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Win-Win Seminar

May 7 2025, 12.30-15.30 CEST

Interreg
Baltic Sea Region

Co-funded by
the European Union

Supported by

SWEDISH MARITIME ADMINISTRATION

TRAFICOM
Finnish Transport and Communications Agency

Finnish Transport Infrastructure Agency

Online Seminar on the Co-existence of Offshore Wind Farms and Winter Navigation - Agenda

12:30	**Welcome**
12:45	Session 1: Ice structure • Aalto University: Windy Sea project – pylon effects on ice • Finnish Transport Infrastructure Agency: studies of ice structures within the WINMOS III-project
13:30	Session 2: Ship operations • Uppsala University: CO2-emission effects by changing routes • Finnish Geospatial Research Institute: Ice boat – ship optimization tool • Finnish Meteorological Institute: Wind trapped - Proof of Concept traffic analysis
14:30	Session 3: impact on assistance • Chalmers University of Technology & Uppsala University – Impact study • Finnish Transport and Communications Agency & Ramboll – offshore wind farms without ice – risk analysis in the Bothnian Sea • Swedish Maritime Administration & Research Institutes of Sweden – Offshore wind farms with ice – effects on shipping and icebreaking
15.15	Summary – which new research needs are identified
15:30	Closing

Session 1 - Ice structure

- Aalto University: Windy Sea project – pylon effects on ice
- Finnish Transport Infrastructure Agency: studies of ice structures within the WINMOS III-project
- Panel discussion open for questions and input
  - synergies
  - future needs
  - new ideas for projects and studies

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WindySea

Arttu Polojärvi, arttu.polojarvi@aalto.fi

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Aalto University

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NextGenerationEU

WindySea - The Challenge The Project Aimed to Solve

Framework for “Digital Twin of an Offshore Wind Farm” for a cold sea area; modelling engine for forecasting future marine environmental and ice conditions, with capability to describe interaction between ice and wind farms.

→ GOAL IN BRIEF WAS TO GENERATE TOOLS/APPROACHES TO STUDY SEA ICE PROBLEMS RELATED TO WIND FARMS ON THE SCALE OF A WIND FARM, YET WITH DETAIL NEEDED FOR STRUCTURAL DESIGN.

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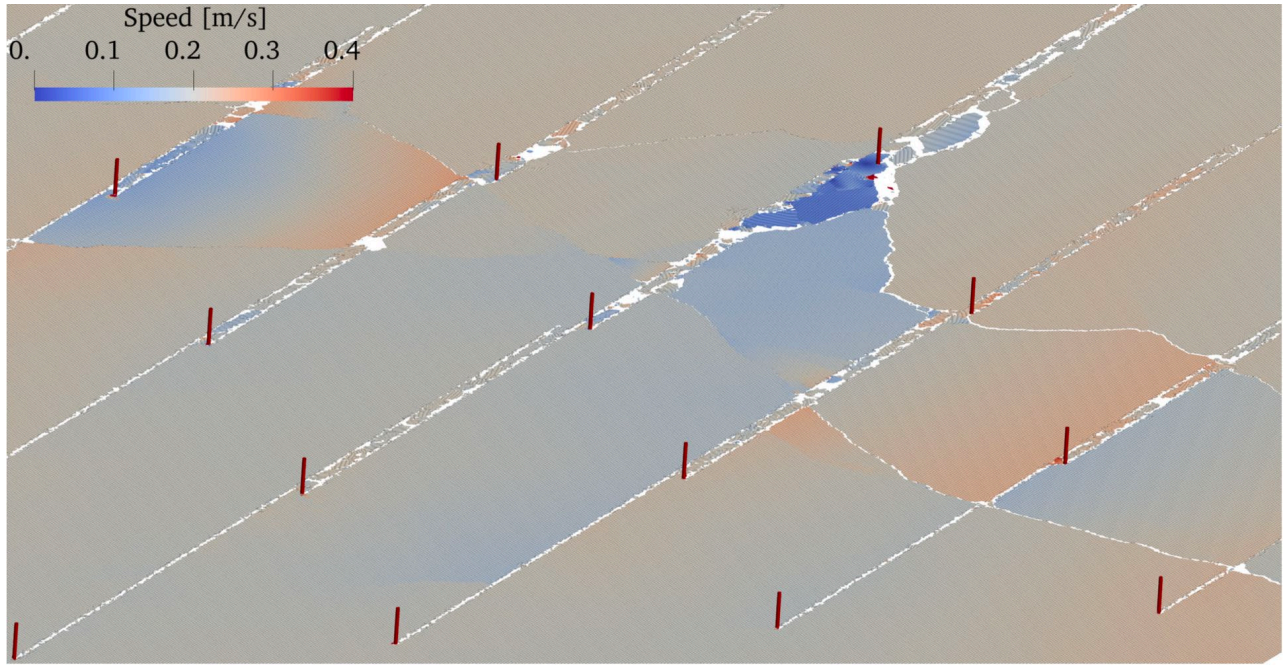
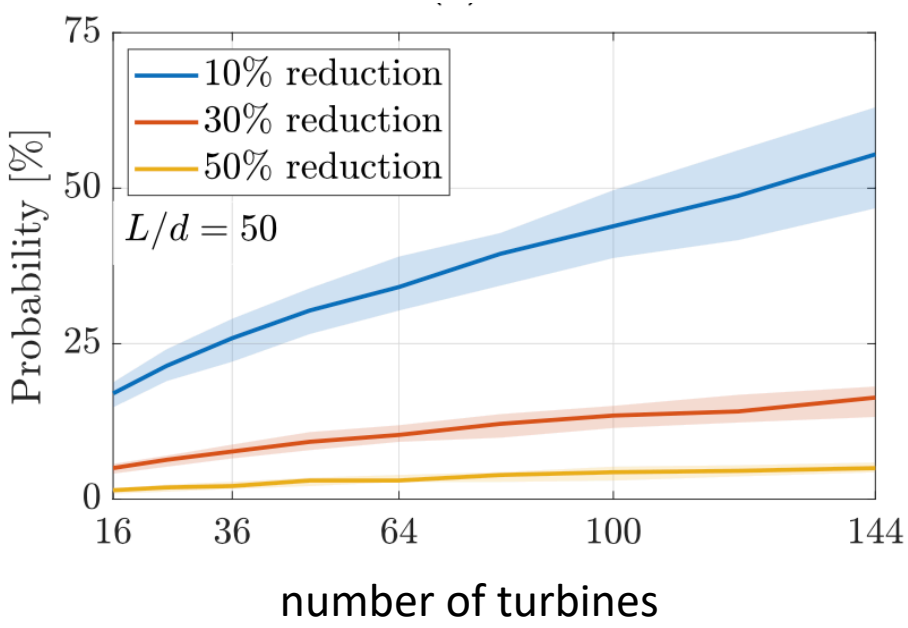
WindySea - Results





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WindySea - How to Implement Results

- We are now taking the results into action in ”sea ice dynamics report”-project through funding from WINMOS III together with Finnish Meteorological Institute and VTT.

- Implementation up to the level of regulations (?) requires a hybrid approach:
  - Model what you need with DEM and upscale the results to large scale ice dynamics model
  - We have tested the hybrid approach and it is a feasible way to do this.
  - Another way: Implementation of simplified ”rule-of-thumb” models.

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WindySea - Further Research Recommended

- More complicated ice loading scenarios:
  - Deformed ice, ice floe fields
  - More complicated forcing
  - When increased ice deformation?
- Further steps in continuum model implementations
  - General rules for increased deformation
  - Effects of several farms

→ Large-scale season-long simulations.

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Thank you!

Arttu Polojärvi
arttu.polojarvi@aalto.fi

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WINMOS III

Online Seminar on the Co-existence of Offshore Wind Farms and Winter Navigation

Effect of windfarms on sea-ice dynamics

Lauri Kuuliala,
lauri.kuuliala@vayla.fi

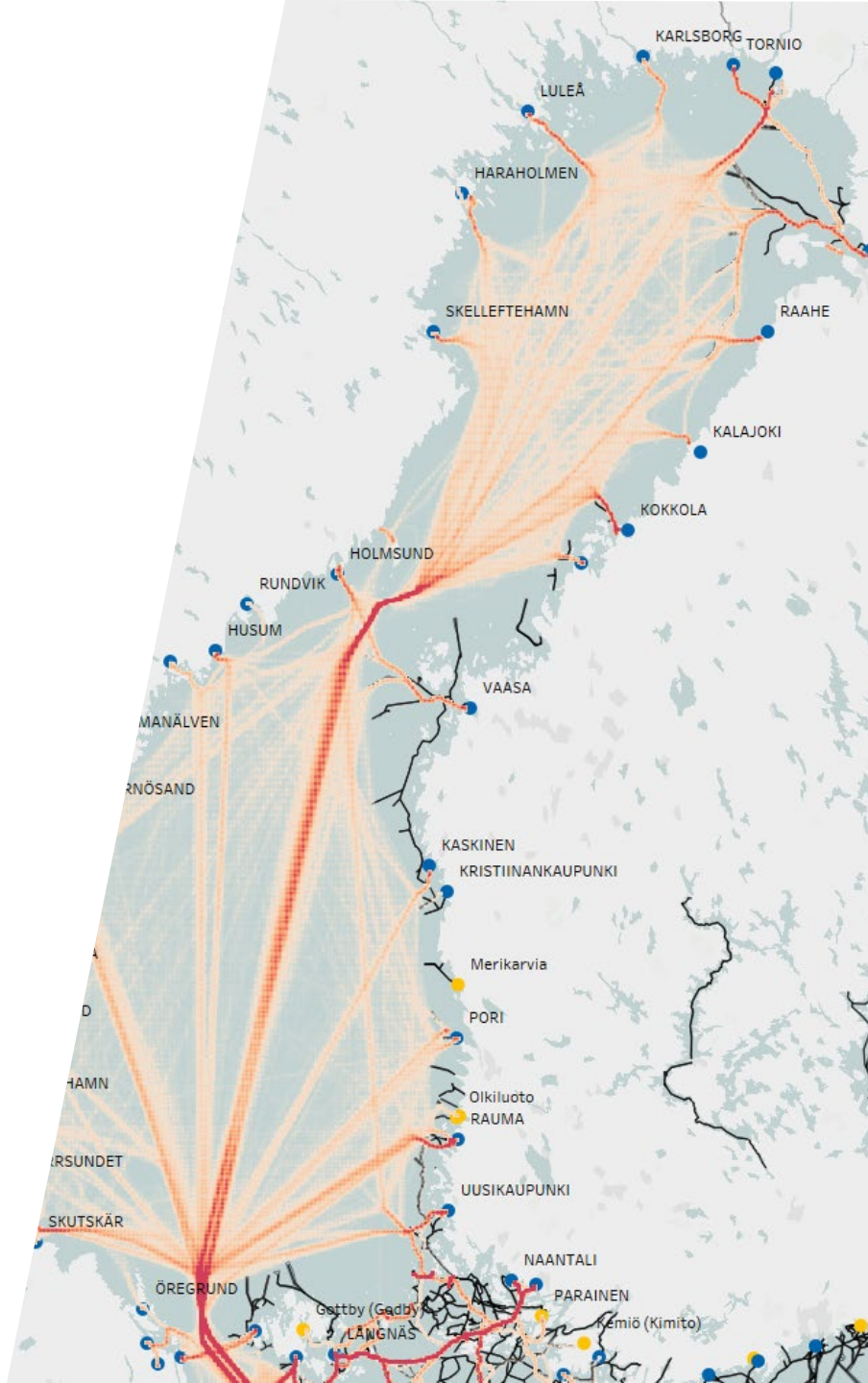
7.5.2025

Finnish Transport Infrastructure Agency

Co-funded by the European Union

WINMOS III

- The CEF-funded WINMOS III project has a work package dealing with future challenges to the winter navigation system
- One of the future challenges is maritime wind farm development in the Gulf of Bothnia and its effects on the sea-ice
- There are no windfarms in navigated ice-infested waters
- More information is needed on the effect of wind farms to ice dynamics



