

An underwater photograph showing a dense kelp forest with many green and brown kelp leaves. Several small fish are visible swimming in the blue water above the kelp.

# Bioeconomic Modelling of Coastal Cod and Kelp Forest Interactions: Co-benefits of Habitat Services, Fisheries and Carbon Sinks

**Wenting Chen**  
[wch@niva.no](mailto:wch@niva.no)

**Norwegian Institute for Water Research**

Kofi Vondolia, Norwegian Institute for Water Research

Claire Armstrong, The Arctic University of Norway

EU MAIA Marine Accounting Workshop

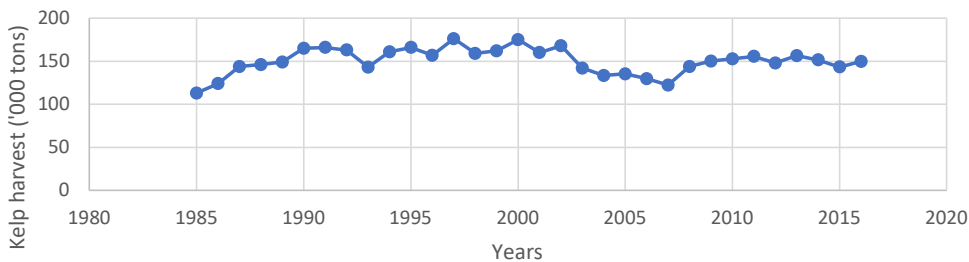
19 May 2021

# Current kelp harvest regime

- Industrialized since 1970s, including trawling
- The depth of harvesting: 5-15 meter
- Norwegian Agency of Fishery estimates about 0.3% of total *Laminaria hyperborea* biomass is harvested.
- Current harvesting region: Rogaland-Trøndelag
- Harvesting regulation divides each coastal harvesting area into 5 fields and only one field is open for harvesting each year.



Kelp harvests in Norway (in thousand tons)

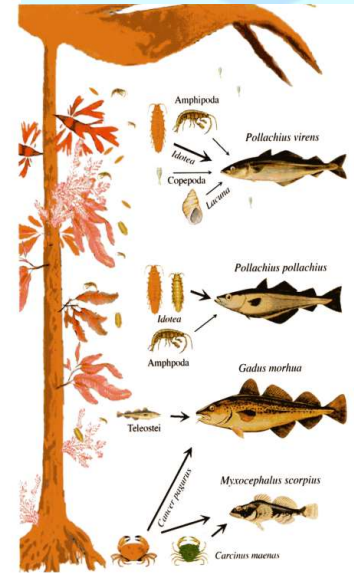




# Environmental impacts of kelp harvesting



Biomass recovers within 3-5 years, but flora and fauna take more time to recover (e.g. 6-7 years)



Hartvig Christie, NIVA

# How should kelp harvest change if fishery and carbon storage values are considered?

- Using a bioeconomic model with one social planner
- Maximizing: the profit from kelp harvesting + profit from the cod fishery + the values from stored blue carbon
- The kelp habitat effect goes through
  - 1) Increased intrinsic growth rate of coastal cod
  - 2) Improved carrying capacity of coastal cod

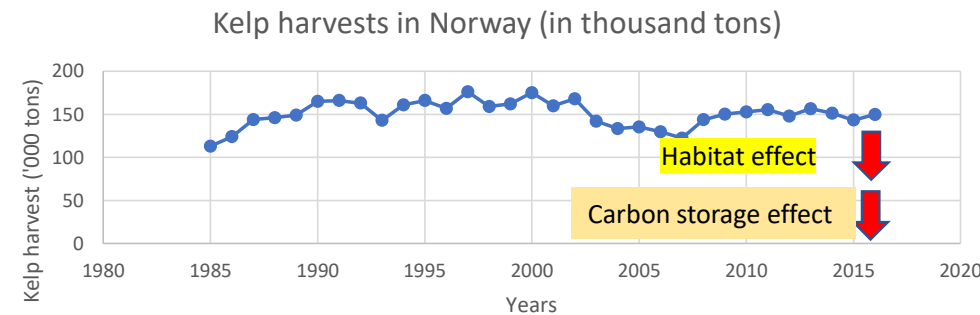
Environmental and Resource Economics (2020) 75:25–48  
<https://doi.org/10.1007/s10640-019-00387-y>



## Bioeconomic Modelling of Coastal Cod and Kelp Forest Interactions: Co-benefits of Habitat Services, Fisheries and Carbon Sinks

Godwin K. Vondolia<sup>1,2</sup> · Wenting Chen<sup>2</sup> · Claire W. Armstrong<sup>1</sup> · Magnus D. Norling<sup>2</sup>

Accepted: 19 November 2019 / Published online: 26 November 2019  
© Springer Nature B.V. 2019



## Next step

- Better linkage between kelp forest habitat to cod biomass
- Downscaling the harvesting and carbon values into smaller regions
- Take into consideration the different management regions of coastal cod (62N)
- Adaptive harvesting and multiple agents

# Conclusion

- Bioeconomic models and other models integrating ecosystem and ecosystem services/values are useful tools to show how the ecosystem service values /accounts can be included in private and public decision making.
- The modelling outcome also provides a knowledge base for what policy and economic incentive measures and instruments can be used to facilitate the take-up of ecosystem services and their values, and how to quantify the incentive measures.

THANK YOU!

Contact information:  
[wenting.chen@niva.no](mailto:wenting.chen@niva.no)