NTNU

Institutt for marin teknikk

# *Scale and nature of emissions from fisheries*

## Seas at Risk

### Climate and the Ocean

Impact and Mitigation Challenges for Fishing and Shipping

Brussels, 5th November 2008

Cod - Gadus morhua - 70-110 cm

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# Content of presentation

- Norway and fish
- Scale of the problem in Norway and international
- Fuel use for mixed fisheries with trend lines
- Premises for the different gear types
- Comparison with other food chains
- Some conclusions

# Norway and fish

- 10. largest fishing nation
- 2. largest export nation
- 3.3 million tons in total (2,7 form fisheries, 0,6 from aquaculture)
- 95% exported
- 2,5 kg. per citizen per day if not exported

- Large potential for increased value added identified (new products, new industries, bio-technology etc.), but sustainability is a pre-requisite.

# Fisheries and green house gas emissions

- Fisheries consumes 1,2% of the global oil consumption (Tyedmers et. al. 2005)
- Global energy subsidization (energy content of the fuel burned is 12,5 times the edible protein energy content of the resulting catch) (Tyedmers et. al. 2005)
- Fisheries consumes around 2,5% of the total oil consumption in Norway
- Norway struggle to meet several international agreements as Kyoto and Gothenburg
- Energy costs have increased strongly latest years resulting in financial challenges within several fleet segments

# Fuel use calculations for various parts of the Norwegian fishing fleet

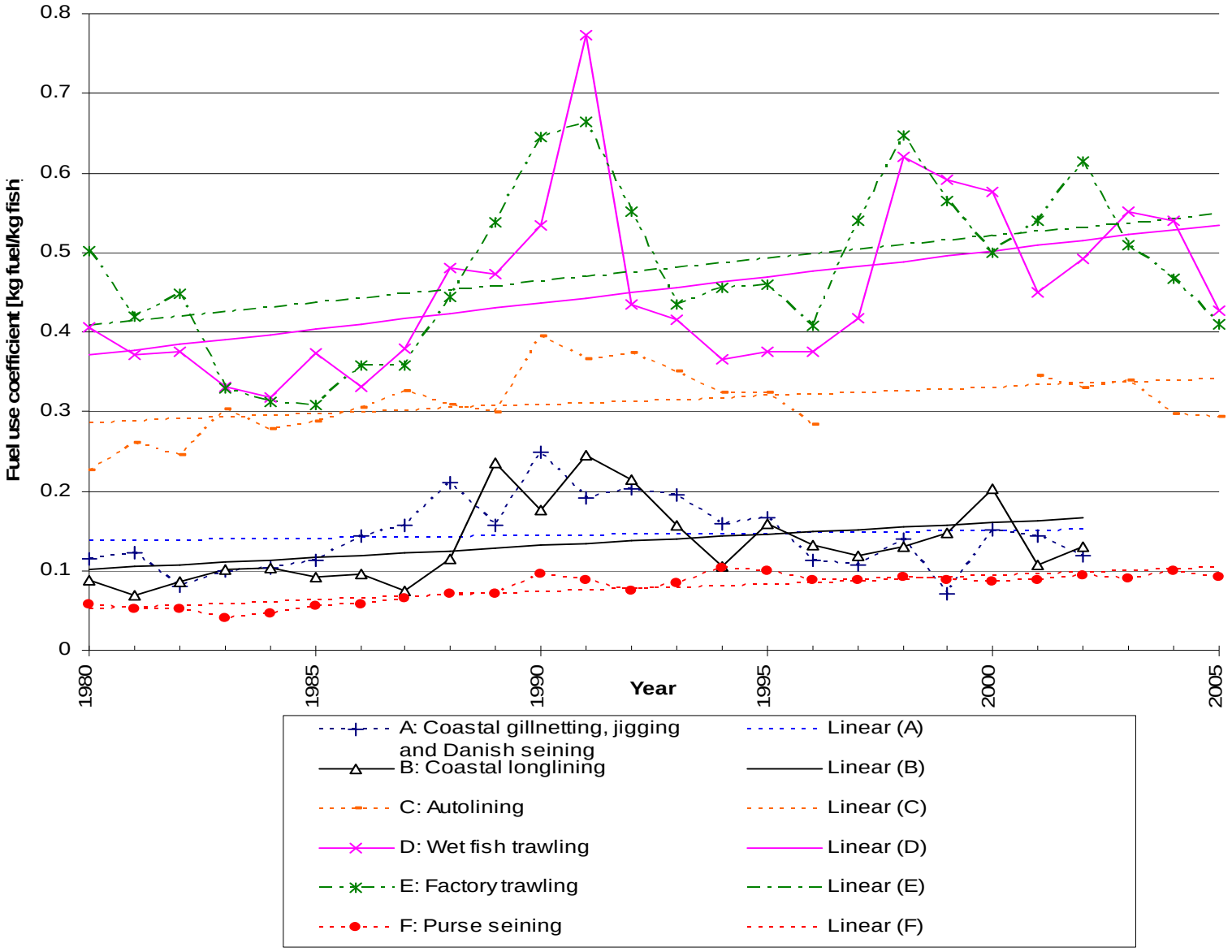
- 1980 to 2000: Fuel use for mixed fisheries calculated based on costs (data from the Norwegian Directorate of Fisheries) and fuel price data from various sources.
- 2001 to 2004: Fuel use based on direct data from the Directorate.
- Mass allocation is performed to derive specific consumption for fishing gear.
- LCS analyses performed to compare various food chains and find hot spots within food chains