WINDRIFT

- A project by Aalto University, FMI and VTT as a part of WINMOS III
- Numerical modelling in two scales
  - Windfarm scale
  - Basin scale
- Crucially also coupling results between scales

- Aim is to gain a better understanding of how wind farms affect sea-ice dynamics -> effect of windfarms on winter navigation

Finnish Transport
Infrastructure Agency

Session 1 - Ice structure

- **Panel discussion open for questions and input**
  - **synergies**
  - **future needs**
  - **new ideas for projects and studies**

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Session 2 - Ship operations

- Uppsala University: CO2-emission effects by changing routes
- Finnish Geospatial Research Institute: Ice boat – ship optimization tool
- Finnish Meteorological Institute: Wind trapped - Proof of Concept traffic analysis
- Panel discussion open for questions and input
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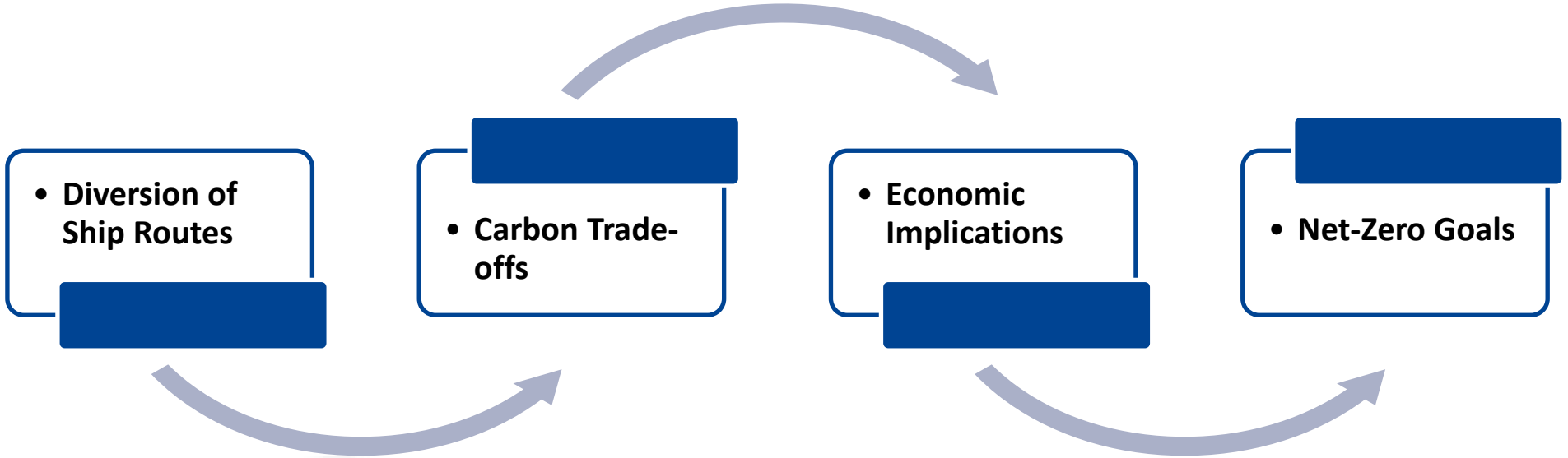
Assessing the Carbon Trade-off of Shipping Routes due to Offshore Wind Farm Development

Rohan Kumar & Anna Rutgersson,Uppsala University
rohan.kumar@geo.uu.se

TRAFIKVERKET

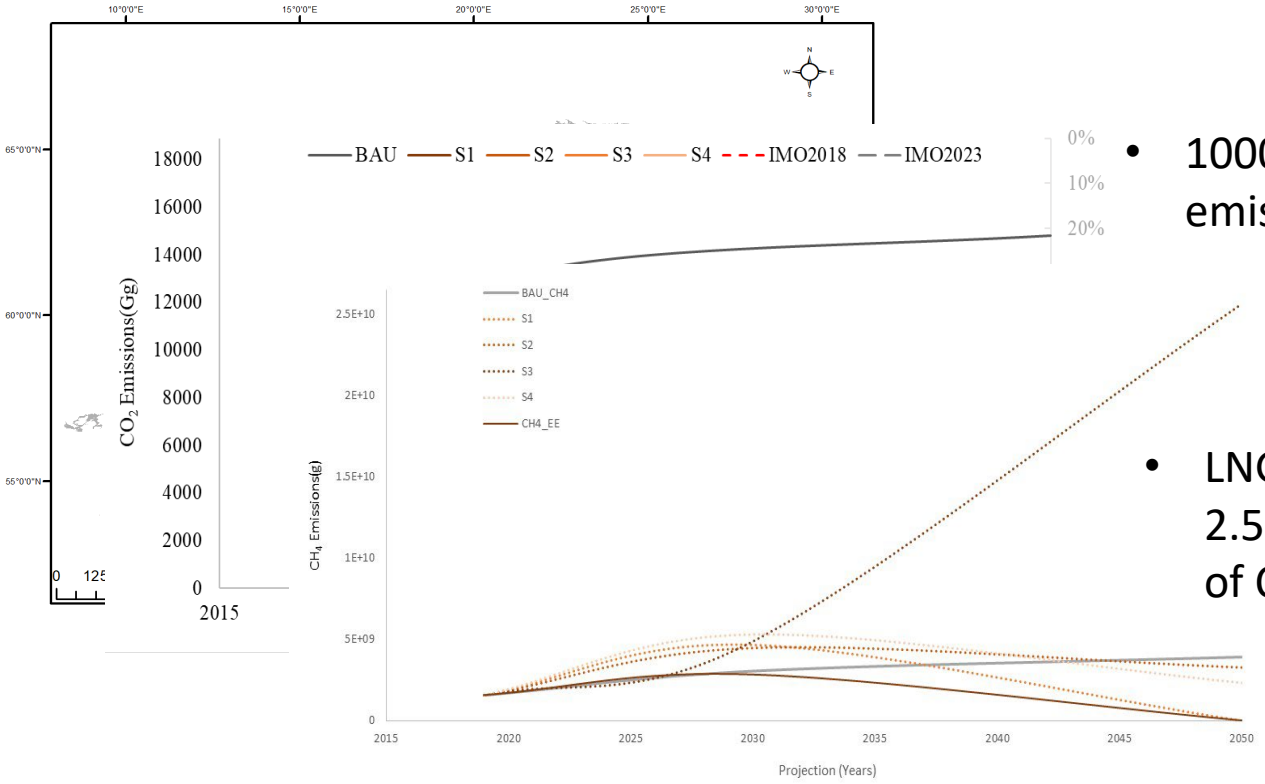
Assessing the Carbon Trade-off of Shipping Routes due to Offshore Wind Farm Development- The Project Aim

- Carbon trade-offs from shipping route changes due to offshore wind farm and their impact on the maritime industry's net-zero goals



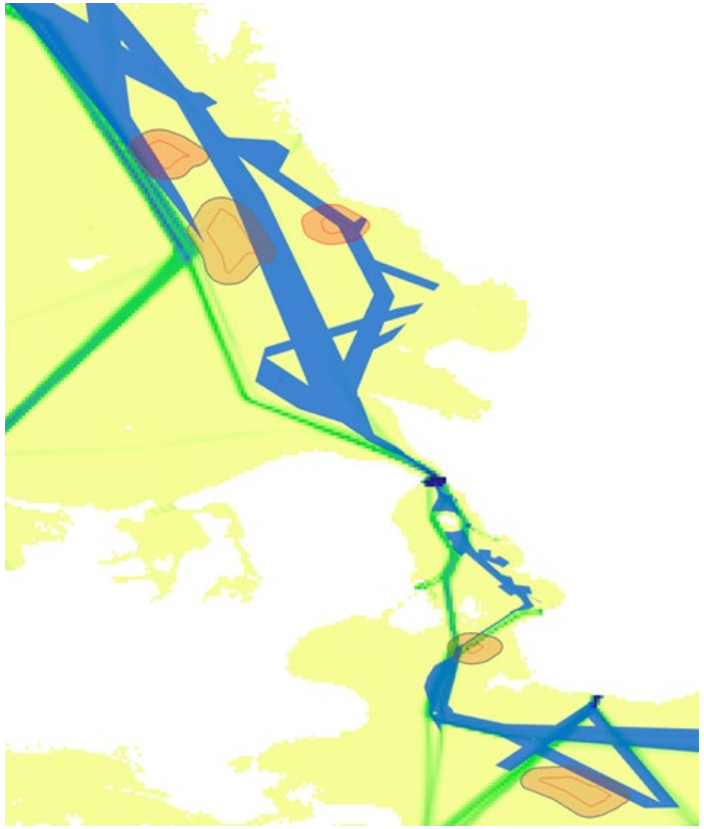
TRAFIKVERKET

Assessing the Carbon Trade-off of Shipping Routes due to Offshore Wind Farm Development - Results



- 10000(Gg) CO_2 emissions

- LNG-ships could add 2.5Gg of CH4 or 70Gg of CO_2 equivalent



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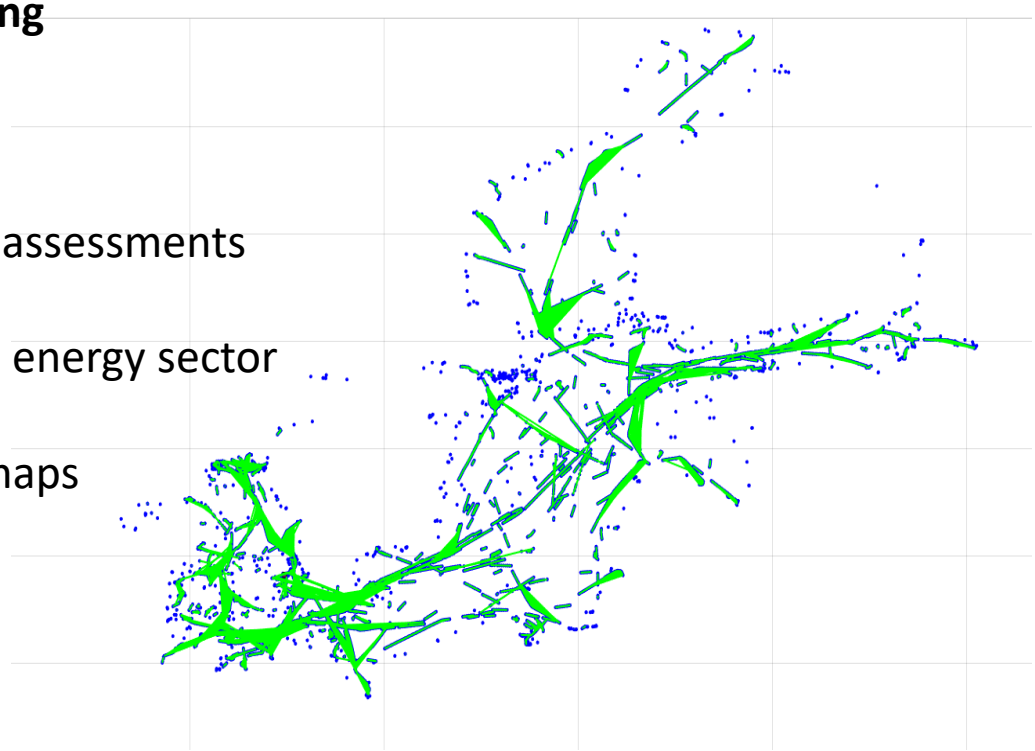
Assessing the Carbon Trade-off of Shipping Routes due to Offshore Wind Farm Development - How to Implement Results

- Integrate emission trade-offs into **maritime spatial planning**
- Develop **optimized** shipping route algorithms
- Inform regulatory **frameworks** and environmental impact assessments
- **Facilitate collaboration** between maritime and renewable energy sector
- Incorporate results into **climate policy** and net-zero roadmaps
- **Scenario analysis** and long-term planning
- Establish **decision-support system** for stakeholders



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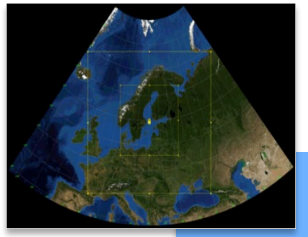
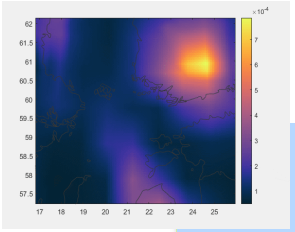
Assessing the Carbon Trade-off of Shipping Routes due to Offshore Wind Farm Development - Further Research Recommended



Inventory

- Estimation of gridded CO_2 emissions for different fuel types
- Assessing the possible CO_2 due to route deviation



Atmospheric Modelling

- Impact of CO_2 emissions
- Alternate fuels for long run and possible combination of HFOs and Alternate Fuels (Transition)

Scenarios

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Collaboration with:

Mistra C2B2
Co-Creating
Better Blue

ShipTRASE

SAAC
SWEDISH WIND CENTRE
Research centre within wind power

Thank you!

