CIT and Pär Olsson from SIK. Raul presented a Swedish (internationally) documented and fully reviewed LCA database built on SPINE. Lisa presented LCAiT4, which is to some degree based on SPINE and, finally, Pär presented a Swedish project “ IRIS-LCA database” where industrial research institutes put data in a database catalogue. The structure of this catalogue is also based on the SPINE database format.

After these presentations, the participants discussed how they could use this information to build our own database and how we should proceed with this.

In Denmark there is a another database format, developed by the industry, which is called SPOLD. The question is whether it is perhaps more useful for us. Is it better to have a small amount of data fairly well documented or a whole lot of data that is not so much documented? The participants agreed on a minimum standard which includes, among other things:

- Reference for the data
- Geographically data
- Information about the origin

It was decided that it is too early to make a decision on a definite format for our seafood data and that we will wait for the ISO 14048 standard.

An e-mail group will ensure that the participants will remain in a close contact with one another, that they will be able to ask questions about how to handle problems methodologically and that they can share information about published reports and other interesting material.

Also on the agenda was a discussion of problems concerning functional unit, allocation and system boundaries. The participants had been asked to bring their specific problems to the workshop and discuss them there. Several problems were discussed :

- Allocation:
 - Sweden. In the Swedish project, there are questions about whether it is better to use economical allocation vs. mass allocation because the fisherman catches both Norway lobster and cod at the same time. It was pointed out that if it was possible, it would be useful to expand the system boundaries (find a system where only one of the species is caught) and use that as a part of the system. If that is not possible, the economical allocation would be better.
 - Iceland. When the trawlers fish at distant fishing grounds, the main purpose is usually to catch cod. However, they also catch several other species, both species that can be used commercially and also those that are not commercial. Furthermore, when processing the fish there are several by-products not so valuable as the main product. Everybody agreed that economical allocation is better than mass allocation.
- System boundaries:
 - Iceland. After the fish has been transported to Europe, there awaits a huge and a complex transport system for processing and selling the fish. In

some cases the fish is used as a raw material for further processing and sometimes it is sold on the open market. The question is if the analyses should contain everything or if it would be possible to let the system boundaries end at the harbour. It was considered better to follow one stream (the most common one) and look at the others as by-lines

- Functional unit. No direct problems were discussed there but the question was raised if it were perhaps necessary to be able to compare different studies to use some criteria for the quality as an index for the functional unit. No conclusion was reached but the participants agreed that this was certainly something to bear in mind when choosing the functional unit.

After that the participants exchanged some published reports and papers and the workshop was closed.

5. APPENDIX

- 1 Contact information of participants
- 2 Participants in the two networks
- 3 Presentation of the two networks
- 4 Presentation from Norway
- 5 Presentation from AAU, Denmark
- 6 Presentation from DTI, Denmark
- 7 Presentation from Iceland
- 8 Presentation from Sweden

NARP vs NMR

- Forum for scientists, directly into concrete problems - methodology
- More applied focusing. The connection between industry, biology etc.

HRE-NARP WORKSHOP- FEB '01



Cooperation between the two network

- Workshop at the same time as today?
- Mutual themes for both workshops
- Others ??
- Internet IFL – connection to participants

HRE-NARP WORKSHOP- FEB '01



Introduction

- Objective: Establish a work forum for scientists working on LCA in fisheries and fish production
- Project cost: The payment cover travelling expenses, but not salaries- total of 200.000
- Time: 3 year- 1 workshop /year
- Project leader: Helga R. Eyjólfsdóttir-IFL
- Participants:
 - IceTec-Halla Jónsdóttir, SIK-Berit Mattson, TI-Jens Munk, SINTEF-Kristin Hassel

HRE-NARP WORKSHOP- FEB '01



Aim of the project

- Provide opportunity for participants to meet and learn from each other experience
- Motivate cooperation and coherence on this field within the Nordic countries
- Discuss LCA-streamlining
- Promote development of LCA model
- Discuss practical utilization of the results