# Energy cost in percent of income various fleet groups (2006)

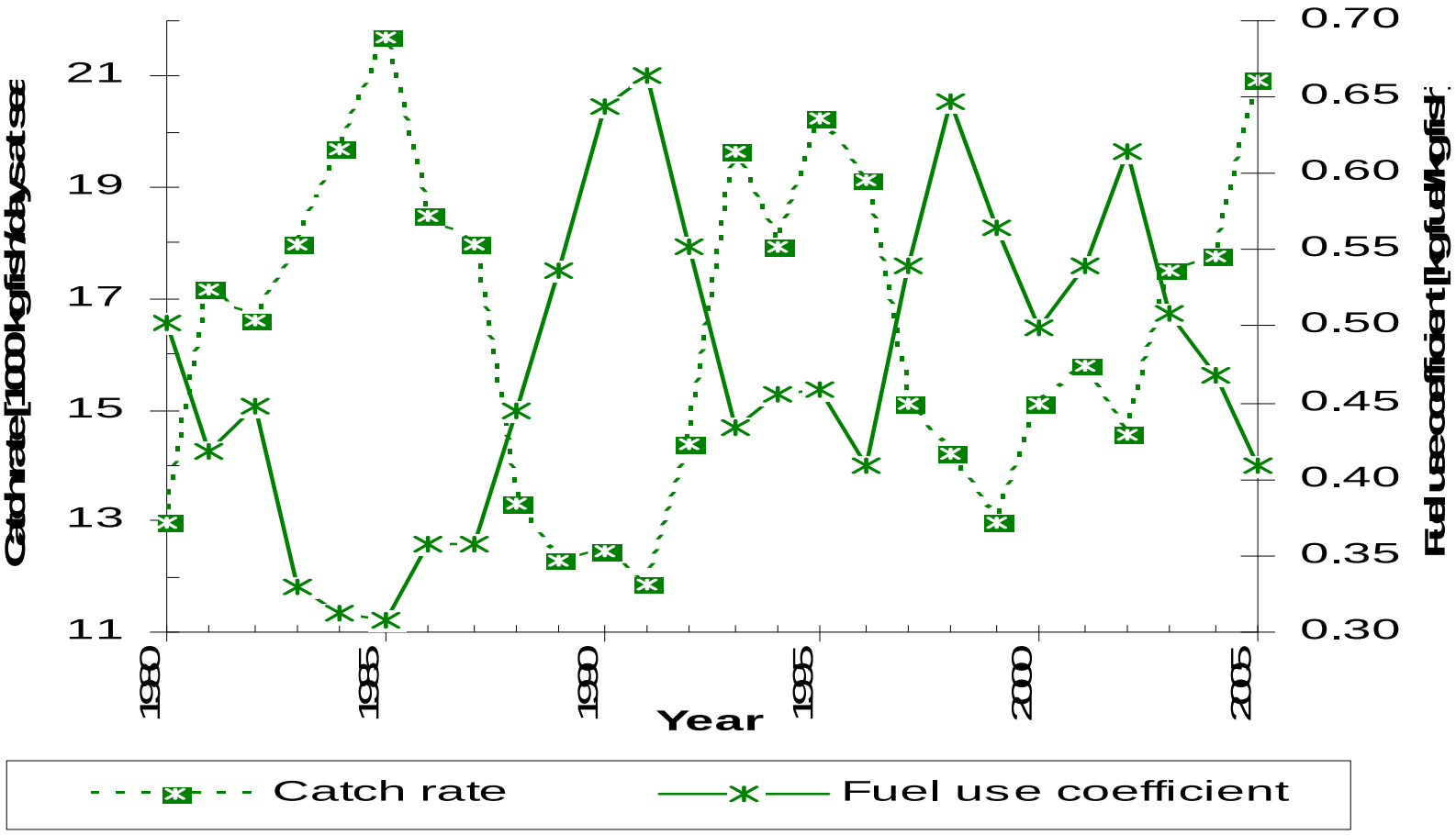
| Group | Length [m] | Main fishing tool | Income [NOK] | Energy [NOK] | % |
|---|---|---|---|---|---|
| **Demersal fisheries** | | | | | |
| 001 | 8 - 9,9 | Conventional | 695 120 | 34 370 | 4,9 |
| 002 | 10 - 14,9 | Conventional | 1 493 736 | 76 595 | 5,1 |
| 003 | 15 – 20,9 | Conventional | 3 230 266 | 186 420 | 5,8 |
| 004 | 21 – 27,9 | Conventional | 7 123 458 | 520 705 | 7,3 |
| 005 | 28 and above | Conventional | 29 692 660 | 2 416 281 | 8,1 |
| 006 | Larger | Cod/shrimp trawlers (Processing) | 66 871 595 | 9 359 443 | 14,0 |
| 007 | Larger | Cod/shrimp trawlers | 43 584 519 | 7 684 926 | 17,6 |
| 008 | Larger | Cod trawlers | 41 609 744 | 7 265 633 | 17,5 |
| 009 | 8 – 10,9 | Coastal shrimp trawlers | 874 081 | 110 556 | 12,6 |
| 010 | 11 – 20,9 | Coastal shrimp trawlers | 2 726 232 | 464 661 | 17,0 |
| 011 | 28 and above | Shrimp trawlers | 40 610 860 | 15 797 231 | 38,9 |
| **Pelagic fisheries** | | | | | |
| 013 | 8 - 12,9 | Coastal seining | 1 220 515 | 68 773 | 5,6 |
| 014 | 13 – 21,35 | Coastal seining | 6 895 394 | 455 031 | 6,6 |
| 015 | 21,36 – 27,49 | Coastal seining | 12 261 003 | 919 042 | 7,5 |
| 016 | 27,5 and above | Purse seining/pelagic trawling | 24 658 991 | 2 538 440 | 10,3 |
| 017 | 27,5 and above | Purse seining/pelagic trawling including blue whiting | 41 894 922 | 4 882 007 | 11,7 |
| 018 | 27,5 and above | Pelagic trawlers | 16 769 098 | 3 068 321 | 18,3 |