Rohan Kumar and Anna Rutgersson, Uppsala University
rohan.kumar@geo.uu.se

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16th Baška GNSS Conference: PNT Technologies, Techniques and Applications
and
The 3rd Workshop on Smart, Blue and Green Maritime Technologies

Towards autonomous maritime situational awareness in sea ice conditions – study on an ice breaker in the Finnish Bothnian Bay

Martta-Kaisa Olkkonen, Toni Hammarberg, Mika Saajasto, Ajinkya Gorad*, Saiful Islam, Sanna Kaasalainen
Finnish Geospatial Research Institute, Espoo, Finland
*Aalto University, Espoo, Finland

NLS FINNISH GEOSPATIAL RESEARCH INSTITUTE FGI

Aalto University

14 - 18 May 2023, Baška, Croatia

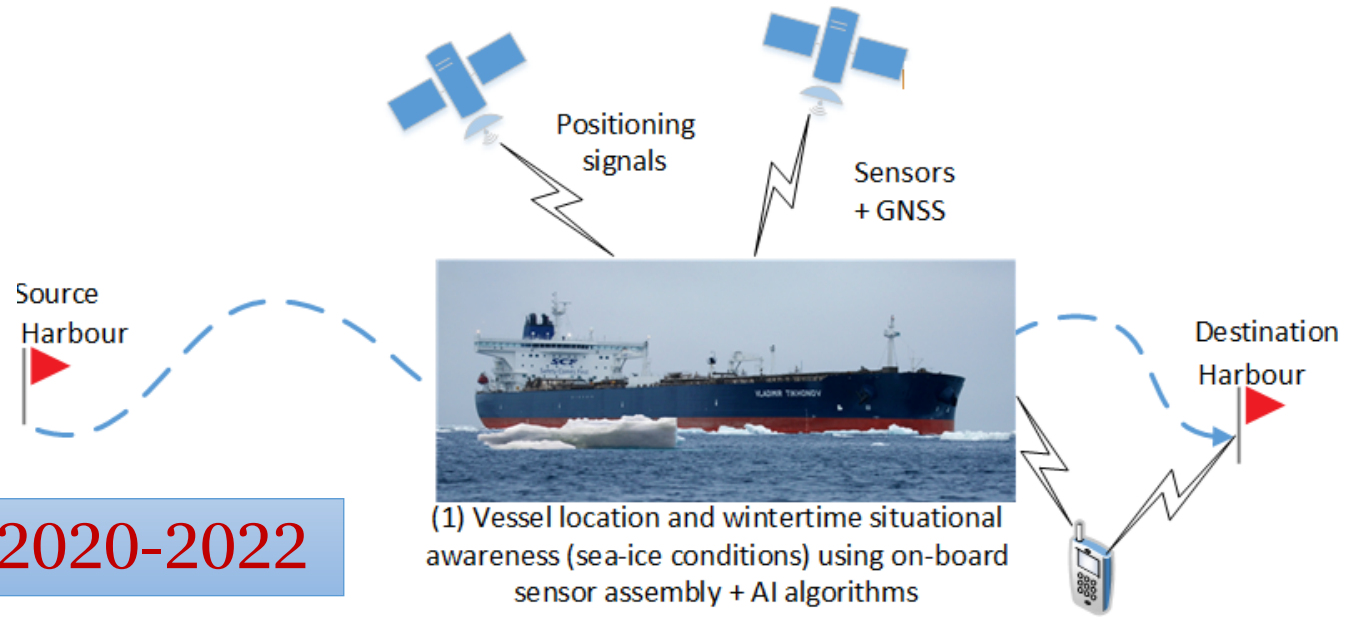
GNSS

1. Maritime situational awareness in winter?

- Very few studies in wintertime
- IMO gives one horizontal alert limit (HAL)
- Even today the most reliable way to classify ice types is by human lookouts while passing through leads

IMO Resolution A.915(22)

Voyage phase	Accuracy (interpreted as R95) [m]	HAL [m]
Ocean and Coastal waters	10	25
Port approaches, inland and restricted waters	10	25
Port	1	2.5



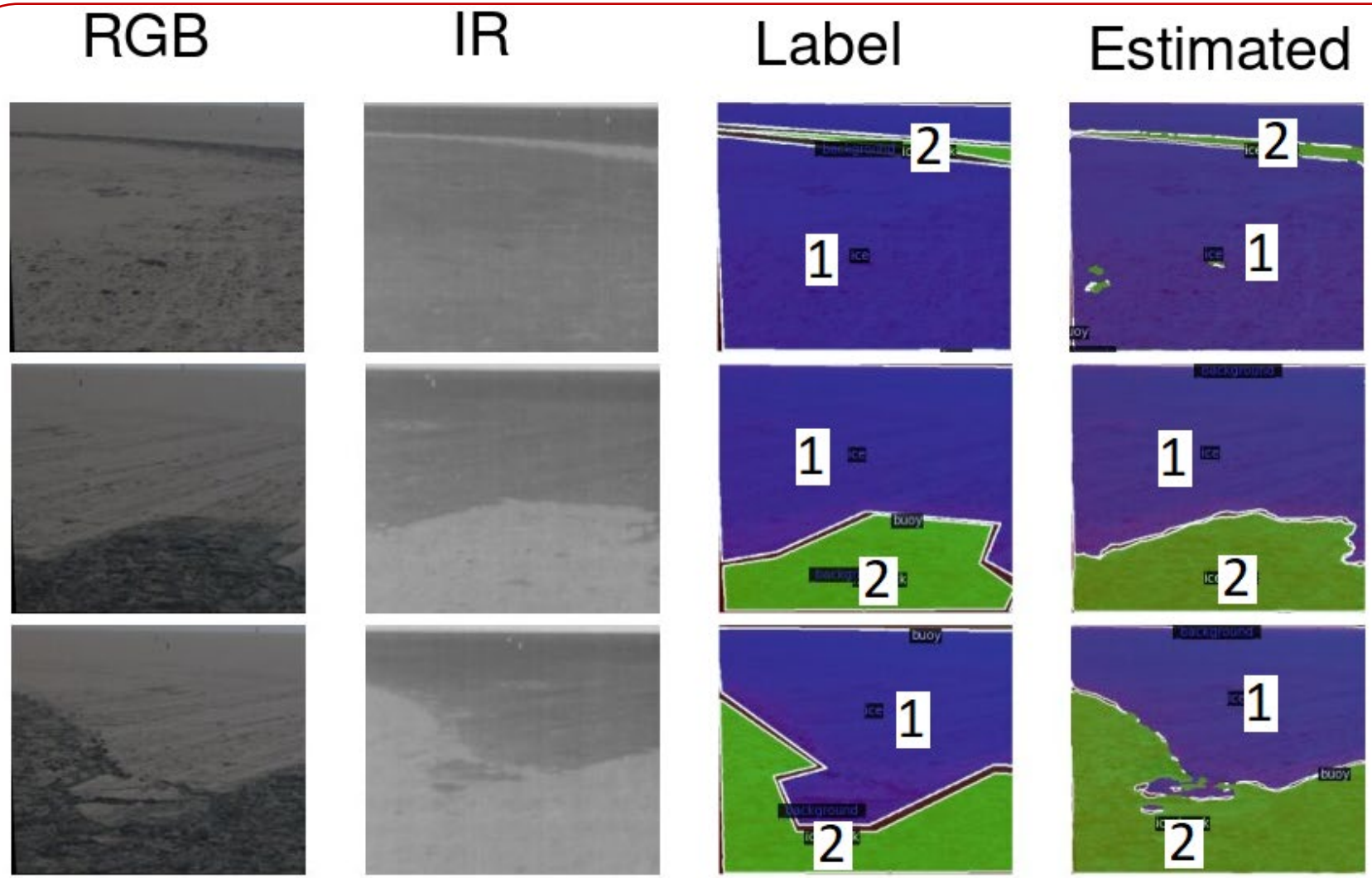
(1) Vessel location and wintertime situational awareness (sea-ice conditions) using on-board sensor assembly + AI algorithms

(2) Impact analysis of Interference to satellite navigation signals at harbor or along route

ENHANCE project 2020-2022

➢ Purpose was to bridge these gaps in ENHANCE towards increased situational awareness and autonomy

2. AI image processing – result



- Semantic segmentation for sea-ice classification (LABEL)

1 ice

2 ice track

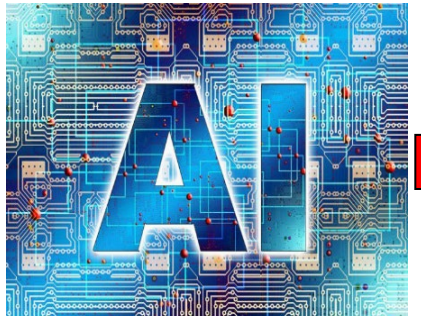
- Image classification by using deep learning methods (ESTIMATED)
  - Deep convolutional neural networks

3. Technology strategy – how to implement

- Applying AI to ice detection has drawn less attention than ship detection
- However, many possible applications
- Challenges of situational awareness in icy waters:

Daylight is short; rain, which makes the ice very translucent; snowfall and fog

➢ IR, RGB, GNSS positioning



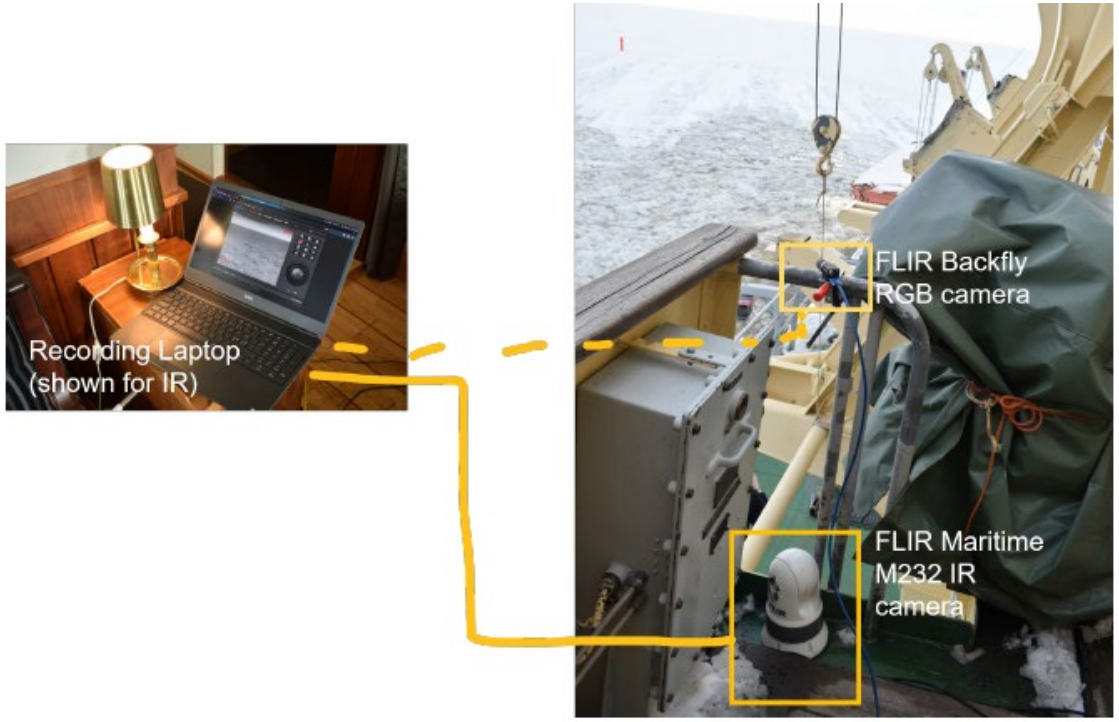
AUTONOMOUS SITUATIONAL AWARENESS IN SEA-ICE CONDITIONS

- Thin ice
- Fast ice
- Consolidated ice
- Ice floe
- Brash ice etc…

AI: Collection of labelled training data?

