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Energy efficiency of fishing fleet: available data and methods

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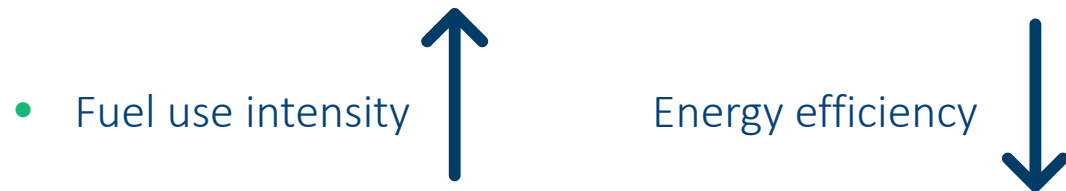
Technology for a better society



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Energy efficiency of fishing fleet

- Fuel use intensity: L fuel/kg catch



- Whole fleet vs. fleet segments
- For whole catch vs. catch specific (L fuel/kg total catch vs. L fuel/kg herring)



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Data available on fleet level

- Directorate of fisheries



- Statistics Norway



Statistisk sentralbyrå
Statistics Norway

- Garantikassen



GarantiKassen
FOR FISKERE

- NOx fund

NOx-fondet

- Automatic Identification system (AIS), for example through



IHS Markit® or



KYSTVERKET



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Directorate of fisheries



- A subset of Norwegian fishing fleet
- Annual profitability surveys
- A sample representing specific fishing vessels in each year (population hereafter)
- The population is not all Norwegian fishing vessels
- Population before 2009
 - Vessels longer than 8 meters
 - Vessels landing fish during at least 7 months a year
 - A certain minimum catch income
 - An owner who was not retired or disabled
- Population since 2009
 - No longer a limit on the vessel length and months of operation
 - The income threshold remains and depends on vessel size and fish price in the year of interest



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- Defined income thresholds for vessels above 15 meters:
 - In 2007: 869,200 NOK
 - In 2017: 2,572,000 NOK
- The length groups:
 - In 2007: below 10 m, 10–12.9 m, 13–14.9 m and above 15 m
 - In 2017: below 10 m, 10–10.9 m, 11–14.9 m and above 15 m
- Sampling:
 - Grouping vessels based on their operation and length.
 - Determining the number of samples from each group based on its income relative to the total income
 - Simple random sampling without replacement



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Year	Norwegian fishing vessels	Active vessels ^a	Population of profitability surveys	Sample size in profitability surveys	Respondents to profitability surveys (response rate)
2007	7,039	5,744	1,709	741	624 (84%)
2017	6,134	5,397	2,060	390	324 (83%)

^a Vessels registered with a catch income in the Norwegian Directorate of Fisheries' Register of Landings

Winther U., Jafarzadeh S., Hognes E. S., Ziegler F. (2020) Greenhouse gas emissions of Norwegian seafood products in 2017, FHF 901524



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- Fleet segment, fuel consumption, fuel type, catch and gears of individual vessels,...
- Fleet segment (2007–2017):
 - Coastal conventional vessels
 - Ocean-going conventional vessels
 - Coastal seiners
 - Purse seiners
 - Pelagic trawlers
 - Ocean-going crab vessels (2015–2017)
 - Coastal shrimp trawlers
 - Ocean-going shrimp trawlers (2007–2008, thereafter merged with cod trawlers)
 - Cod trawlers
- A vessel may use several fishing gears
 - The most important fishery specifies the segment in each year
 - A vessel may change fleet segment from one year to another

