



Windpower plants Lake Vänern, Sweden

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CEO of ReWind Offshore AB
since 2009, Karlstad, Sweden

Initiated and managed the
project Vindpark Vänern.

Green party politician and
City commissioner/vice
Mayor of Karlstad from
2002-2010.

Board chairman of municipal
utility Karlstad Energi, etc.



Tore Wizelius

Writer

Developing Wind Power
Projects, etc.

Teacher

Gotland University 1998-
2008

SLU University of
Agricultural Science
2010-11

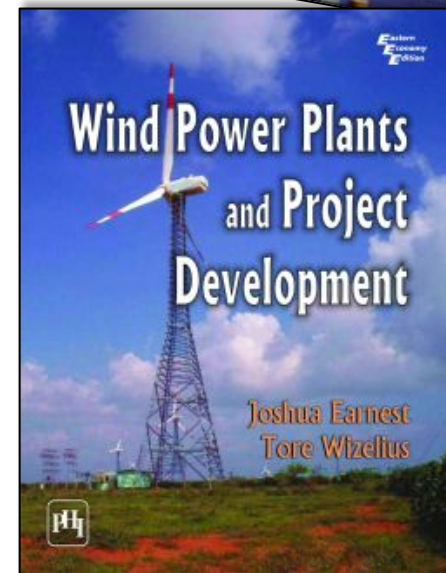
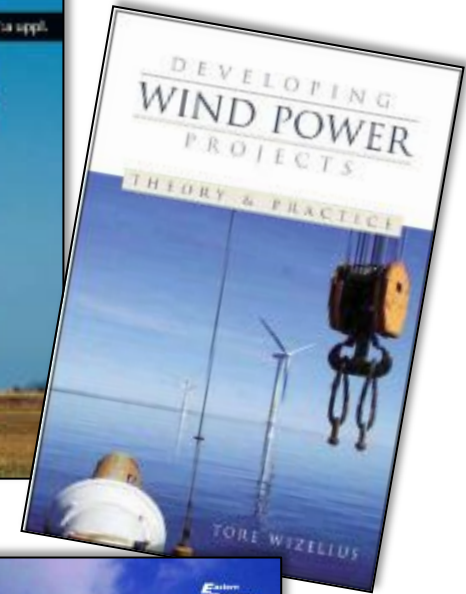
Entrepreneur

ReWind Offshore AB

Vindform AB

WindCap Fond AB

Boge Vindbruk AB, etc.





Introduction

Vindpark Vänern – overview
Vindpark Stenkalle – overview
Environment Impact Assessments
– Scope and Contents





Lake Vänern



Lake Vänern is the largest lake in the EU and covers an area of 5,655 km² (2,183 sq mi).



Great Lakes vs Lake Vänern

Lake Superior

31,700 sq mi (82,100 km²)

Lake Michigan

22,300 sq mi (58,000 km²)

Lake Huron

23,000 sq mi (59,600 km²)

Lake Erie

9,940 sq mi (25,744 km²)

Lake Ontario

7,340 sq mi (18,960 km²)

Lake Vänern

2,183 sq mi (5,655 km²)