HRE-NARP WORKSHOP- FEB '01



Project explanatory

- First meeting-feb '01
 - ▣ Definition of boundaries, allocation and functional unit
 - ▣ Comparison and evaluation of different approaches
- Second meeting-xx '02
 - ▣ Obstacles, assessment, streamlining possibilities
- Third meeting-xx '03
 - ▣ Assessment and environmental impact
 - ▣ Practical use of the result
 - ▣ Model for other LCA studies in fisheries

HRE-NARP WORKSHOP- FEB '01



Workshop -year 2002

- Question: Should we have it in connection with NMR-project?
- Location: Iceland
- Time: ?
- Participants- the same as here
 - ▣ Others: shall we invite someone
- Speaker? Like today?

HRE-NARP WORKSHOP- FEB '01



Workshop-2003

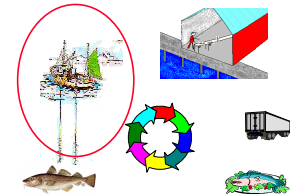
- Where?



National LCA fish projects

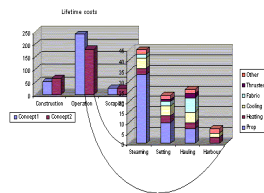
Kristin Hassel
Research Scientist

The fishing vessel - a part of the production chain

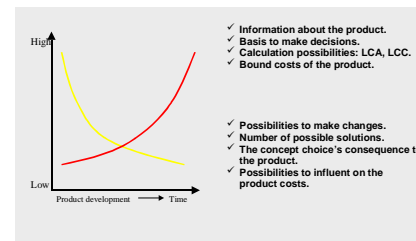


LCA used in design

- The constructor will be able to identify "problem areas" and try out alternative solutions in an early stage.
- Traditional design tools used in combination with LCA can be used to show potential ship owners that environmental thinking is economical thinking!
- It can be used to document a ships robustness against "the demands of tomorrow".



"The conflict"



- ✓ Information about the product.
 - ✓ Basis to make decisions.
 - ✓ Calculation possibilities: LCA, LCC.
 - ✓ Bound costs of the product.
- ✓ Possibilities to make changes.
 - ✓ Number of possible solutions.
 - ✓ The concept choice's consequence to the product.
 - ✓ Possibilities to influence on the product costs.

Calculation tool / TEES

- The calculation tool project was funded by the Norwegian Research Council in co-operation with the ship yard Fiskerstrand Verft AS.
- The TEES project was funded by the European Commission under the 4th Framework Programme. Other RTD partners: IKP (Germany), NEA Transport Research and training (The Netherlands) and Eric Støttrup Thomsen ApS (Denmark).
- Scope of work: Develop a data model that helps the user in the decision making process. The designer will have the possibility to test and evaluate different design solutions from optional design criteria.
- The TEES project resulted in a "Design For Environment"-tool, with SFH's calculation tool for fishing vessels as a part of it.

Energy saving

- SFH has during the last years accomplished several research projects with regard to energy saving.
- "The Kyoto agreement": The fisheries possibility to contribute to the fulfilment of the Kyoto agreement. Funded by the Norwegian Research Council, completed December 2000.
- Operational data collection for longliners and trawlers.
- The project resulted in suggestions of several energy saving initiatives, based on data collected in the project.

Fleet modelling

- How should the fishing fleet be put together, so that each and every vessel can be operated in an effective and sustainable way?
- Data collection
- Calculation models



Where to go next?

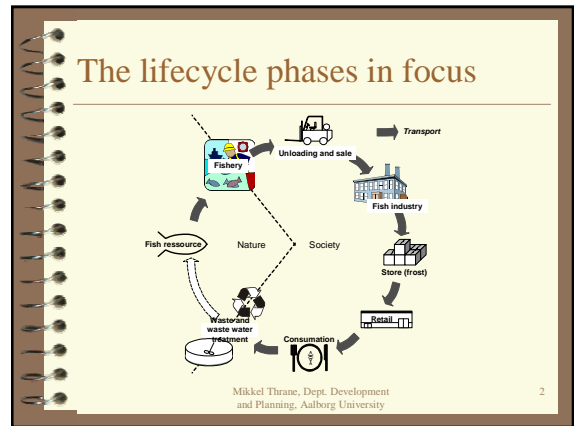
- Perform a full LCA of a fishing vessel
- Make LCA databases communicating with tools for ship design
- Make the fishing industry aware of our existence, -money talks?