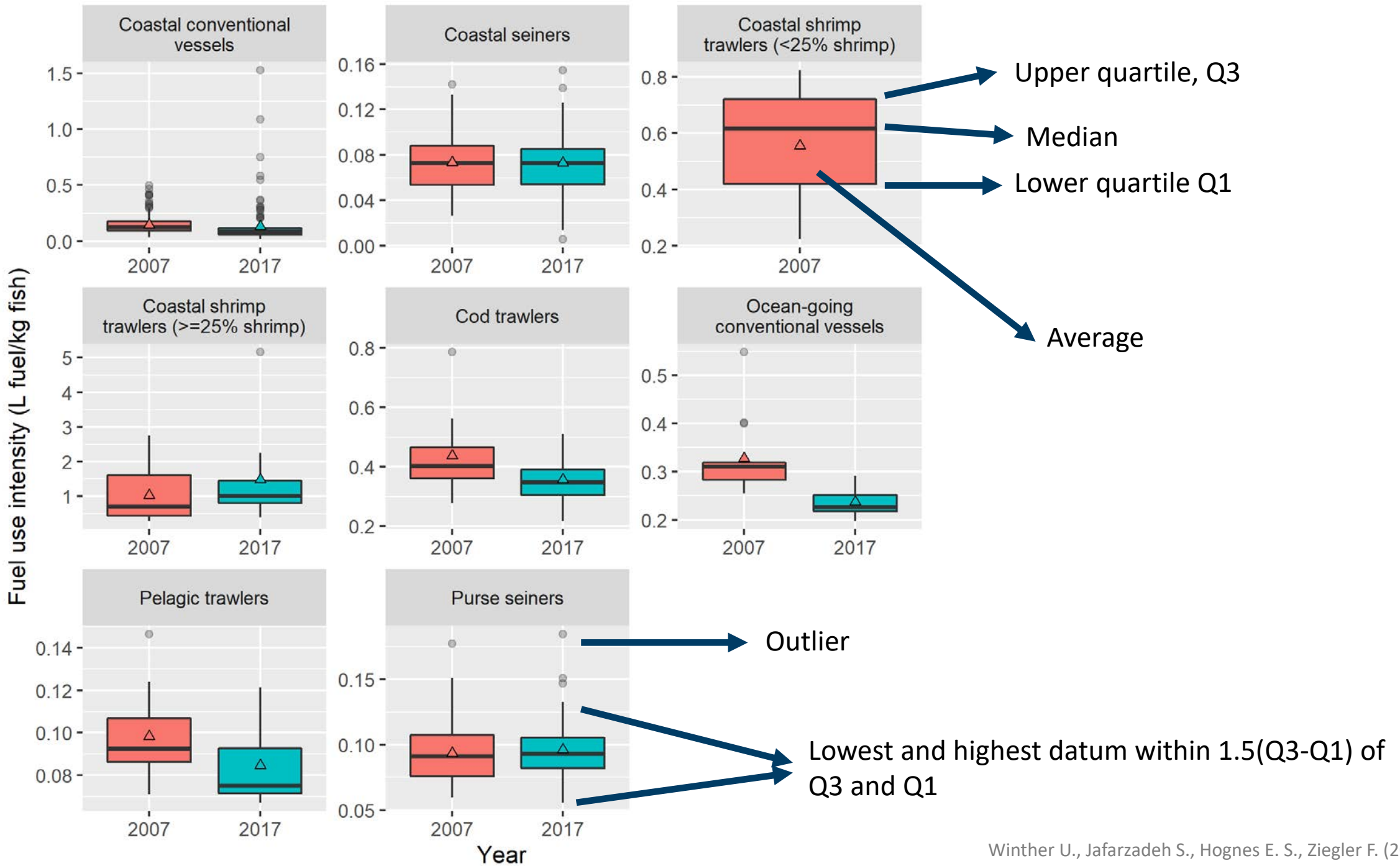


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- Type of fuel and where it is purchased (Norway vs. abroad)
- Fuel consumption is not divided between gears
- Catch is divided between gears



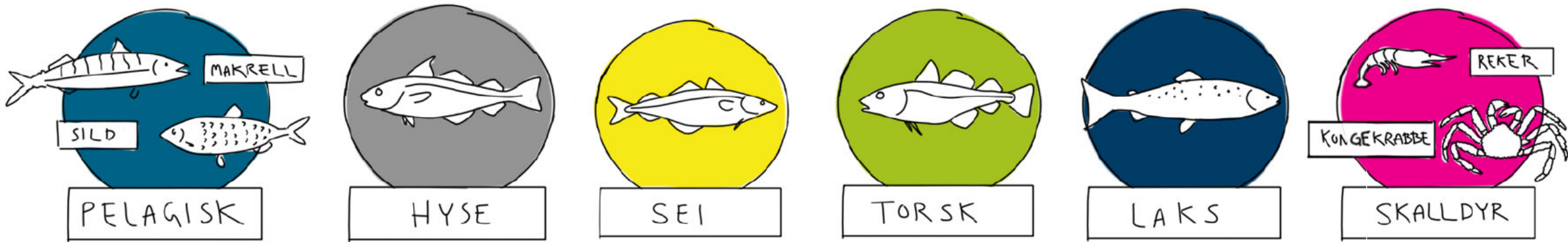


Table 3-4 Fuel use intensity (L fuel/kg liveweight catch) of various species based on median fuel use intensity of Norwegian fleet segments and survey population catch.