Offshore vs land

Lake vs sea offshore

Offshore vs land

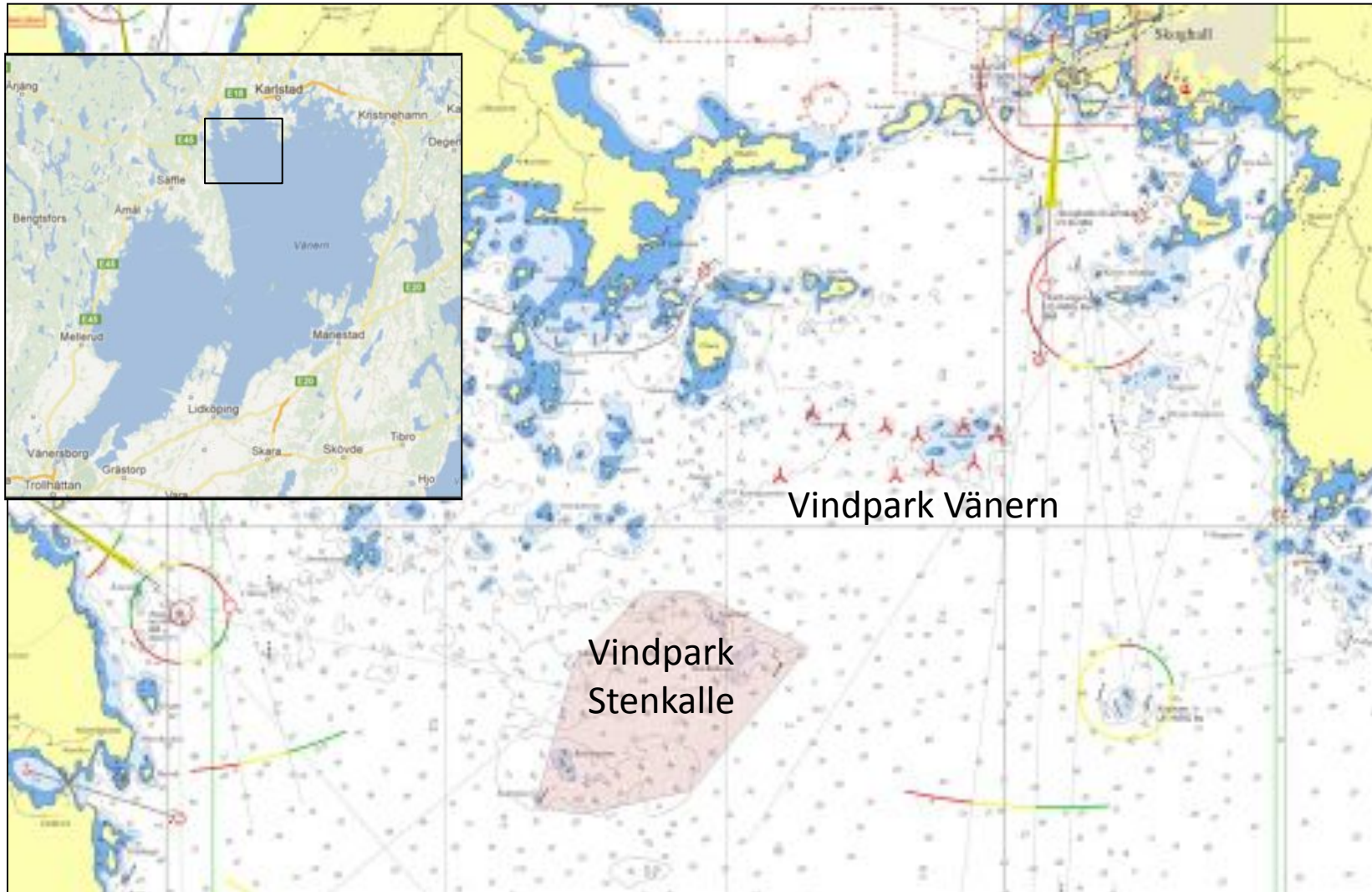
- + More wind energy
- + Laminar wind
- + Less impacts on neighbors
(noise, shadow, visual impact)
- Higher installation costs
- Higher OM costs

Lake vs sea offshore

- + Less corrosion
(no salt in water)
- + Less loads
(lower wave heights, max wind speeds, etc)
- + Lower installation costs