LCA on Danish consume fish

PhD study at Aalborg University
Supervisors:
Per Christensen and
Bo Weidema

Mikkel Thrane, Dept. Development and Planning, Aalborg University



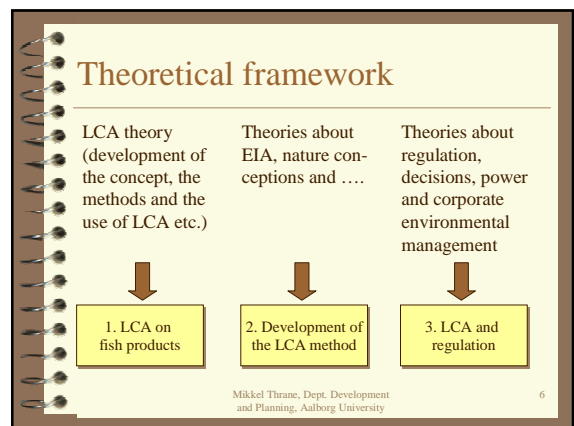
- ## Product types in focus
- **Cod** (a cardboard box of frozen filets - net 250 gram)
 - **Plaice** (a plastic bag of frozen paned filets - net 300 gram and 60% fish)
 - **Herring** (a glass of pickled herring filets - net 205 gram)
 - **Mackerel** (one piece of canned mackerel in tomato pasta - net 80 grams)
- Mikkel Thrane, Dept. Development and Planning, Aalborg University

- ## The purpose of the study
- To provide a basis for fishery- and environmental regulation e.g. environmental labelling
 - To serve as inspiration/eye opener for environmental initiatives at company or branch level
- Mikkel Thrane, Dept. Development and Planning, Aalborg University

Structure of thesis

1. LCA on fish products	2. Development of the LCA method	3. LCA and regulation
<ul style="list-style-type: none"> - Perspectives for LCA in relation to fish products - Lifecycle screening and hot spot analysis - LCA on alternative scenarios 	<ul style="list-style-type: none"> - Collection of data about the effect on the Sea-ecosystem - Integration of non-flow related impacts in LCA - Discussion about new impact categories, quantification, normalisation and weighting 	<ul style="list-style-type: none"> - Analysis of fishery regulation and the conception of sustainable fishery and fish products - Potentials of using the LCA results as basis for a more product oriented regulation - Potentials of using the LCA concept as a tool for authorities and companies

Mikkel Thrane, Dept. Development and Planning, Aalborg University



Status of PhD thesis

- Introduction, purpose and scope (50 pages)
- Company contacts - data collection (ongoing)
- Questionnaire for fishing wessels
- Trying to establish cooperation with the Danish Fishery Organisation

Preliminary results (AAU)

- A previous study of pickled herring (research assistant)
- A previous study of frozen mussels (6th semester Environmental Planning)
- Ongoing LCA study of canned mackerel in tomato paste (final thesis Env. Planning)

Baggrund

- Øget almen interesse for fødevarernes produktionsmåde
- Forbrugerens fokus på ressourceforbrug og miljøpåvirkning
- Fødevarer ansvarlig for en stor del af familiens ressourceforbrug og miljøpåvirkning
- Virksomheders behov for at kunne gennemføre en dokumentation
- Mangel på valide data fra primærlandbrug og fiskeri
- Behov for tilpasning af indikatorer



Udfordring

- Fremskaffelse af solidt og fremadrettet datagrundlag
- Konsensus blandt ledende virksomheder/brancher om systemafgrænsning og allokeringssprincipper
- Let for virksomheder at få fat i de relevante data fra primærproduktionen



Projektafgrænsning

- Typiske vegetabiliske og animalske landbrugsprodukter (cerealier, svinekød, mælk, oksekød, æg og fjerkrækød)
- Udvalgte gartneriafgrøder
- Akvakultur (portionsørreder)
- Fiskemel (tobis)
- Økologisk non-food (baseret på vegetabilier)