Year	Cod	Haddock	Saithe	Mackerel	Herring	Shrimp	King crab ^a
2007	0.244	0.288	0.278	0.096	0.093	0.696	-
2017	0.189	0.237	0.215	0.088	0.086	1.013	0.841

^a estimated through a fisher survey, not based on the profitability surveys like the other species



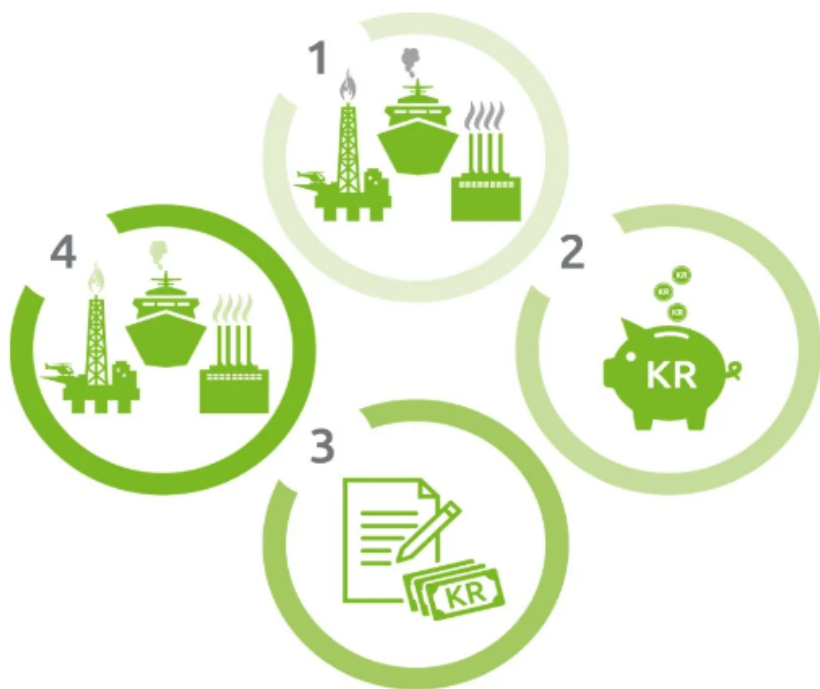
- Refunds marine oil tax for fisheries based on reported claims of fishermen
- Below 250 nautical miles of baseline
- Vessels who can document that they do not operate in this area, do not pay this tax while buying the fuel
- It does not cover fuel bought abroad
- It includes foreign vessels that have fueled in Norway to catch Norwegian species



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NOx-fondet

The NOx Agreement 2018-2025



The NOx Agreement 2018-2025 is an agreement between Norwegian authorities and industry to reduce NOx emissions in Norway

- 1** The NOx Fund is founded and owned by 15 business organizations to reduce NOx emissions in Norway
- 2** Enterprises pay a small fee to the NOx Fund instead of the high fiscal fee to the Government
- 3** Funds paid back to the industry. Affiliated companies can apply for NOx funding for NOx reduction measures
- 4** Investment in NOx-reducing measures and environmentally friendly technology reduces NOx emissions (and greenhouse gas emissions) in Norway

<https://www.noxfondet.no/en/articles/about-the-nox-fond/>



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NOx-fondet

- Covers vessels with total installed power over 750 kW
- Covers emissions in the Norwegian waters
- Vessels report NOx emissions based on fuel use
- Uncertainties
- NOx formation:
 - Thermal formation, as a result of the reaction between atmospheric nitrogen and oxygen at high temperatures
 - Fuel formation, as a result of the reaction between nitrogen in the fuel and oxygen
 - Prompt formation, as a result of complex reactions of hydrocarbons and atmospheric nitrogen

- The official greenhouse gas emission for fisheries sector, which is reported by the Norwegian Environment Agency to the UN.
- Statistics on sale of fuel in Norway
- Tax refund for mineral oil from the Norwegian Tax Administration
- GHGs included: CO₂, CH₄, N₂O, HFCs, PFK, SF₆
- End user is not always clear
- High uncertainty

Automatic Identification System



IMO:

- Vessels above 300 GT on international voyages
- Cargo ships of 500 GT and above not engaged in international voyages
- All passenger vessels regardless of size