Ice and bait production outside vessel are not included
Calculations based on figures from the Directorate of the Fisheries

# Specific energy use Norwegian fisheries 1980 - 2005

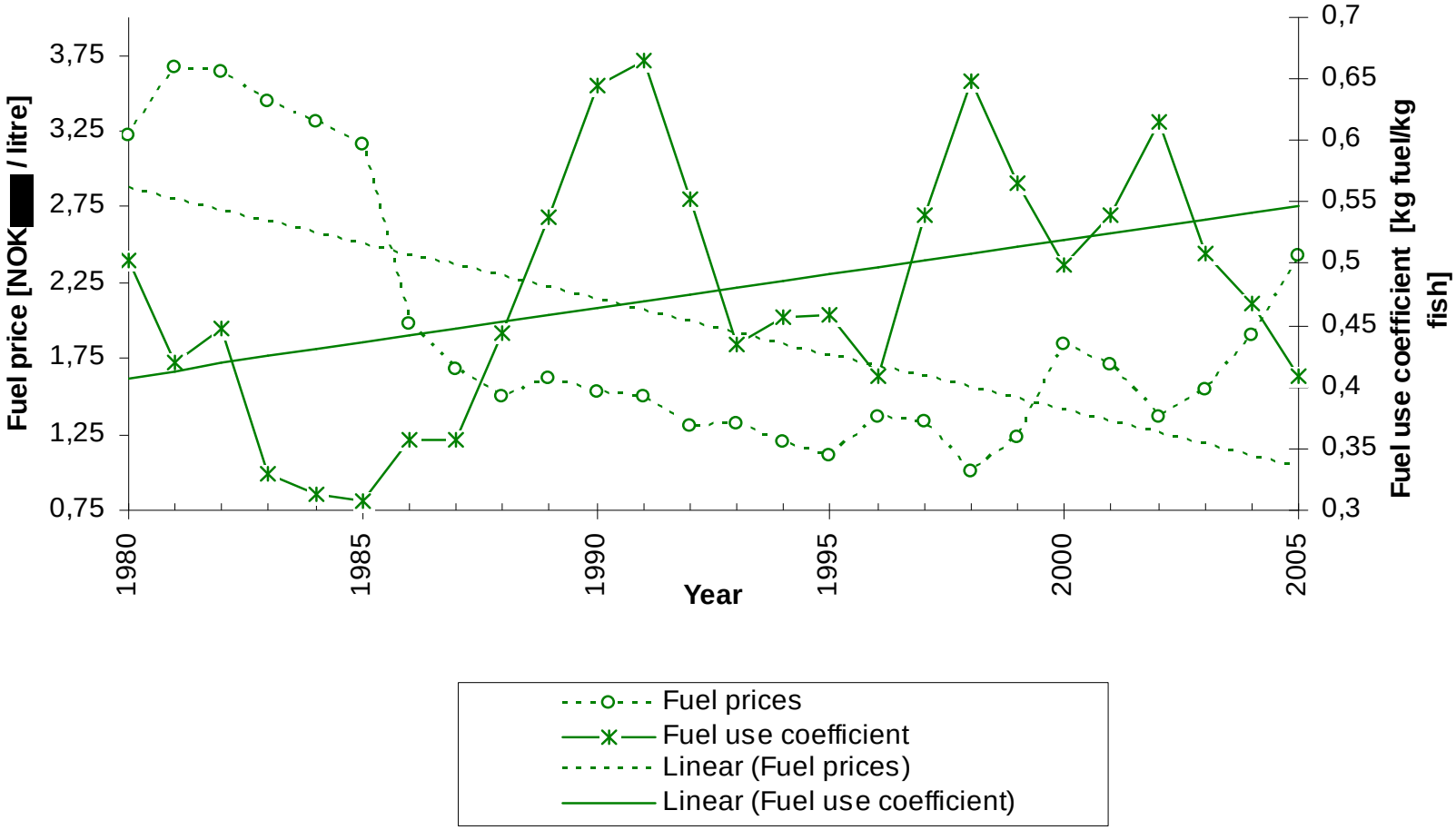


# Catch rate and fuel use coefficient, factory trawling



# Specific fuel consumption versus fuel price development (1998 NOK).

## Trend lines are plotted.



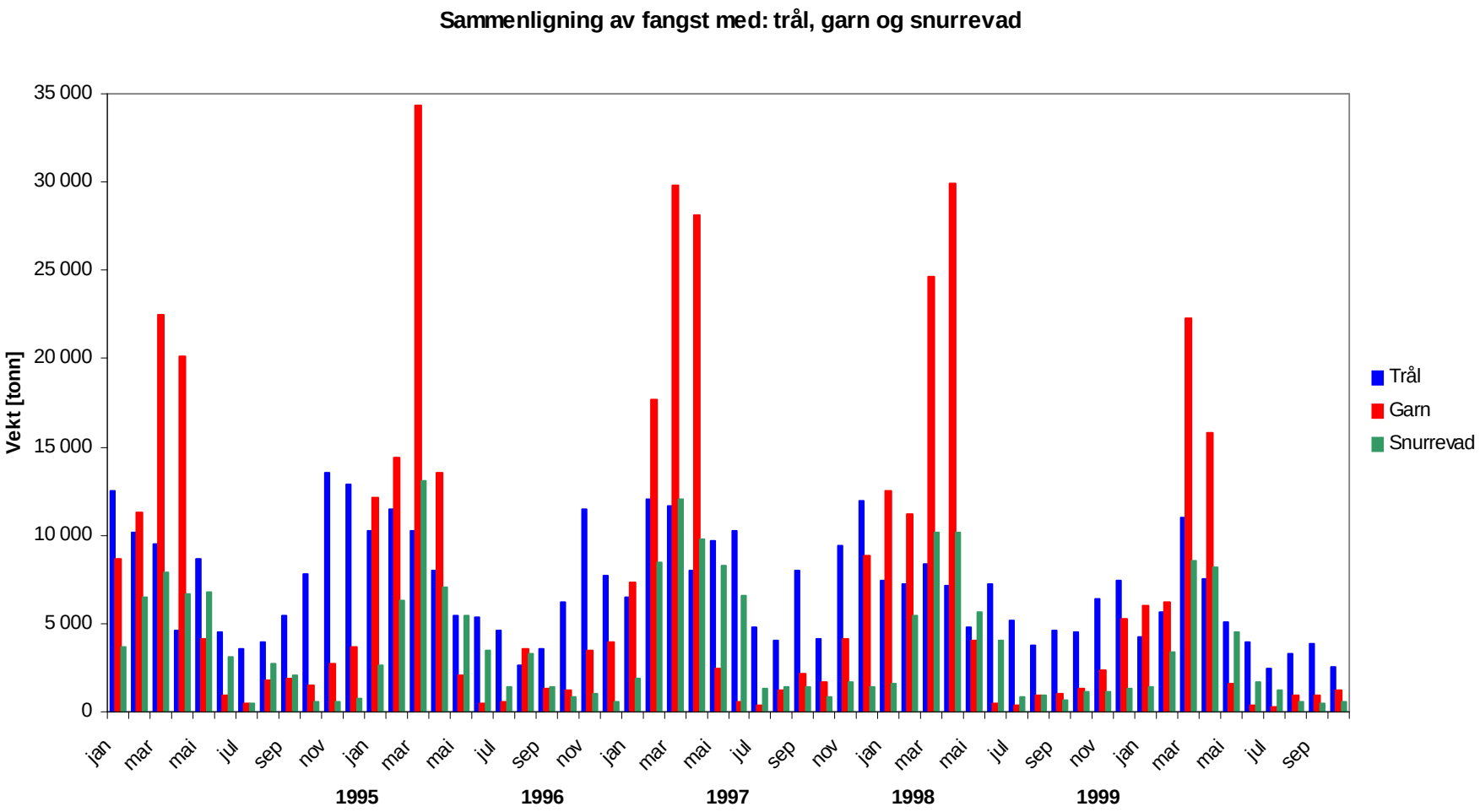

Source: Schaug et. al. (2008)

# Calculated fuel use coefficients for selected fishing gears used in Norway for the years 2001-2004 aggregated

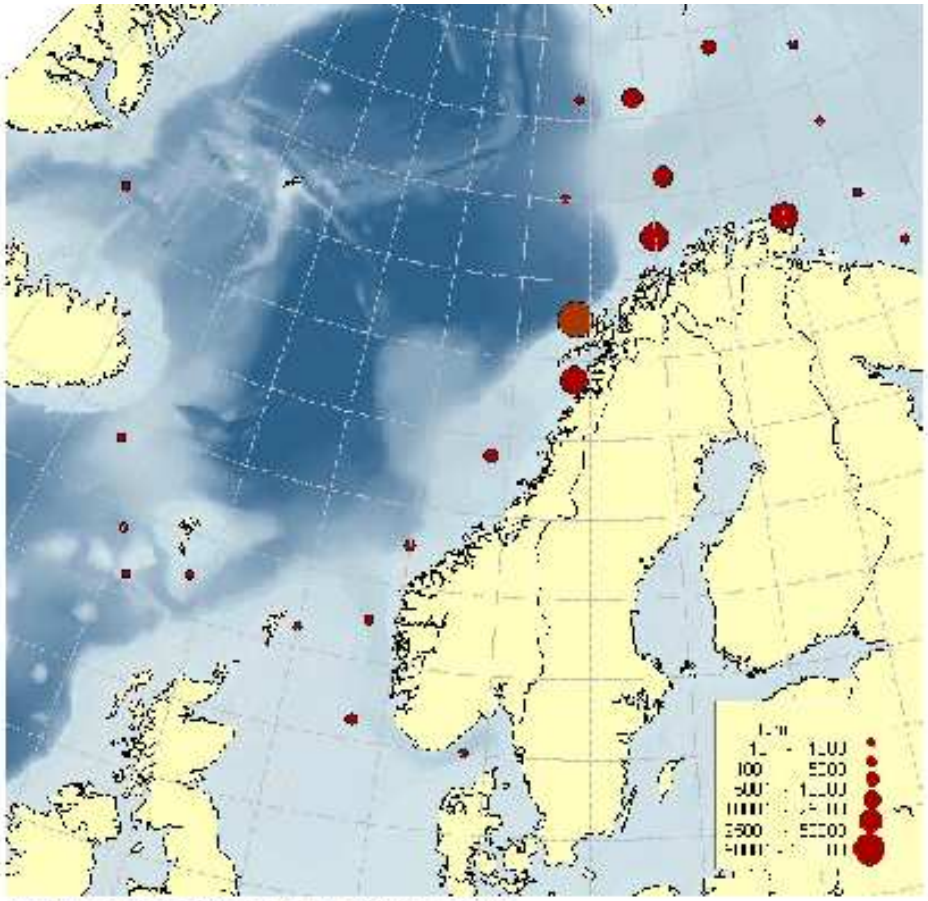
| Gear type | Number of vessels | Average [kg fuel/kg fish] |
|---|---|---|
| Bottom trawl [a] | 449 | 0.28 |
| Double trawl [b] | 26 | 1.01 |
| Pelagic trawl | 307 | 0.09 |
| Gillnet | 1152 | 0.19 |
| Hook (hand line and trolling line) | 708 | 0.15 |
| Longline (floating longline and autoline) | 694 | 0.31 |
| Shrimp trawl | 356 | 1.04 |
| Purse seine/ring seine | 726 | 0.09 |
| Danish seine/round-fish trawl/ Flat fish trawl | 343 | 0.11 |
| Trap (for various fish and crustaceans) | 282 | 0.13 |