4. Overall project outcome and discussion

1. Maritime situational awareness is strengthened by using sensors + AI
2. Achieved information can be fed:
   - to situational awareness systems ashore (for remotely controlling the vessel)
   - weather observation platforms (to improve ice forecasting and ice chart creation)
3. project was performed in the public domain, results available
4. helps to optimize routes of vessels
   - ➢ stepping stone towards fully autonomous shipping



- 60 GB of data was collected, only a fraction was annotated
- Most time-consuming part!

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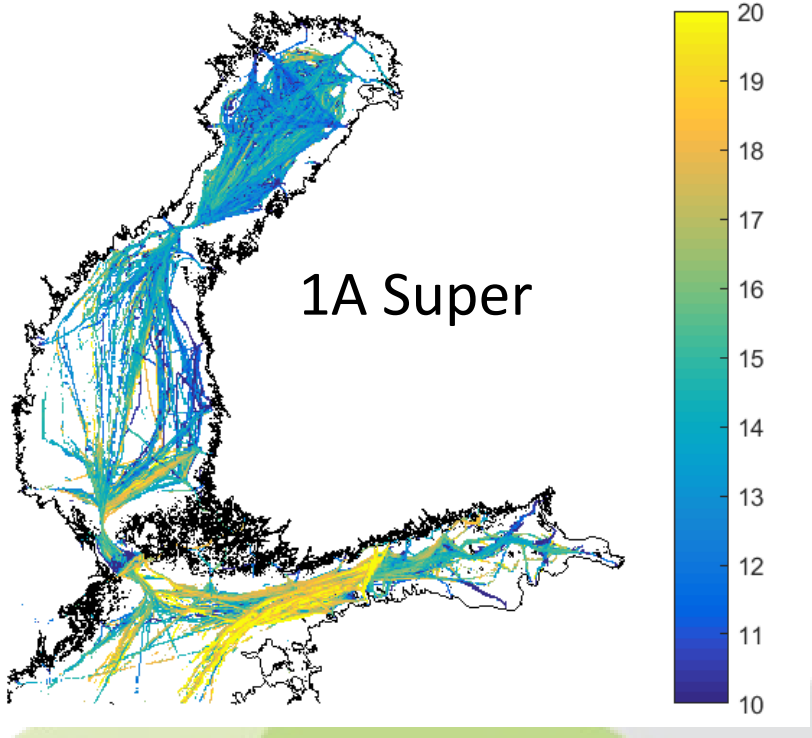
Wind-Trapped

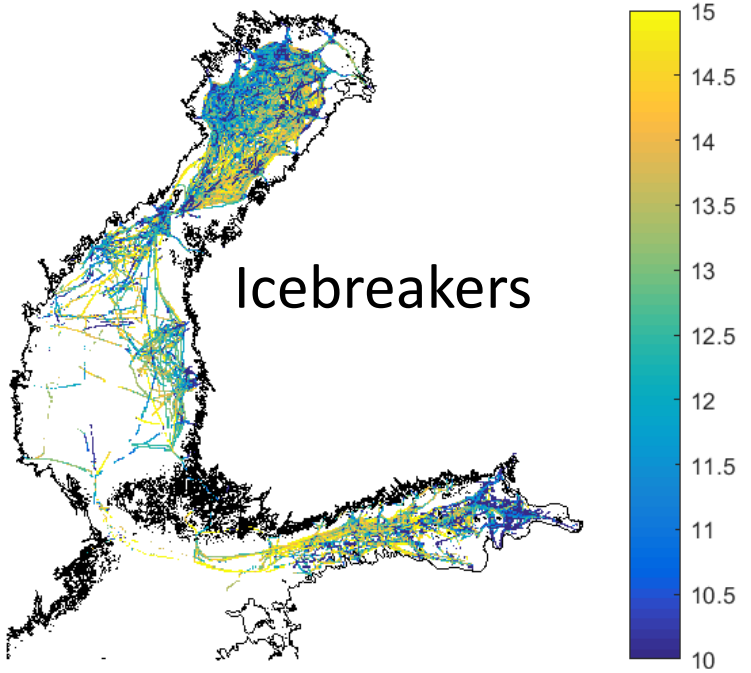
- Mikko Lensu, Henri Vuollekoski, Marko Mäkynen, Jari Haapala
- henri.vuollekoski@fmi.fi
- Finnish Meteorological Institute

- Funding: Winter Navigation Research Board

Wind-Trapped - The Challenge The Project Aims/Aimed to Solve

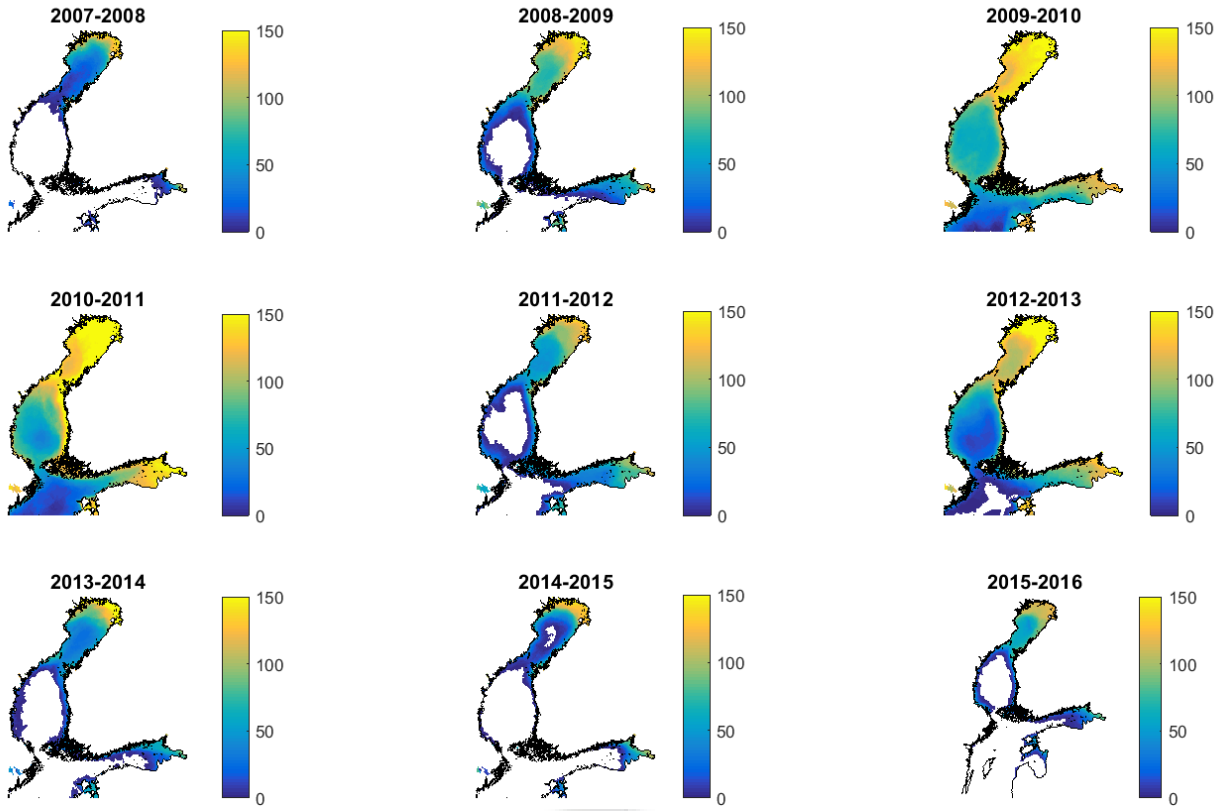
- A large number of off-shore wind farms planned in Bay of Bothnia
- OWFs limit marine traffic in their vicinity
- During ice-winters, marine traffic has less options to navigate





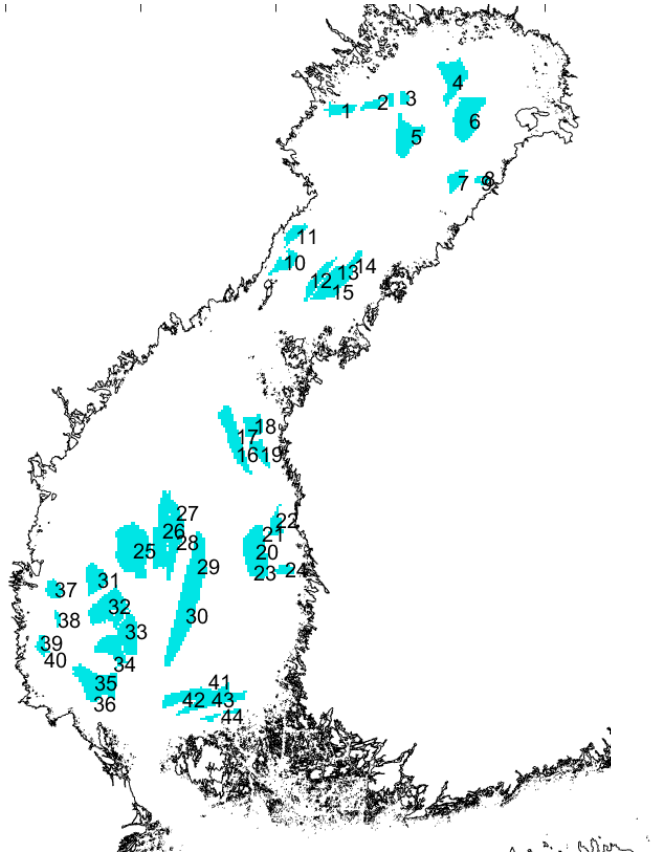
Average independent ice steaming speed [kn] during 2007-2016

Wind-Trapped - How to Implement Results

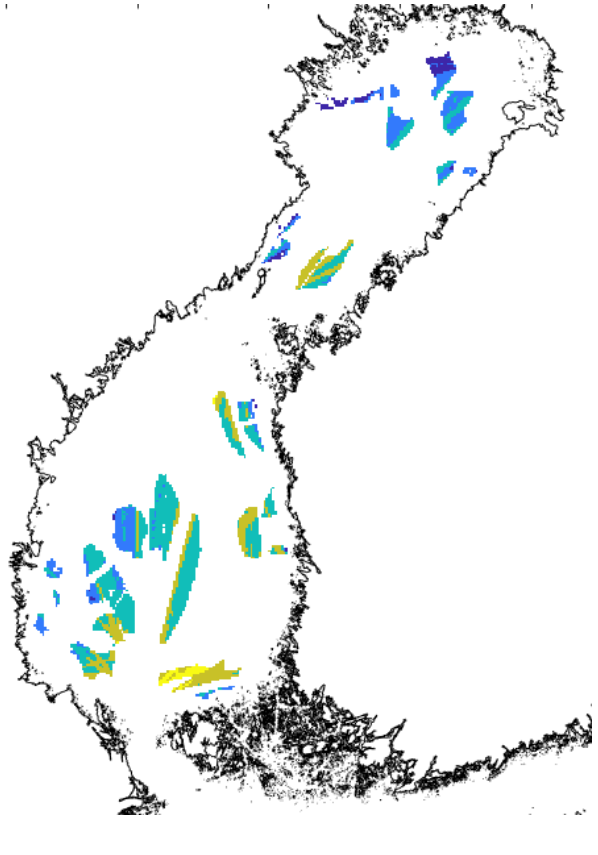


(Number of ice days)