AIS Norway was established in 2005

Approximately 50 base stations

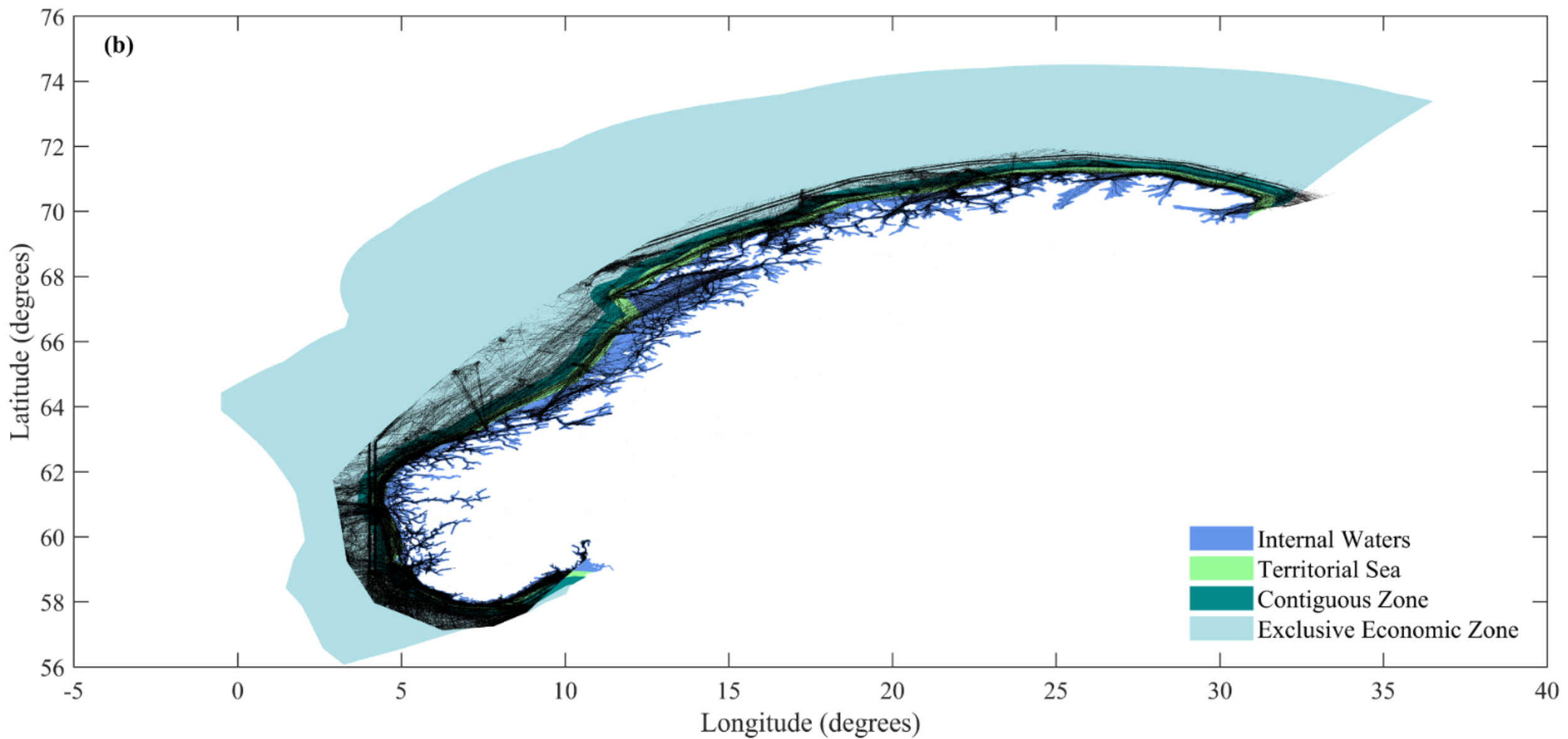
Satellites

Norwegian Regulations on the construction, equipment and operation of fishing vessels of 15 m in length and over:

- Vessels of 15 metres in overall length (LOA) and over calling at ports in Norway or any other EEA country shall be fitted with an Automatic Identification System (AIS).
- The system shall be maintained in operation at all times, except where international agreements, rules or standards provide for the protection of navigational information.

The Norwegian Directorate of Fisheries has, in some cases, also imposed a requirement for AIS on vessels fishing for special species.

<https://www.barentswatch.no/fiskinfo/settings>



Jafarzadeh S., Schjøllberg I. (2018), Operational profiles of ships in Norwegian waters: An activity-based approach to assess the benefits of hybrid and electric propulsion, Transportation Research Part D: Transport and Environment, Volume 65, Pages 500-523, ISSN 1361-9209, <https://doi.org/10.1016/j.trd.2018.09.021>.



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Automatic Identification System

- Bottom-up approach
- A vessel may go out of the range
- In our dataset:
 - Time gaps from one second to 54 h
 - 97-99% of monthly time gaps were below 10-13 min
- Estimating load factor based on ship design speed/ship speed at MCR and engine power
- For fishing vessels their power is not directly to their speed
- About 5000 fishing vessels do not have AIS (under 15 m)



KYSTVERKET



IHS Markit®

Utarbeidelse av kunnskapsgrunnlag for reduksjon av CO₂-utslipp fra fiskeflåten på kort (2030) og lang sikt (2050)

- New FHF project lead by SINTEF Ocean
- A WP lead by Sepideh Jafarzadeh
 - Establishing a method for using various sources
 - Suggestions on improvements for data collection for better estimation of CO₂ emissions
 - Including rest raw material



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