[a] Includes industrial fish and blue whiting
[b] Deepwater prawn (*Pandalus borealis*) in the years 2003 and 2004 only.

# Catch delivered by trawling, gillnetting and Danish Seine throughout the year



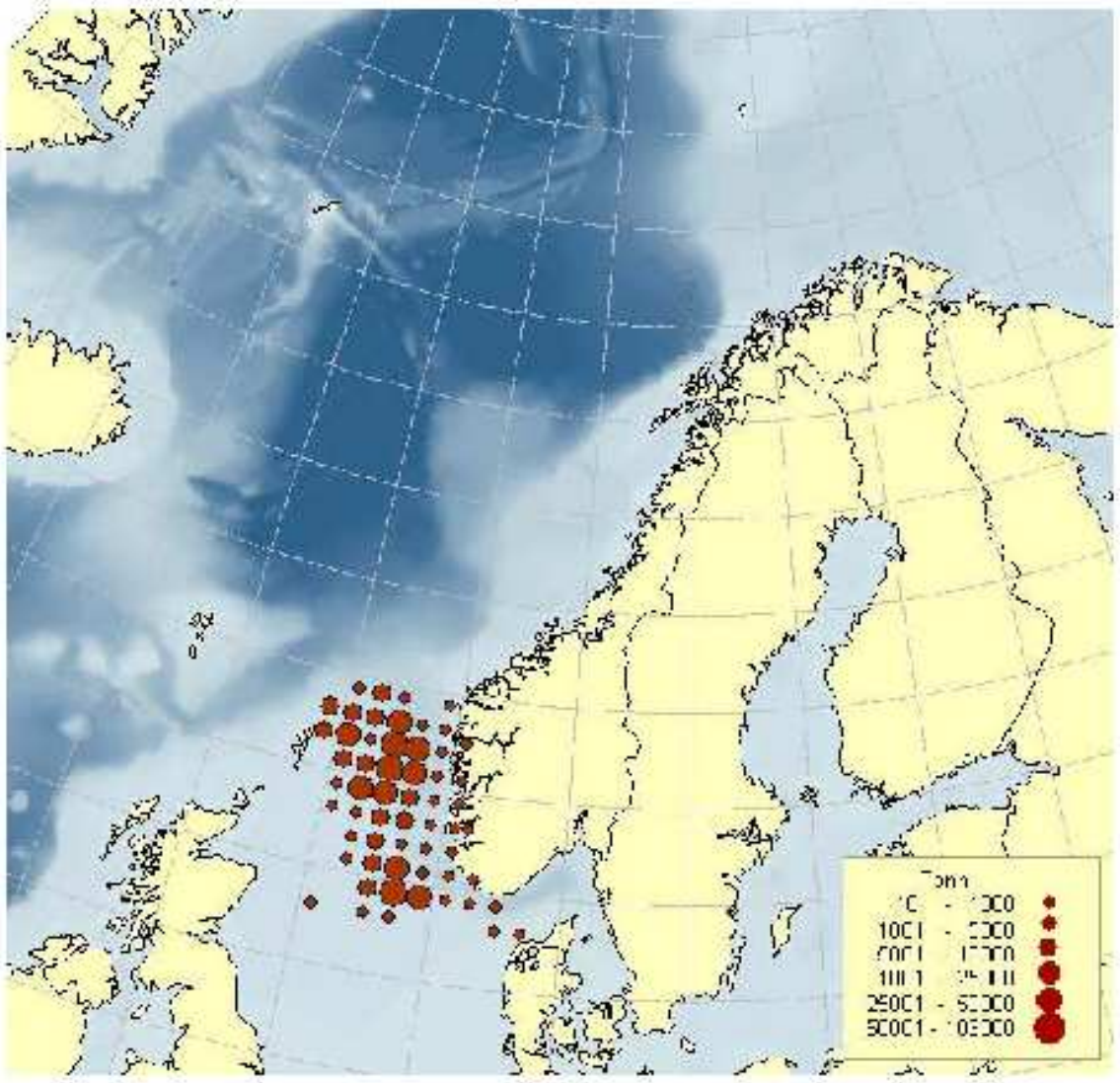
# Cod - Norwegian catches (2004)