Windpower plants in Lake Vänern





VINDPARK VÄNERN

10 WIND TURBINES

30 MW

90 GWh/year

**Electricity for 20 000
households**

90 m hub height

100 m rotor diameter

Total weight 220 ton

Operating since 2010



Stenkalles grund

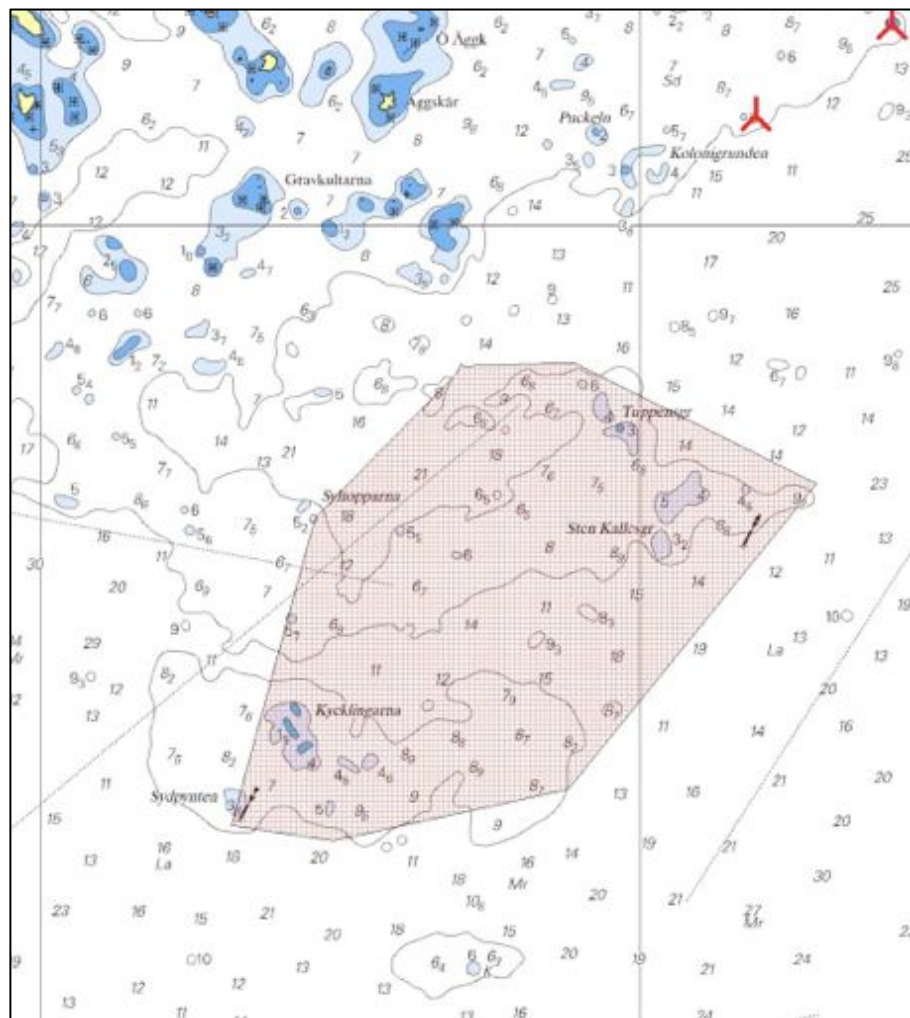
Application incl. EIA submitted in June 2011 to Swedish Environment Court.

Hearing in October 2012.

Decision expected before end of year.

The project area is within an area in Vänern defined as:

- **National interest for windpower**
- **Windpower area in Municipal Comprehensive Plan for Karlstad**



Stenkalle EIA: Contents

Siting

Siting evaluation, A, B, C, O

Seabottom conditions (prof. Tom Flodén)

Flora och fauna

Impacts on aquatic life (ÅF)

Hard bottom inventory

(Tronerud Miljö & Natur)

Exploratory fishing (Modins Biologi)

Impacts on bird life (JP Fågelvind)

Impacts on bats (Ecocom)

Environment impacts on Natura2000-areas (ÅF)

Grid connection to land (Cleps)

Impacts on Natura2000-area

Klarälvsdeltat (consultant)

Cultural environment

Checks of indications in cable routes
(consultant)

Marine archeological check
(Bohusläns muséum)

Sound propagation

Sound immission (ÅF)