Projektstruktur

- | | | |
|-------------------------|-----------------|--|
| • Jordbrug | DJF | (John E. Hermansen, Anders H. Nielsen) |
| | 2.-0 | (Marianne Wesnæs, Bo Weidema) |
| | SJFI | (Ole Olsen) |
| • Akvakultur og fiskeri | DFU | (Erling P. Larsen) |
| | SJFI | (Ole Olsen) |
| • Branchekontakt | 2.-0 | (Marianne Wesnæs) |
| | F-dir. | (Lene M. Christensen, Bent E. Mikkelsen) |
| | DTI | (Jens Munk, Henriette Ølgaard) |
| • Modeludvikling | DJF, 2.-0, SJFI | |



Styregruppe

<i>Fødevaredirektoratet</i>	Marianne Cleemann
<i>Mejeriforeningen</i>	Carsten Fricke
<i>Dansk Industri</i>	Ole Linnet Juul
<i>Dir. for FødevarerErhverv</i>	Ulla Blicher Mathiesen
<i>Fore. af Danmarks Fiskemel- og Fiskeolieindustri</i>	Frank Minck
<i>Danske Slagterier</i>	Børge Mortensen
<i>Landbrugsraadet</i>	Lis Thodberg
<i>Miljøstyrelsen</i>	Rikke Traberg
<i>Danmarks Fiskeindustri- og Eksportforening</i>	Peter Villadsen



Primær jordbrug

- Miljøeffekter og allokering
 - Principper for allokering (ex. mælk-oksekød)
 - Pesticider (klassificering i miljøeffektkategorier)
 - Arealforbrug
- Repræsentative datasæt
 - Typologisering
 - SJFI's 2000-regnskaber
 - Beregning af ressourceforbrug og afstemning mod nationalt opgjort forbrug
- Modeller for typiske produktioner



Primær fiskeri

- Miljøeffekter og allokering
- Repræsentative datasæt
 - Tobis
 - Portionsørreder



Branchekontakt

- Identificere interesserede aktører og brancher
- Formidle grundlag for at skabe konsensus indenfor brancher
- At få feed-back fra aktører
- At tilvejebringe LCA-data vedr. forarbejdning for nøgleprodukter
- Eksemplificering af LCA for nøgleprodukter



Data og modeller

- Offentlig tilgængelig database til brug for LCA for basislevnedsmidler (dyrkning og forarbejdning)
- Tilgodese evt. behov for forenklede metoder til praktisk brug
- Sammenhæng i data fra forskellige led fra primærproducent til forarbejdning



Samarbejde med virksomheder

- "Produktet" bliver bedst af at blive brugt
- Fremadrettede virksomheder nyder gavn af at være i front med LCA
- Virksomhedernes viden om produktionsprocesser og ressourceforbrug bør nyttiggøres



Virksomheder inviteres til at deltage i workshop-række marts - sept. 2001

- Introduktion til LCA (1 dag)
- Kursus i brug af PC-værktøj (1 dag)
- Anvendelse af LCA (1 dag)
- Handlingsplan for virksomhederne (1 dag)



Virksomheder inviteres til at deltage i projektet sept. 2001 - 2003

- Dataindsamling
- Gennemførelse af LCA for egne produkter med konsulenthjælp



Tilbud til virksomheder

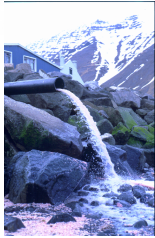
- Gratis kursus i LCA
- Hjælp til gennemførelse af egen LCA
- Åbne data / fortrolige data
- Være med til at præge de grundlæggende rammer for LCA

Deltag i de kommende workshops



Fishery research in Iceland

- Past
- Present
- CP !