Kartet baserer seg på fangst fordelt på hovedområder

| Fangstområde | Periode | Fangstredskap |
|---|---|---|
| Barentshavet | Hele året | Garn, line, bunntrål og snurrevad |
| Svalbard | Hele året | Garn, line, snurrevad |
| Lofoten (østsiden) | Februar-mai | Garn, line, snurrevad |
| Lofoten (vestsiden) | Januar-mai | Garn, line, snurrevad og trål |
| Mørekysten | Mars-april | Garn, line, snurrevad og trål |
| Nordsjøen | Bifangst hele året | Garn, line, snurrevad og trål |

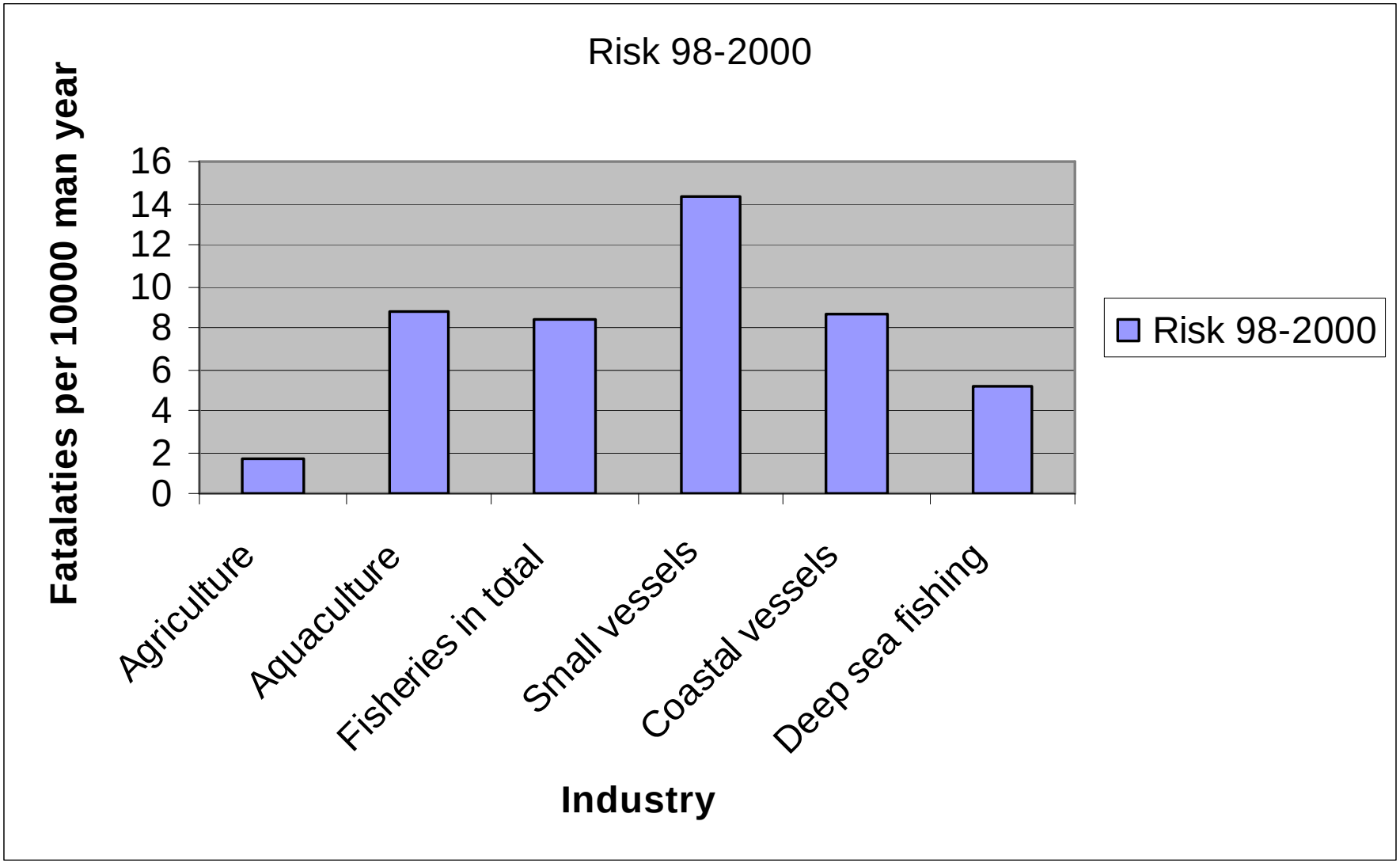
# North Sea Herring – Norwegian catches (2004)



# Distribution of the Cod North of 62°N

| Total quota | Conventional fleet | Trawlers |
|---|---|---|
| Less than 130 000 tons | 72% | 28% |
| 130 000 – 330 000 | Linear down to 67% | Linear up to 33% |
| Over 330 000 tons | 67% | 33% |