Visual impact

Photo montages

Visualisation zones



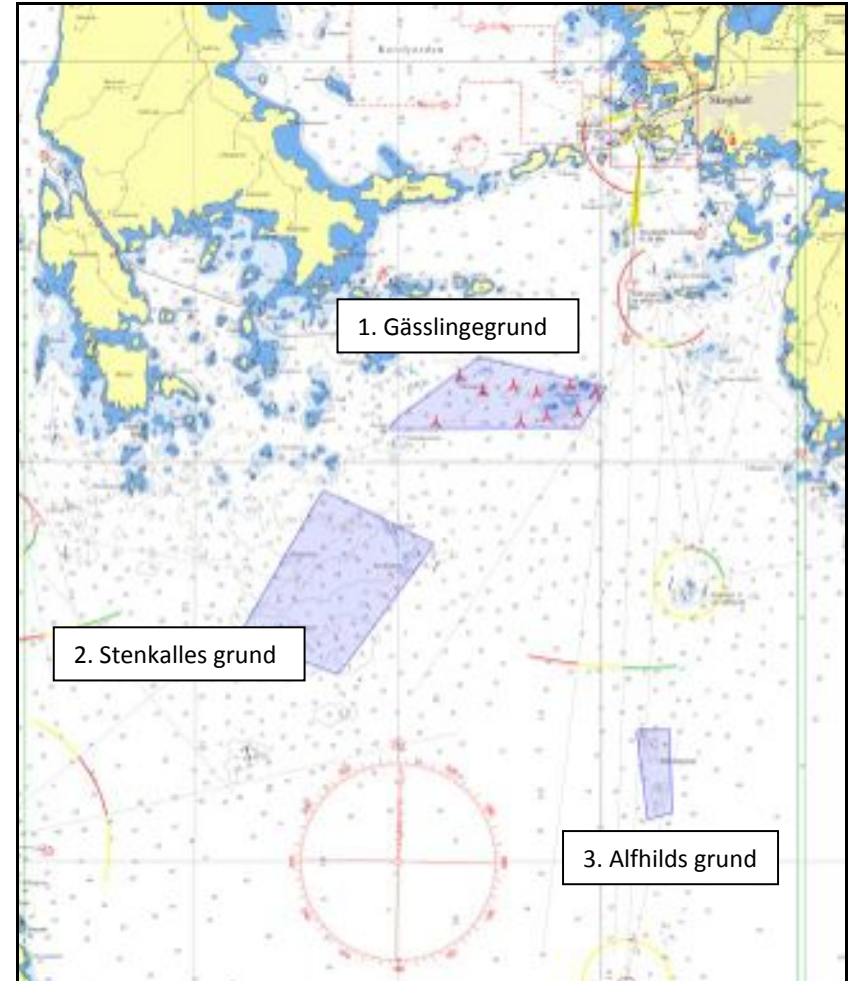
Options for current project

Three options were studied:

1. **Densification of Vindpark Vänern**
2. **Stenkalles grund**
3. **Alfhilds grund**

These three siting options have been evaluated using the following criteria:

- Wind resources
- Distance to houses
- Impacts on landscape
- Nature & Cultural environment
- Fishery & Shipping
- Recreational environment
- Distance to power grid
- Noise
- Security
- Technical and economic preconditions

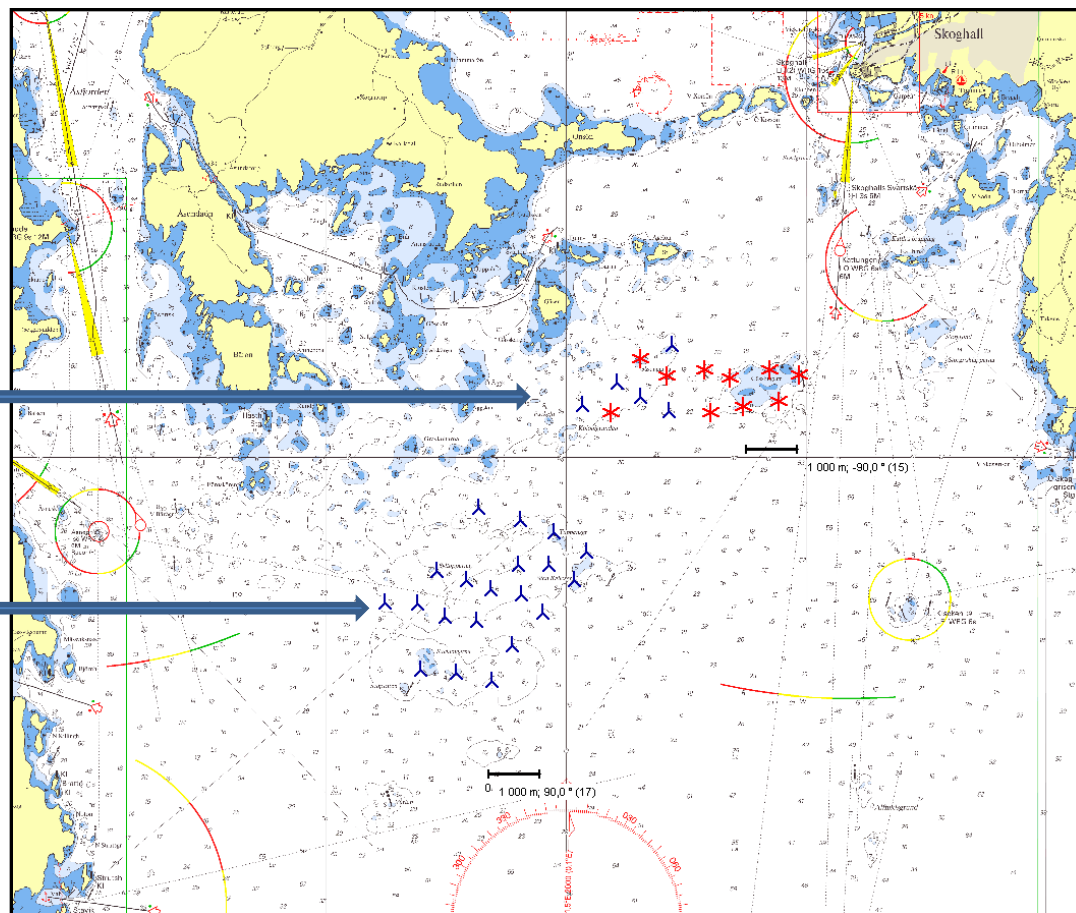




Project design december 2010

1. **Densification of Vindpark Vänern**
+ 5 wind turbines (blue symbols).