- Future
 - LCA
 - Green...
 - Reports
 - Laws
 - Regulation



HRE at IFL and HJ at IceTec



Icelandic project

- Evaluates the impact on environment from cradle to grave.
- Indicates where most environmental benefit can be gained.
- LCA of cod fished on a full production vessel.
- Collaboration with firms:
 - **Haraldur Böðvarsson**-fish and exporting company
 - **ÍS-sales organisation** (distribution of fish)
 - **Minister of Fishery**
 - **The Fisheries association of Iceland**
 - **Other interested parties** to collect basic and information on input/output in the life cycle of cod.

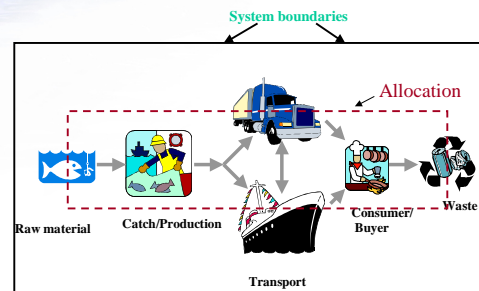
HRE at IFL and HJ at IceTec



Life cycle assessment of cod products - aim of the project -

- Evaluation of environmental impact of cod production
- Environmental labelling
- Eco-friendly product development

HRE at IFL and HJ at IceTec



HRE at IFL and HJ at IceTec

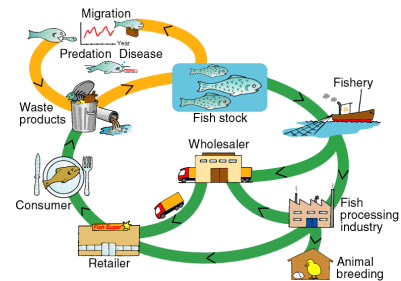


Environmental Assessment of seafood products with a life-cycle perspective

A Ph.D project in collaboration between the Swedish Institute for Food and Biotechnology (SIK), Göteborg University, the National Board of Fisheries, the KK-Foundation and Allt i Fisk.

Friederike Ziegler, Per Nilsson, Berit Mattsson, Thomas Ohlsson

Life cycle of fish- what does it mean?



Focus on fishery... to be continued...

Case study:
Swedish cod fishery in 1999

Environmental impact from fishery:

- Stock impact
 - + Discards
 - + Trawling impact on seafloor
 - + Anti-fouling paint
 - + Solid waste
 - + On-board cooling agents
 - + Emissions
-
- = Life Cycle Assessment
data necessary for fishery

Stock impact: On target and by-catch species

Depends on level of exploitation in relation to recruitment success...

...not a constant ratio per kg catch!

What can we do to include it in LCAs?

Index based on management advice from fishery administration and research on recruitment?

Discards: under-sized specimens or low value species

EU programs in the Baltic/ Kattegat and North Sea/ Skagerak provide data for some species and gears

How handle variability?
Include mean over months years?

Contrast: Discards/ birds!

Cooling/Anti-fouling/ Waste

- Questionnaire
- Interviews
- Literature
- Databases

Trawling effect on the seafloor-physical, chemical and biological

Classical approach: Total area trawled

New method: GIS

Can be used to estimate intensity in different parts of a fishery and in certain areas.

Requires fine-tuned effort data

Biological, physical and chemical effects can be estimated qualitatively from literature

Emissions from fuel combustion

- Separated the Swedish cod fishery into important segments (Baltic gillnet, Baltic trawl etc.)
- Studied the "engine park" in the fleet; chose typical engines for each segment.
- Fuel consumption from fisherman questionnaire

continued...

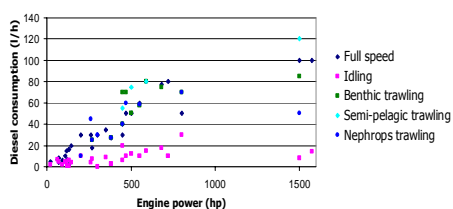
...continued:

Emissions from fuel combustion

- Emission data from Volvo Penta
- Engine load profiles during fishery from Norwegian study

...continued: Emissions from fuel combustion/ questionnaire

Diesel consumption during fishery



...continued: Emissions from fuel combustion/ some results

- Engine load profile not significant
- Engine size important for fuel consumption, but not for emissions
- Age of engine and fuel consumption determine the resulting emissions
- To be continued...