# Risk level in fishing, aquaculture and agriculture

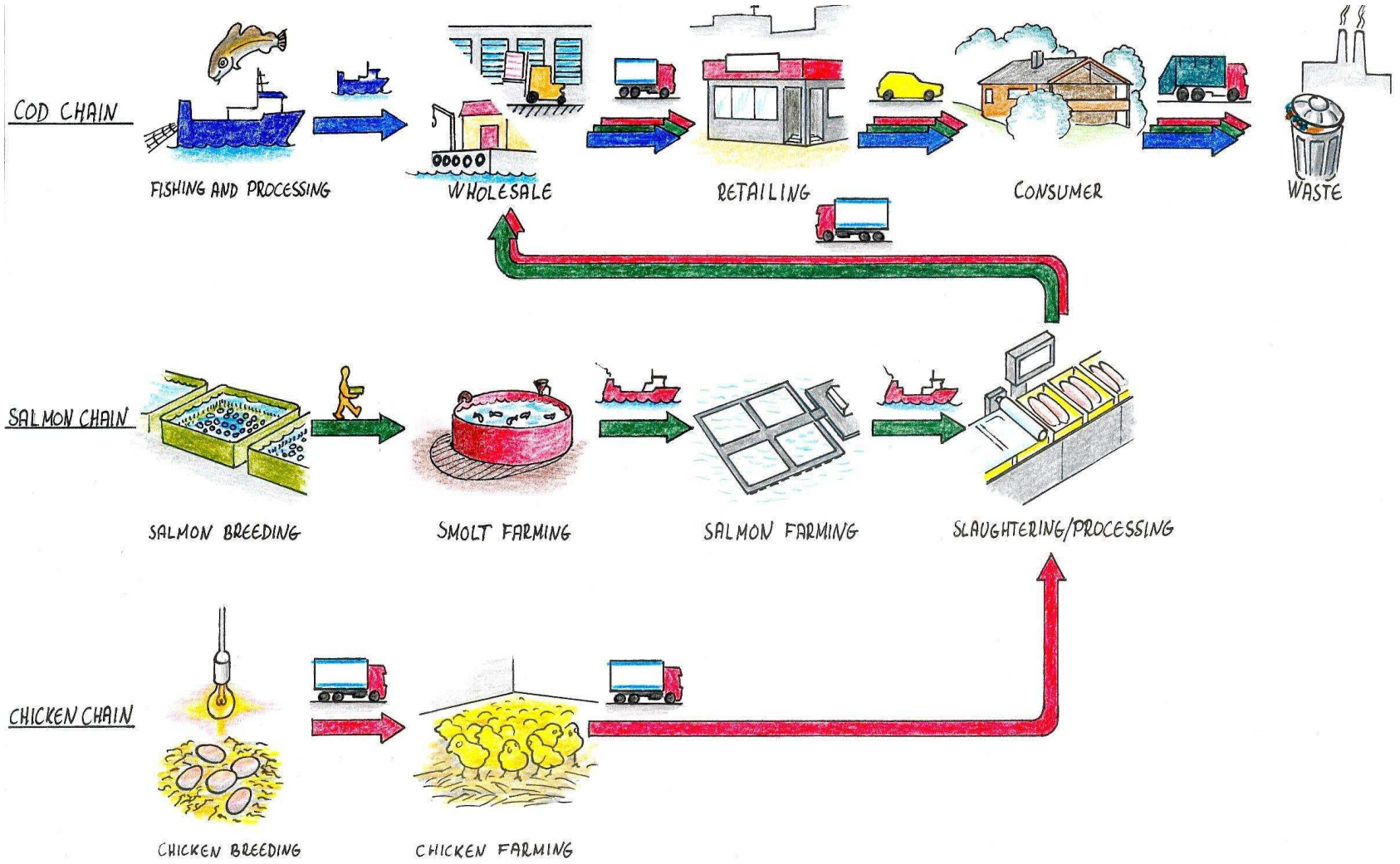



Aasjord, SINTEF Fisheries and Aquaculture

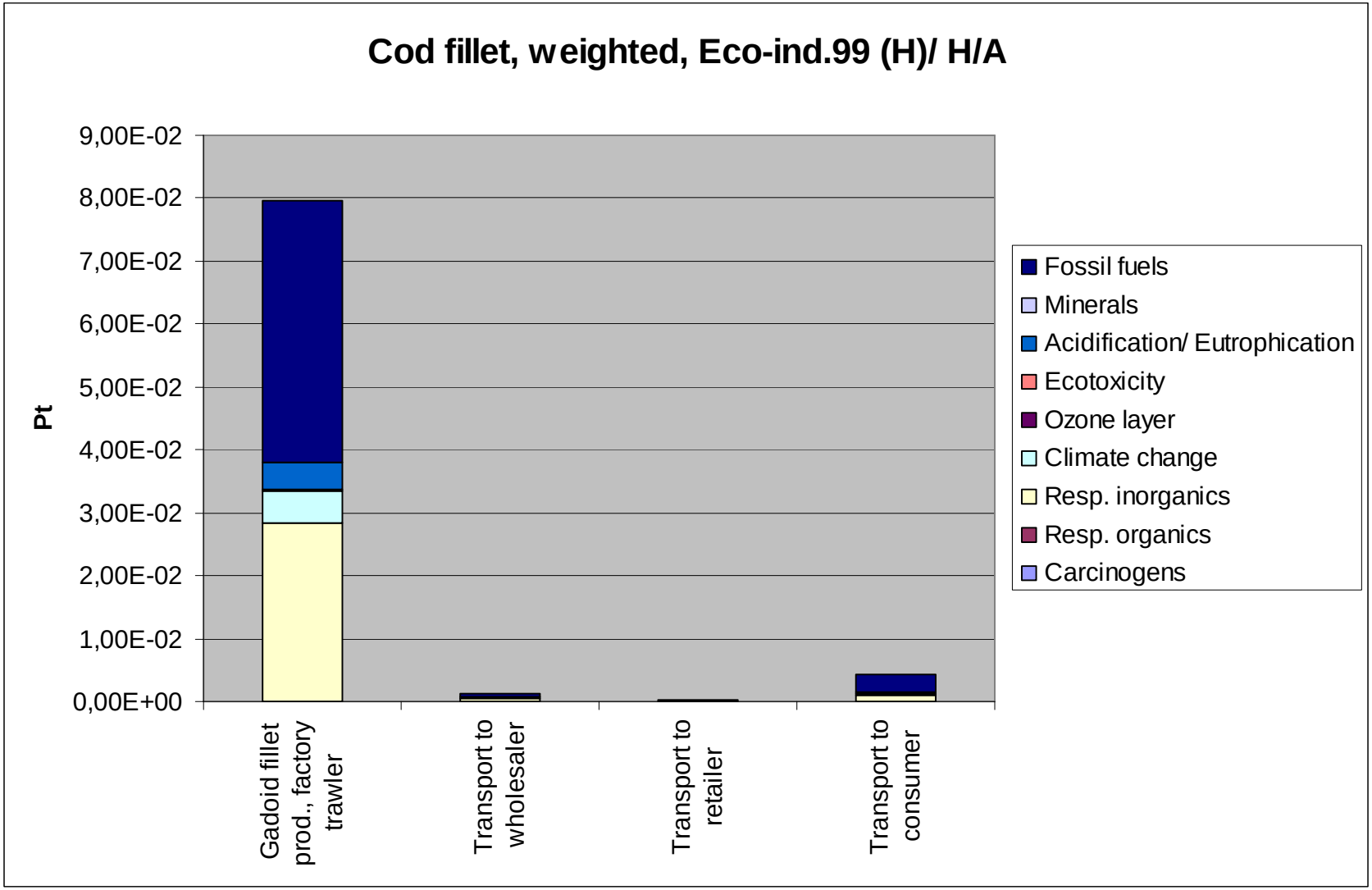
# Comparison of fuel use coefficient in various international fisheries
# Figures refers to round fish or crustaceans converted to [kg/kg]