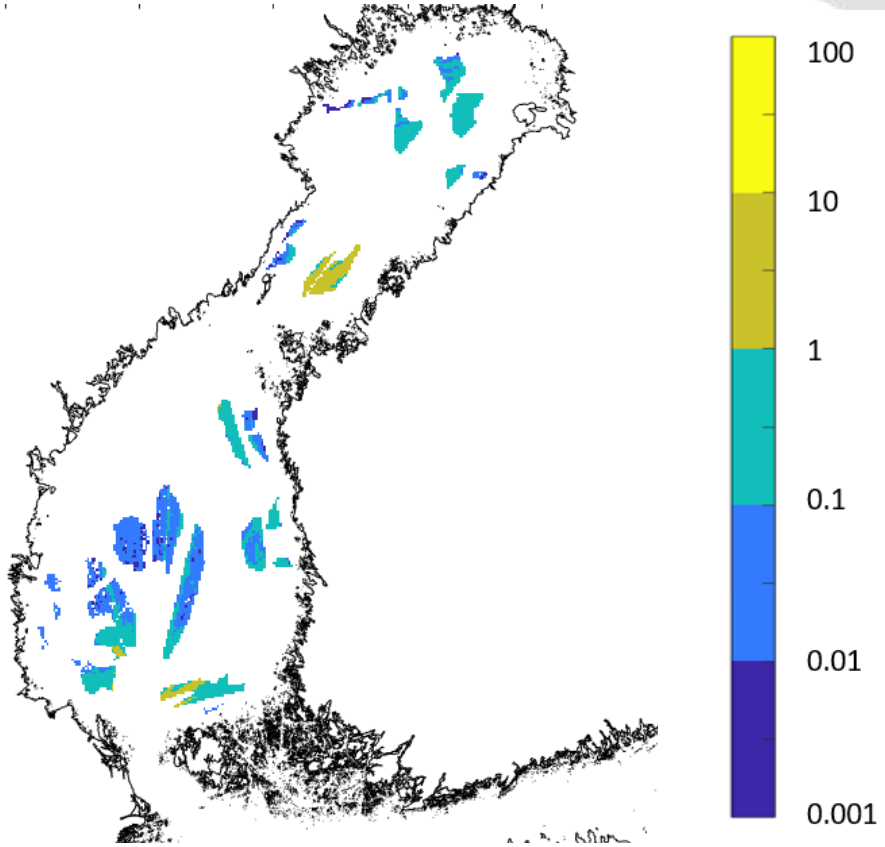
- Automatic Identification System required on ~all vessels >= 300 GT; sends vessel id, location, speed, course over ground etc.
- Database combines AIS-retrieved data with ice conditions data (thickness, concentration, ridging, drift) for 9 ice seasons 2007-2016
- 6 billion AIS messages, 2.5 billion for ice navigation season
- Severe ice winters 2009-2010 and 2010-2011
- Traffic around and within planned OWFs can be analysed



Offshore wind farms planned to Northern Baltic

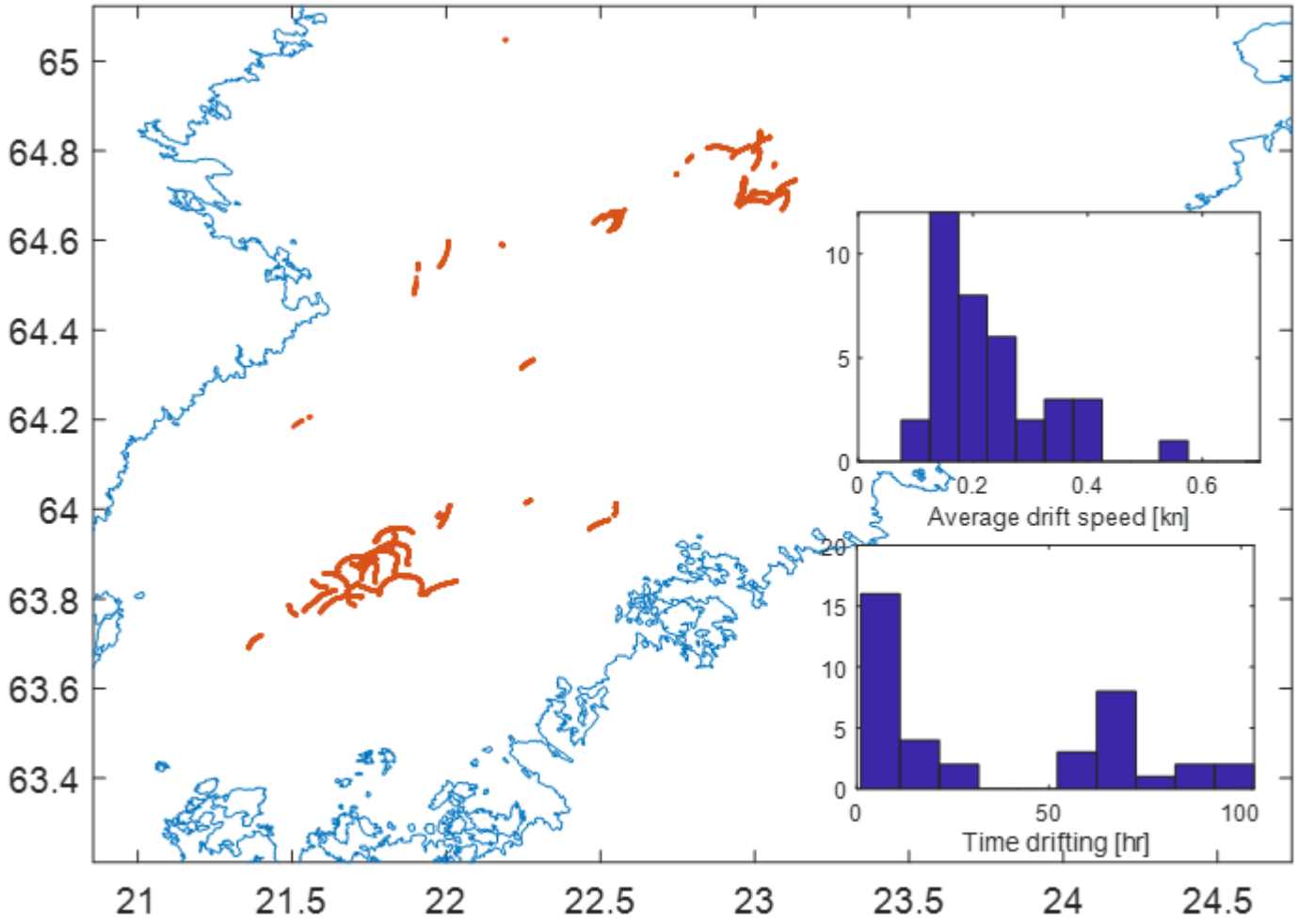


Traffic densities within the farms, open water



Traffic densities within the farms, icegoing

Wind-Trapped - Some Results



38 ships beset in drifting compressive ice in the Bay of Bothnia 1-5 March 2011, waiting for assistance

100 hr drift with 0.5 kn speed → 50 NM distance to OWF a conservative safety margin

During the same period, about 20 ships were beset in the Sea of Bothnia and drifting NE with speeds up to 0.9 kn

Wind-Trapped - The Really Dangerous Beef

Wind-Trapped - Further Research Recommended

- In particular, we need to understand how OWFs affect ice conditions (and vice versa)
- New project about to start, focusing on modelling the effect
- New project about to start, aiming to facilitate sea ice forecasting in the Baltic Sea with AI methods

Thank you!

Henri Vuollekoski henri.vuollekoski@fmi.fi

Session 2 - Ship operations

- **Panel discussion open for questions and input**
  - **synergies**
  - **future needs**
  - **new ideas for projects and studies**

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Session 3 - Impact on assistance

- Chalmers University of Technology & Uppsala University – Impact study
- Finnish Transport and Communications Agency & Ramboll – offshore wind farms without ice – risk analysis in the Bothnian Sea
- Swedish Maritime Administration & Research Institutes of Sweden – Offshore wind farms with ice – effects on shipping and icebreaking
- Panel discussion open for questions and input
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Potential Impacts of Wind Farms on Shipping in the Bay of Bothnia

Joint Presentation: Chalmers University of Technology & Uppsala University

Vasiola Zhaka & Xiao Lang

vasiola.zhaka@angstrom.uu.se
xiao.lang@chalmers.se

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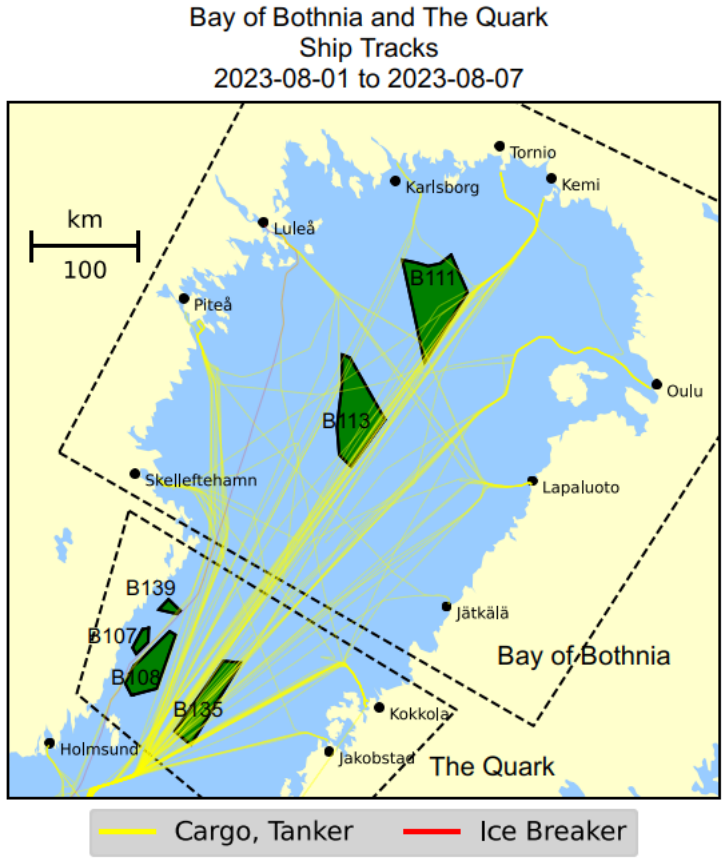
Potential Impacts of Wind Farms on Shipping in the Bay of Bothnia - The Challenge The Project Aims/Aimed to Solve

- Assess **where and how planned offshore wind farms may interfere with winter shipping routes in the Bay of Bothnia**, by analysing historical AIS data and ice maps.
- Review existing research and **conduct interviews with shipmasters** to explore the navigational impacts of wind farm and sea ice interactions.
- **Present a statistical analysis of AIS data** spanning several years to capture ice drift, thickness, concentration, and hardness. Conduct forecast modelling using metocean and ice data.
- **Initiate a dialogue with Finnish maritime authorities** to seek solutions if the planned areas of wind farms interfere with today's routes of Swedish-Finnish icebreaking strategy/tactics.

Potential Impacts of Wind Farms on Shipping in the Bay of Bothnia - Results

- A methodology was developed to assess the **impact of offshore wind farms on shipping routes**
  - ❖ *Impact was analysed by **overlaying ship AIS data with planned OWF areas***
  - ❖ *Integrated ice data (thickness, concentration, and drift) to **identify seasonal patterns***
  - ❖ *Calculated the proportion of ships intersecting OWF zones to **quantify disruption***
  - ❖ *Generated **comparative statistics** across different years and wind farm sites.*
- Identified the need for further analysis of **re-routing and fuel consumption** impacts.