2. **Stenkalles grund**
New WPP with 16-20 wind turbines

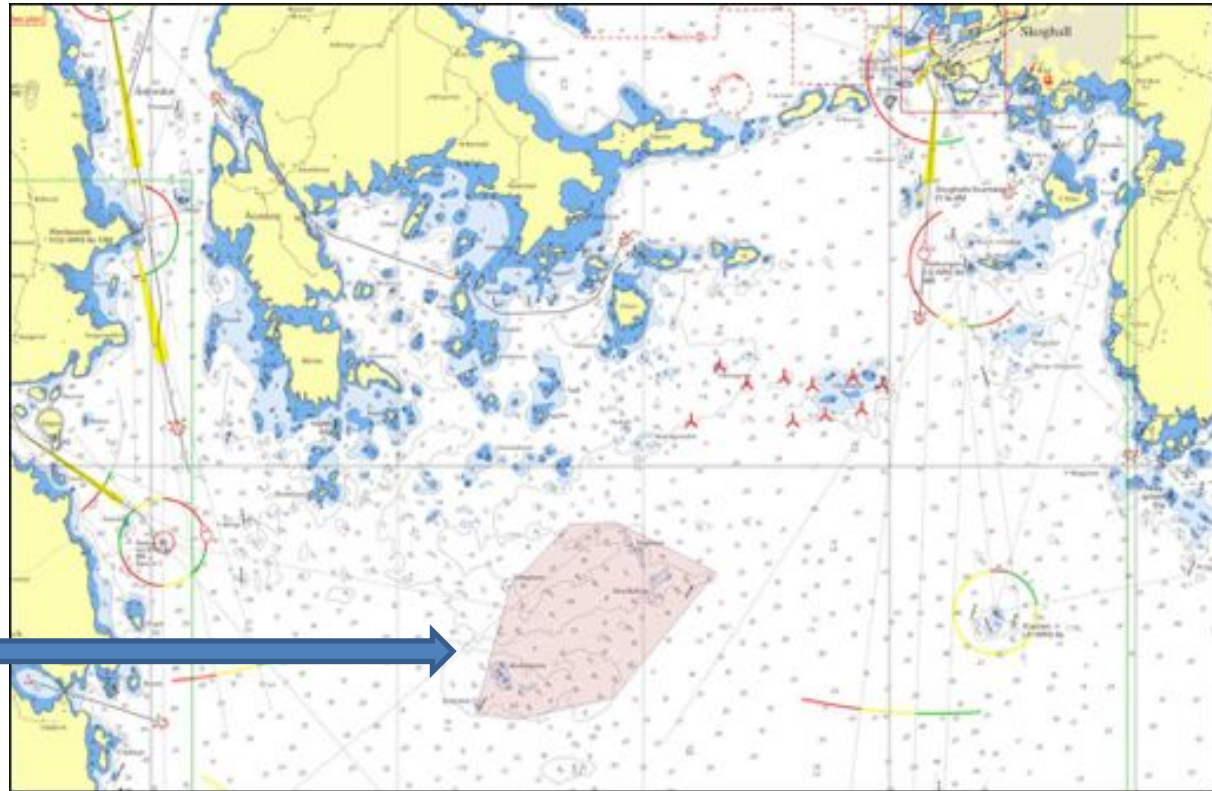




Development by public consultation

3. Stenkalle application

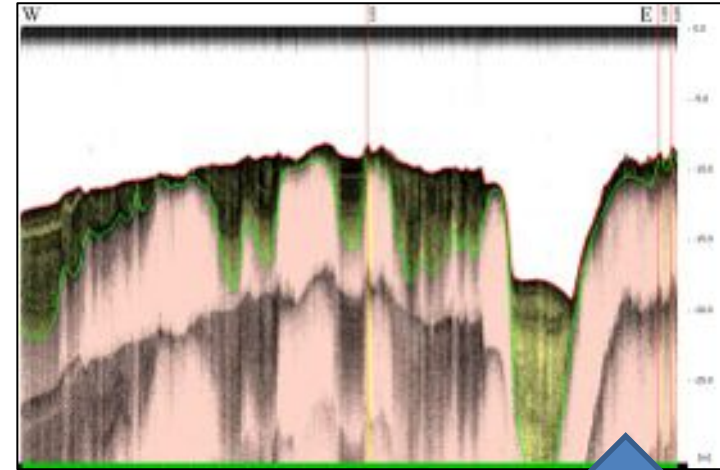
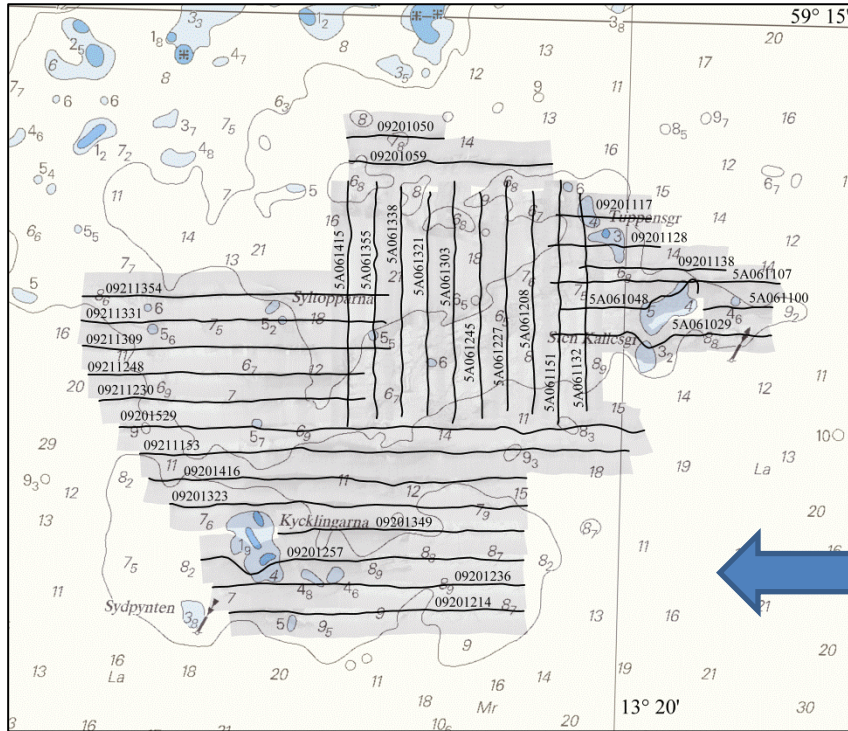
The project is defined by the area shown on the map.



Conclusion: *Stenkalles grund is the best option according to the criterias used and facts and opinions promoted in public consultations.*



Geological survey to identify possible wind turbine sites



Trajectories for side-scan sonar mapping of sea bottom and bottom profiles



Protected areas

Nature reserves

Bird protection areas

National interests:

Nature

Recreation

Fishery

Shipping

Windpower

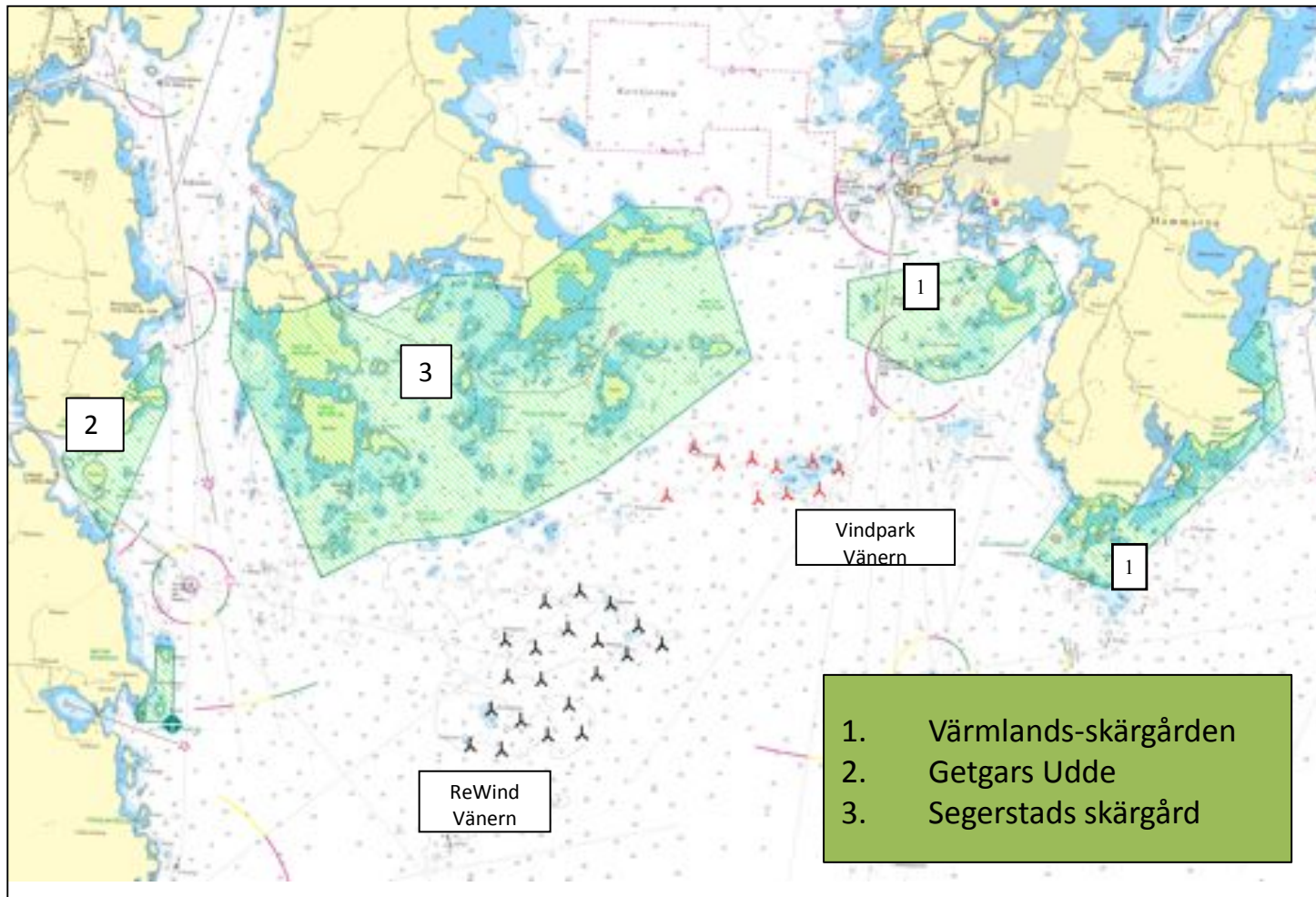
Natura 2000-areas

Vänerskärgården

Klarälvsdeltat