| Fishery (home base or location) | Fuel use coef. [kg fuel/kg fish][a] | Source |
|---|---|---|
| Purse seining for capelin (Iceland) | 0.02 | Ágústsson et al.1978 |
| Purse seining for small pelagics (North Atlantic) | 0.04 | Tyedmers 2001 |
| Purse seining (Norway) | 0.09 | Schau et. al. 2008 |
| Trawling for small pelagics (North Atlantic) | 0.08 | Tyedmers 2001 |
| Trawling for groundfish (North Atlantic) | 0.44 | Tyedmers 2001 |
| Trawling for codfish (Denmark) | 0.40 | Thrane 2004 |
| Bottom trawling for flatfish (Denmark) | 0.84 | Thrane 2004 |
| Trawling for groundfish (Iceland) | 0.65 | Eyjólfsdóttir 2003 |
| Trawling for shrimp (North Atlantic) | 0.76 | Tyedmers 2001 |
| Trawling for Norway lobster (North Atlantic) | 0.85 | Tyedmers 2001 |
| Longlining for groundfish (North Atlantic) | 0.41 | Tyedmers 2001 |
| Longlining for groundfish (Norway) | 0.31 | Schau et. al. 2008 |
| Gillnetting for codfish (Denmark) | 0.21 | Trane 2004 |
| Gillnetting for groundfish (North Atlantic) | 0.53 | Tyedmers 2001 |
| Gillnetting for groundfish (Norway) | 0.19 | Schau et. al. 2008 |
| Trapping crabs (North Atlantic) | 0.28 | Tyedmers 2001 |
| Trapping (Mixed fish and crustaceans) (Norway) | 0.13 | Schau et. al. 2008 |

# A cradle to grave perspective is needed in order to compare the end product



# The production phase is often the hot spot




Source: Elingsen and Aanondsen, 2007

# CO2-emissions from production of 1kg salmon fillet based on various feed drying methods and transport distances

| Drying method fish feed | Food chain from raw material to final destination | | |
|---|---|---|---|
| | Slaughtery | Customer in South Norway | Customer in Paris |
| | $CO_2$-ekv./ kg product | $CO_2$-ekv./ kg product | $CO_2$-ekv./ kg product |
| Heavy oil | 2,4 | 2,7 | 3,0 |
| Natural gas | 2,2 | 2,6 | 2,9 |

Source: Olaussen et. al. 2008

# CO2 emissions for various food chains

| Product | CO2 ekv/kg | Comments | Source |
|---|---|---|---|
| Meat (pig) | 6,4 | Mainly methan (from rumination) and laughing gas (from feed production). CO2 from slaughtering, warehousing and transport. | Fremtiden i våre hender, 2008<br>LCA in Foods |
| Meat (cattle) | 15,8 | | |
| Chicken | 4,6 | | |
| Farmed trout | 4,1 | Troat flilet, Denmark, land based. Frosen from the slaughterhouse. | |
| | 4,5 | Troat flilet, Denmark, land based. Frozen in the store. | |
| Cod, wild caught | 2,8 | Fresh fillet in the store | |
| | 3,2 | Frozen  filet in the store | |
| Salmon | 4,2 | Fillet, Canada, sea based (adjusted based on figures for round fish) | Pelletier and Tyedmers, 2007 |
| Chicken | Ca 2,0 | Round weight, USA | Jones et. al. 2008 |
| Chicken | 4,6 | Round weight, England | Williams et. al. 2006 |
| Salmon | 3,0 | Sea farming Norway, transport to Paris included | Olaussen et. al. 2008 |

# Conclusions

- Passive gear in general more energy efficient than active gear as bottom trawling
- Pelagic trawling, purse seining and Danish seine are energy efficient
- Small vessels are energy efficient, but dangerous working places
- Premises differ between the fleet groups and care should be taken when comparisons are done
- Cheep energy do not motivate for energy efficiency
- Most of the fuel is spent during the fishing phase
- Further work in progress with respect to compare CO2 footprints from various food chains.
- Other impacts as bottom effects, ghost fishing etc. should be looked into