Key findings:

- B111 showed a 60% intersection rate during the first week of April
- B113 had a 45.6% intersection rate in the first week of May

Ceder, V., Helgesson, N., Thomas, B. P., & Ringsberg, J. W. (2024). The impact of wind farms on winter navigation. Chalmers University of Technology, Department of Mechanics and Maritime Sciences, Division of Marine Technology. [The impact of wind farms on winter navigation]

Potential Impacts of Wind Farms on Shipping in the Bay of Bothnia - How to Implement Results

- Apply the developed methodology as a planning tool
  - ❖ *Use intersection rates to screen OWF sites during the **permitting process or marine spatial planning***
  - ❖ *Identify **high-conflict areas** to reduce interference with critical **winter navigation***
- Conduct route-based simulations:
  - ❖ *Quantify potential **re-routing requirements, increased fuel consumption, and GHG emissions***
- Coordinate cross-border strategies
  - ❖ ***Engage with Finnish authorities** to align icebreaker operations with OWF spatial planning*

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Potential Impacts of Wind Farms on Shipping in the Bay of Bothnia - Further Research Recommended

- Quantify OWF impacts on **ice formation** and **shipping** across varying winter severities
- Improve model reliability by incorporating **extended AIS and ice datasets**
- Simulate **cost**, **emissions**, and **fuel consumption** under multiple re-routing scenarios
- Assess navigational risks in **shallow**, **ice-affected areas** near or within OWF zones using combined ice and bathymetric data

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Thank you!

Vasiola Zhaka
vasiola.zhaka@angstrom.uu.se

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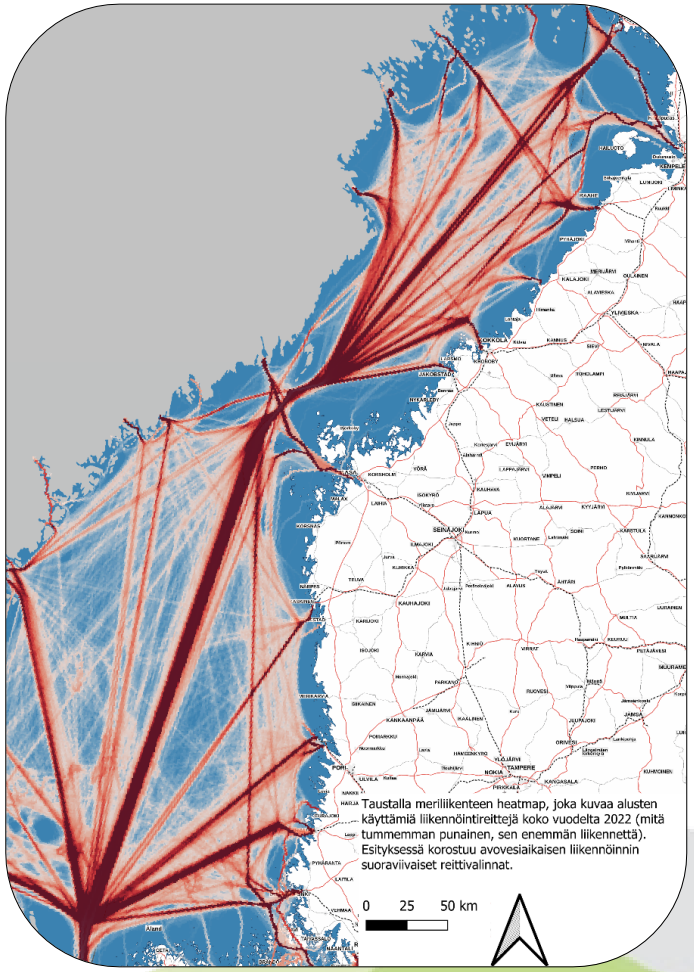
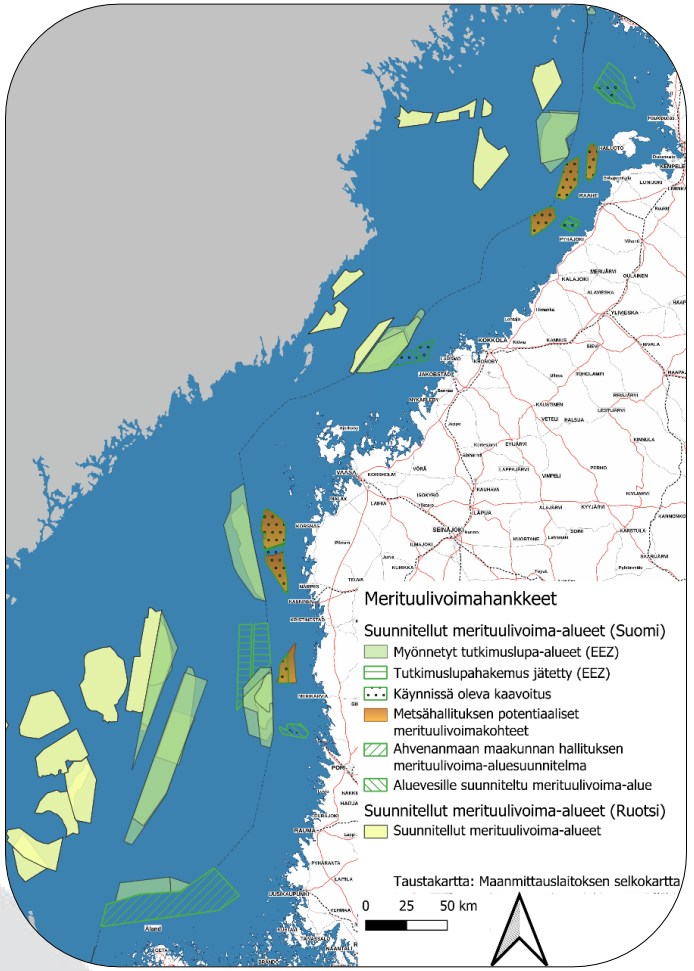
Study on maritime traffic and offshore wind farms

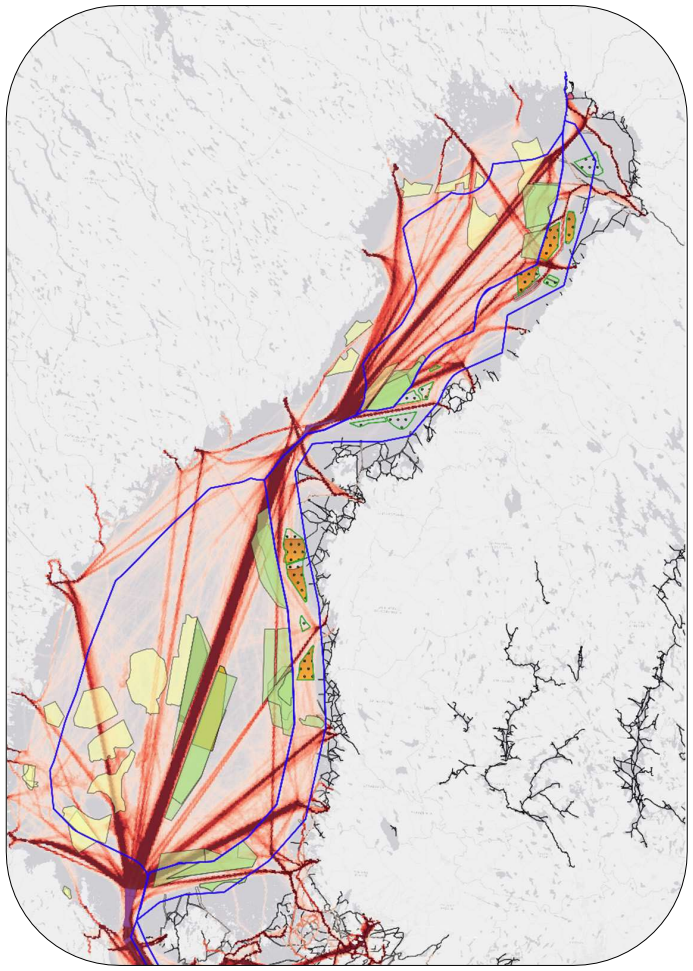
Valtteri Laine
Chief Advisor, Finnish Transport and Communication Agency
valtteri.laine@traficom.fi

Study on maritime traffic and offshore wind farms

How can a compromise be reached for the use of sea areas?



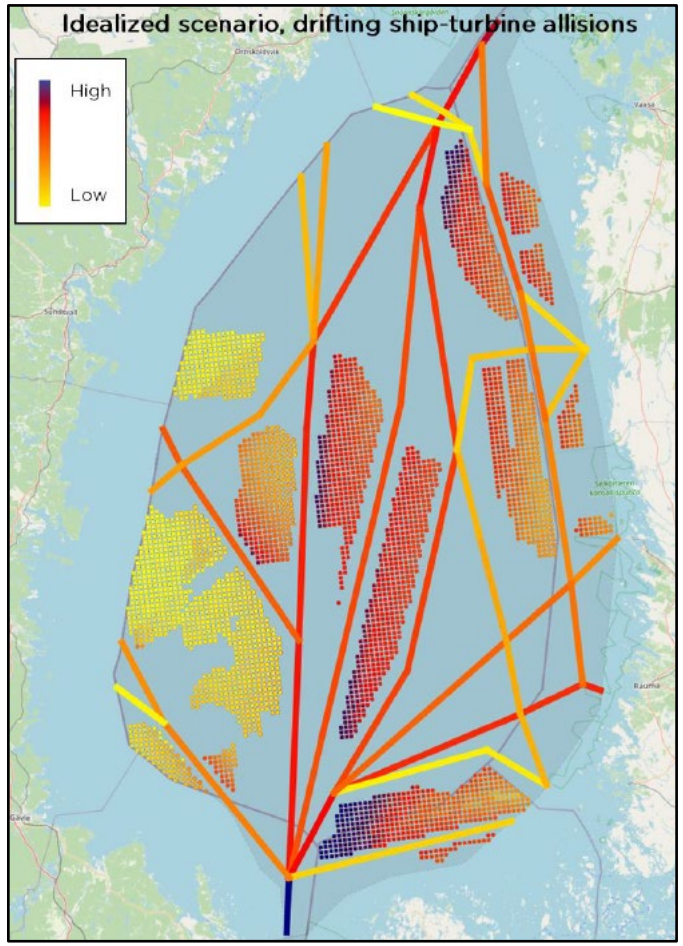


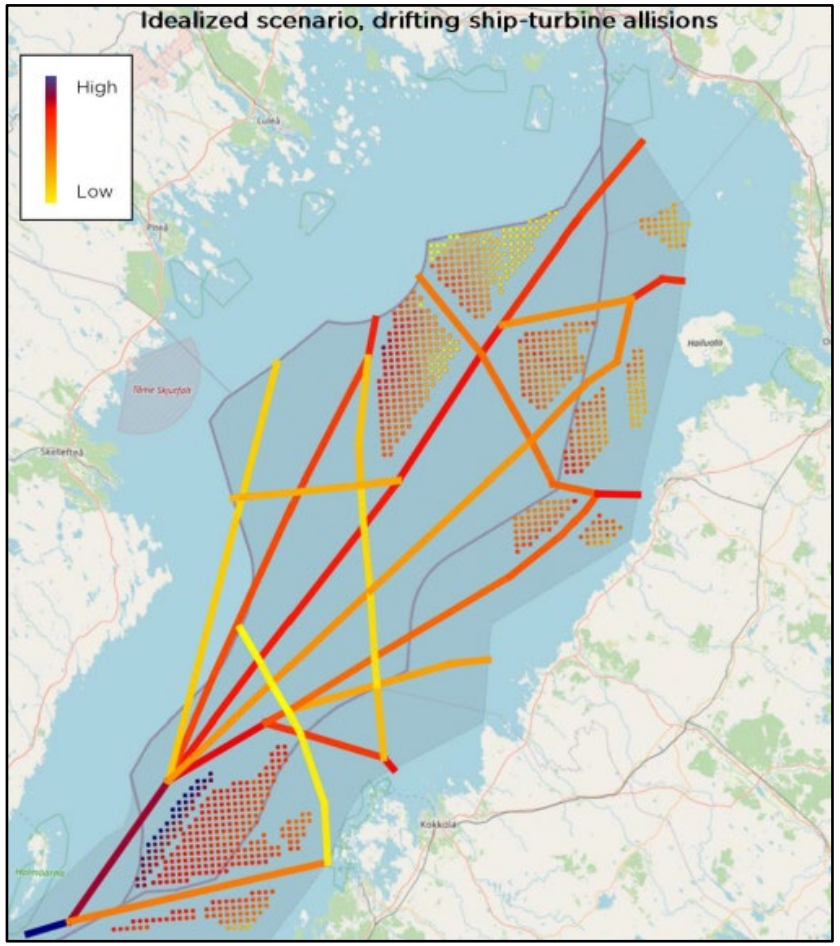


Study on maritime traffic and offshore wind farms - Results

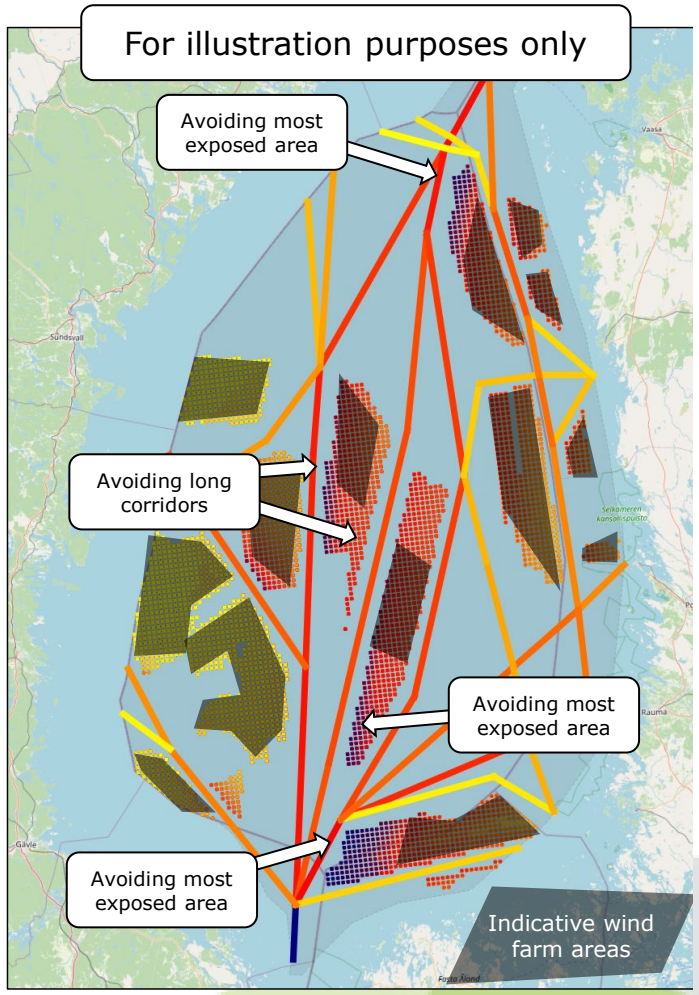
Main conclusion

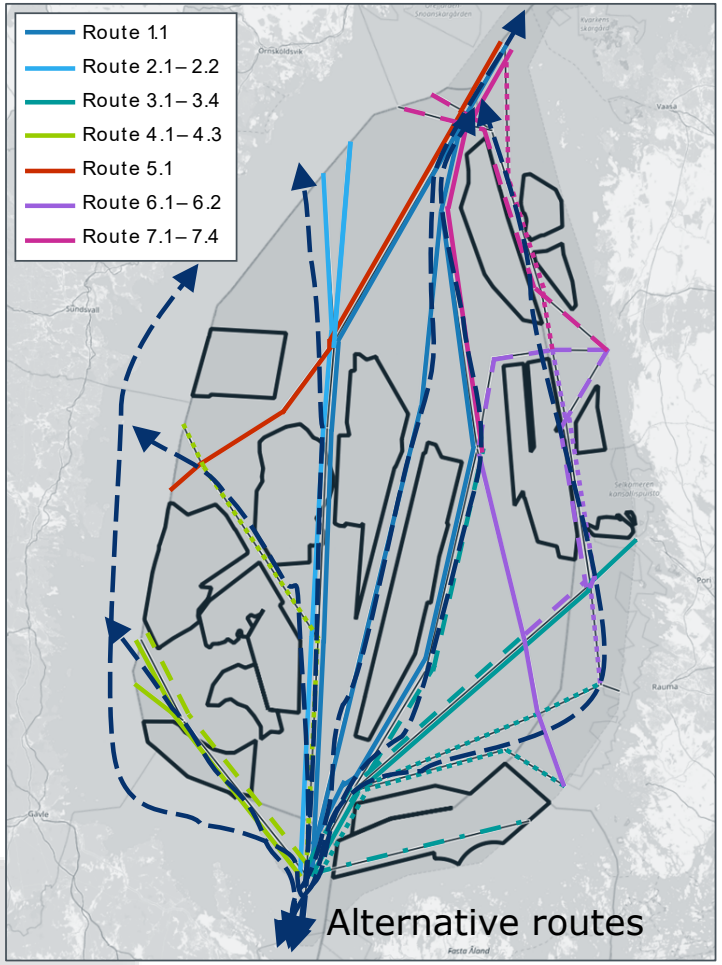
- Collision and allision frequencies, and the risk, is generally assessed to be acceptable in open-water conditions – even with relatively much wind farm development
- Safety space around the ship traffic is needed
- Focus on areas most exposed for drifting ship-turbine allisions

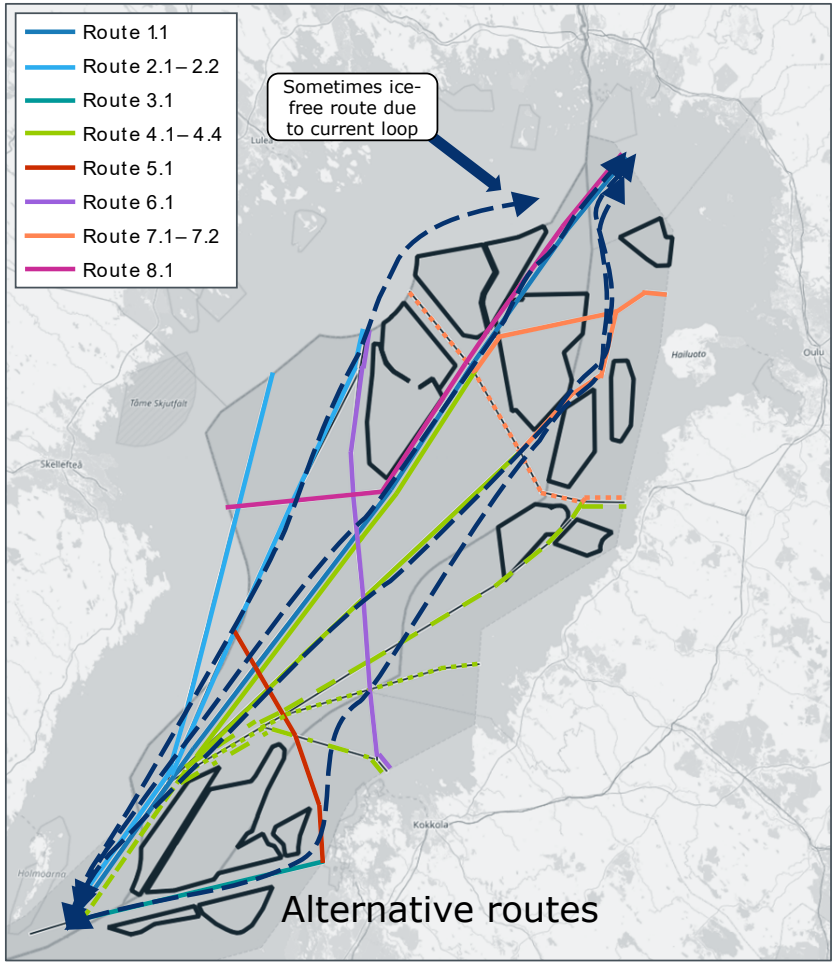




Study on maritime traffic and offshore wind farms - How to Implement Results







Study on maritime traffic and offshore wind farms - Further Research Recommended

Winter conditions

- … may change the picture radically
- There are initially more collisions during winter conditions – already without wind farm development
- Navigation through areas with turbines may be more challenging
- Interactions between turbines and ice-buildup are not known in detail and may complicate winter navigation, ice-breaker assistance, etc.

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Thank you!

Valtteri Laine (valtteri.laine@traficom.fi)

WORKSHOP ON OFFSHORE WIND FARMS WITH WINTER NAVIGATION IN MIND, 2025-05-07

WIN-WIN

Estimation of costs and resource requirements regarding the impact of offshore wind power and winter navigation in the Gulf of Bothnia

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1.CHALLENGE

Need for renewable energy ⟶ offshore wind has become an area of interest ⟶ shipping might be effected

CURRENT PROJECT

The impact on winter navigation from offshore wind – operationally and financially

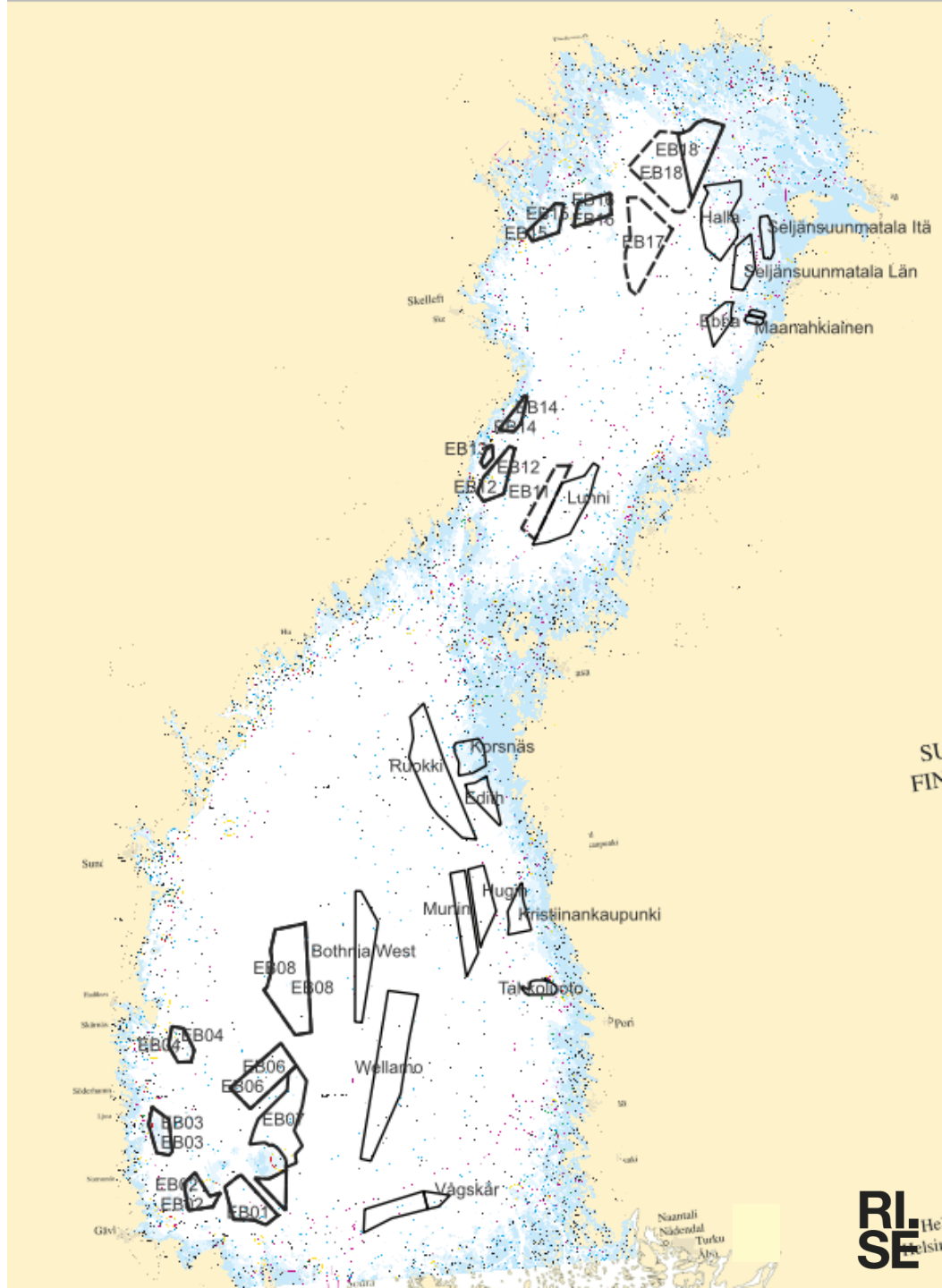
- Rerouting and detours
  - Ice breaking – cost and resources
  - Effects on business transport
- How can coexistence be achieved?

Two scenarios.

Base Case: Including areas for energy production with LCOE* < 98 EUR/MWh (Sweden) + All planned areas in territorial and EEZ for Finland.

Additional case: 3 more areas/extended areas in Swe EEZ.

* Levelized cost of electricity



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2. RESULTS

Ongoing study, preliminary conclusions so far:

- Establishment of all areas – big impact on port accessibility in the Bay of Bothnia, primarily on Luleå, Karlsborg, Kemi, Torneå & Oulu.
- Added distance not the main issue, but routes with harsher ice conditions – more fuel.

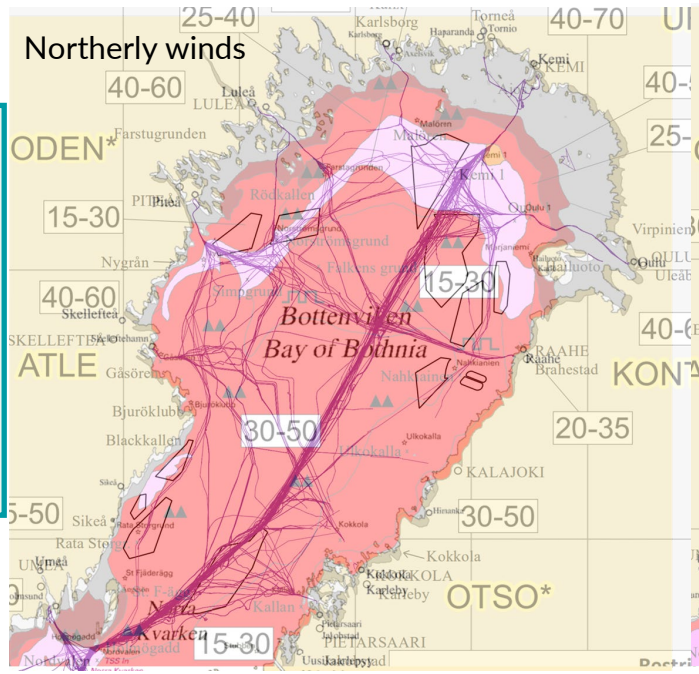
Input/assumptions:

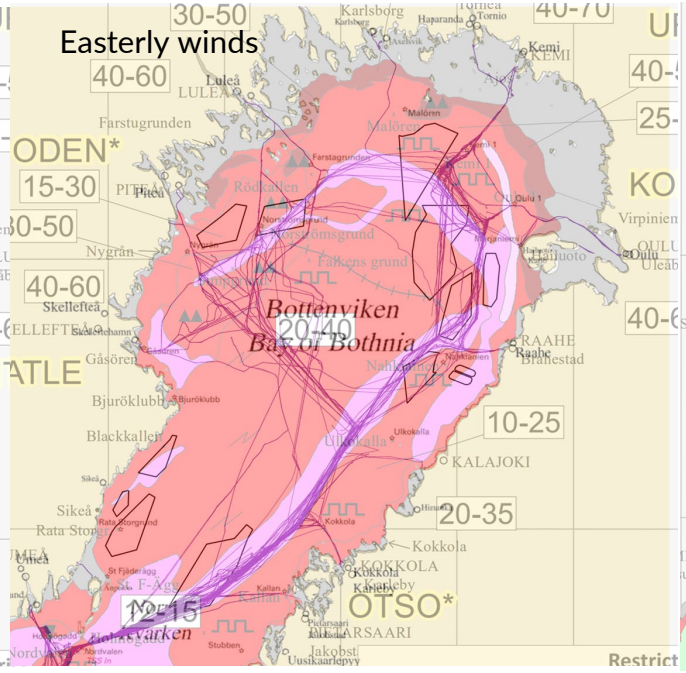
- Winters: 2010/2011 (severe), 2017/2018 (average), 2019/2020 (mild), 2023/2024 (average)
- Certain ports (decided with authorities)
- Average fuel consumtion based on Atle Class (3,5 m³/h)
- Average speed 9 knots
- All vessels assisted past wind farms

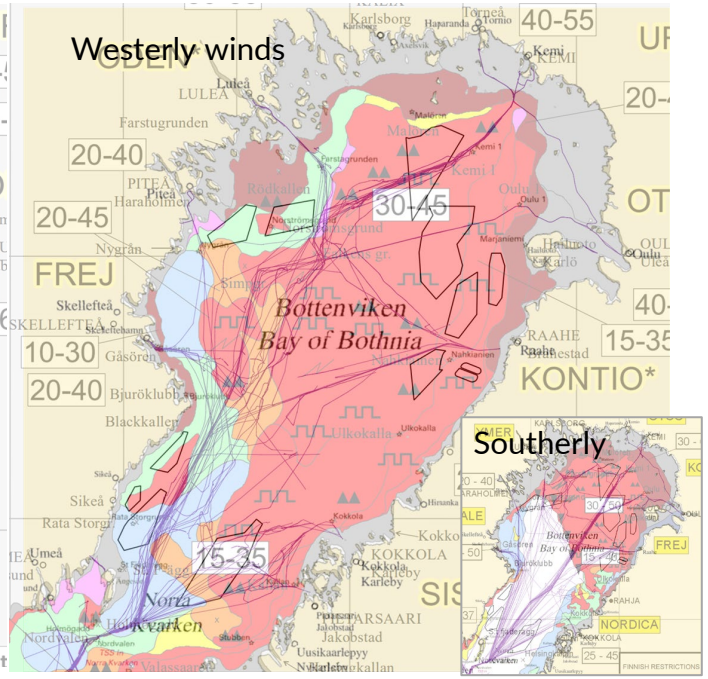
Understanding for the overall effects is vital, for all stakeholders.

Ice patterns for various wind directions.

(Ice charts with AIS-data overlay)







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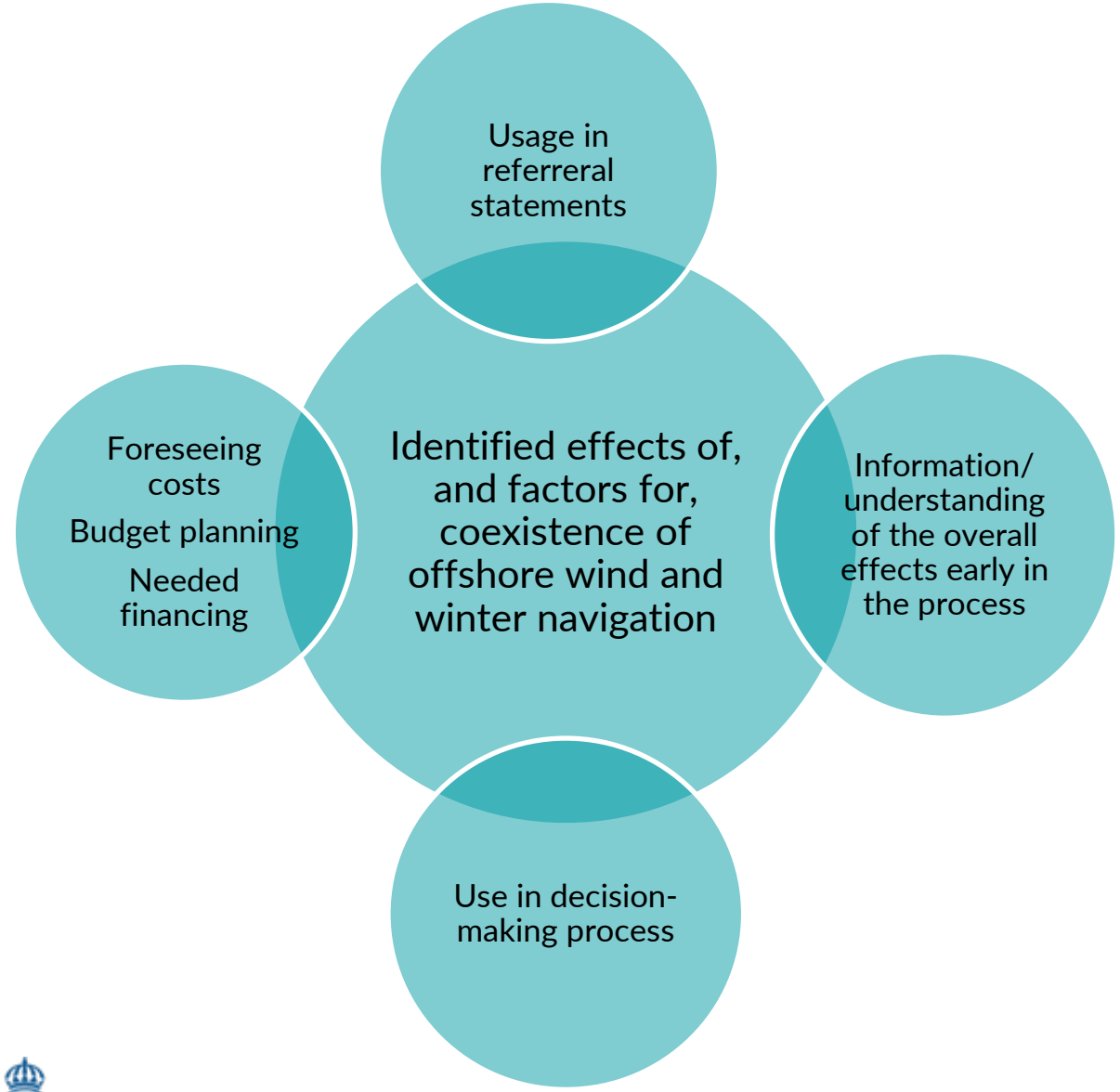
3. HOW TO IMPLEMENT RESULTS



SUGGESSTIONS

- Dissemination of report findings: Seminar / webinar for stakeholders
- Collaboration meetings
- Updated recommendations for establishment of offshore wind.

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FURTHER RESEARCH TO RECOMMEND

- Simulation of winter scenarios on Basin Scale, with following variables:
  - Ice – Sea ice model which can handle multiple fixed objects in the sea
  - Meteorological model
  - Icebreaker operation
  - Merchant vessel movements – Routes
  - Port Calls – information exchange network including ice breaking services

- Combining results of study with e.g. Windy Sea results

- Once offshore wind is established in icy waters – practical experiences should be taken into account.

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Session 3 - Impact on assistance

- **Panel discussion open for questions and input**
  - **synergies**
  - **future needs**
  - **new ideas for projects and studies**

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Summary

- **Which new research needs are identified**

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Thank you!

SWEDISH MARITIME ADMINISTRATION

Finnish Transport Infrastructure Agency

TRAFICOM

Finnish Transport and Communications Agency

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