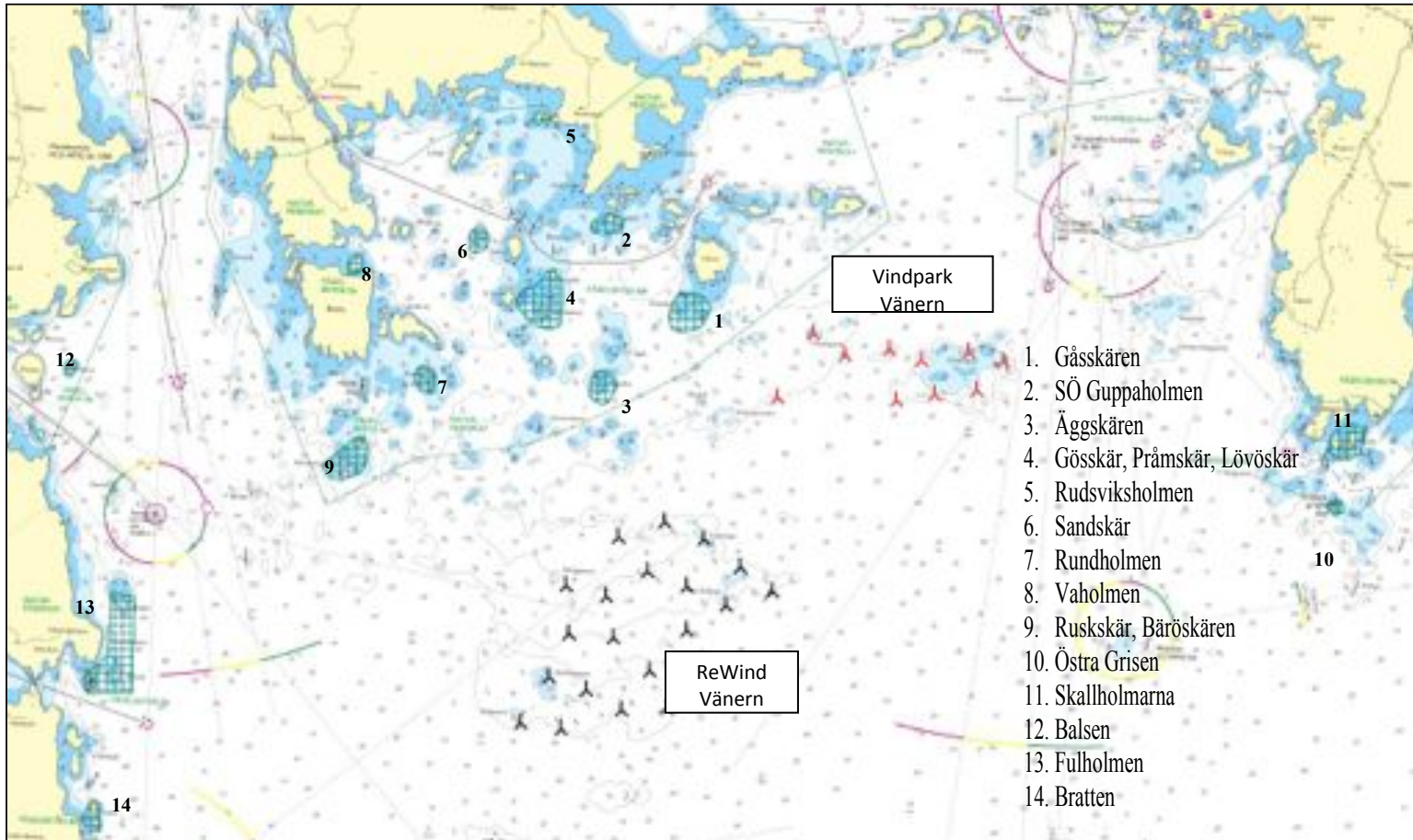


Nature reserves



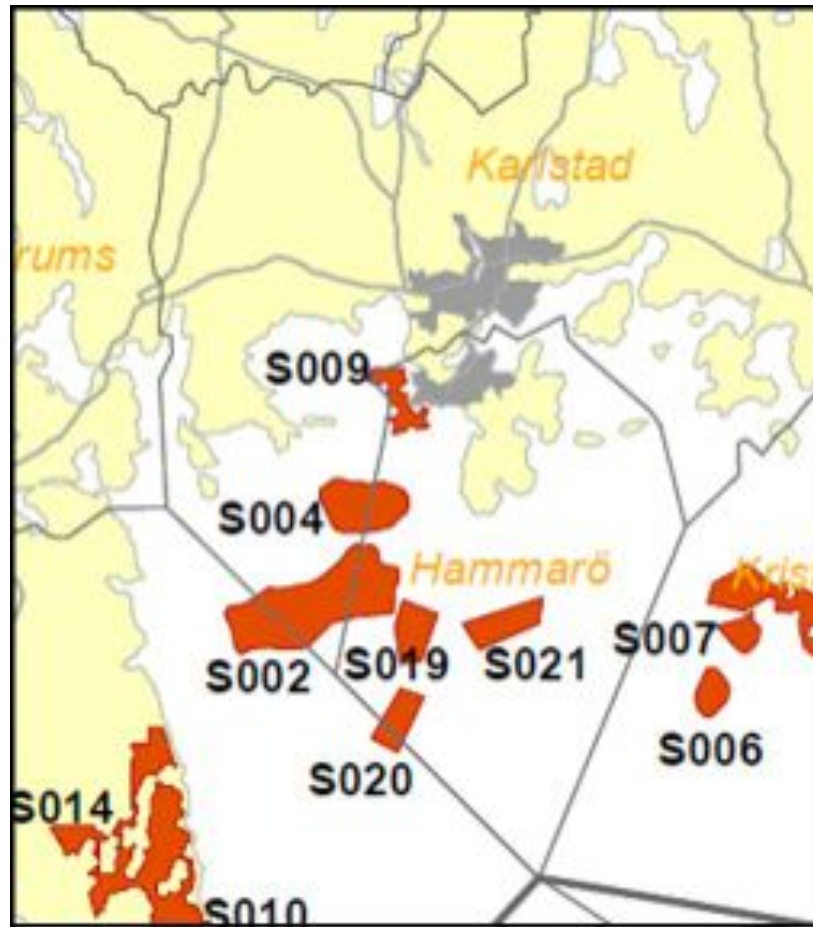


Bird protection areas



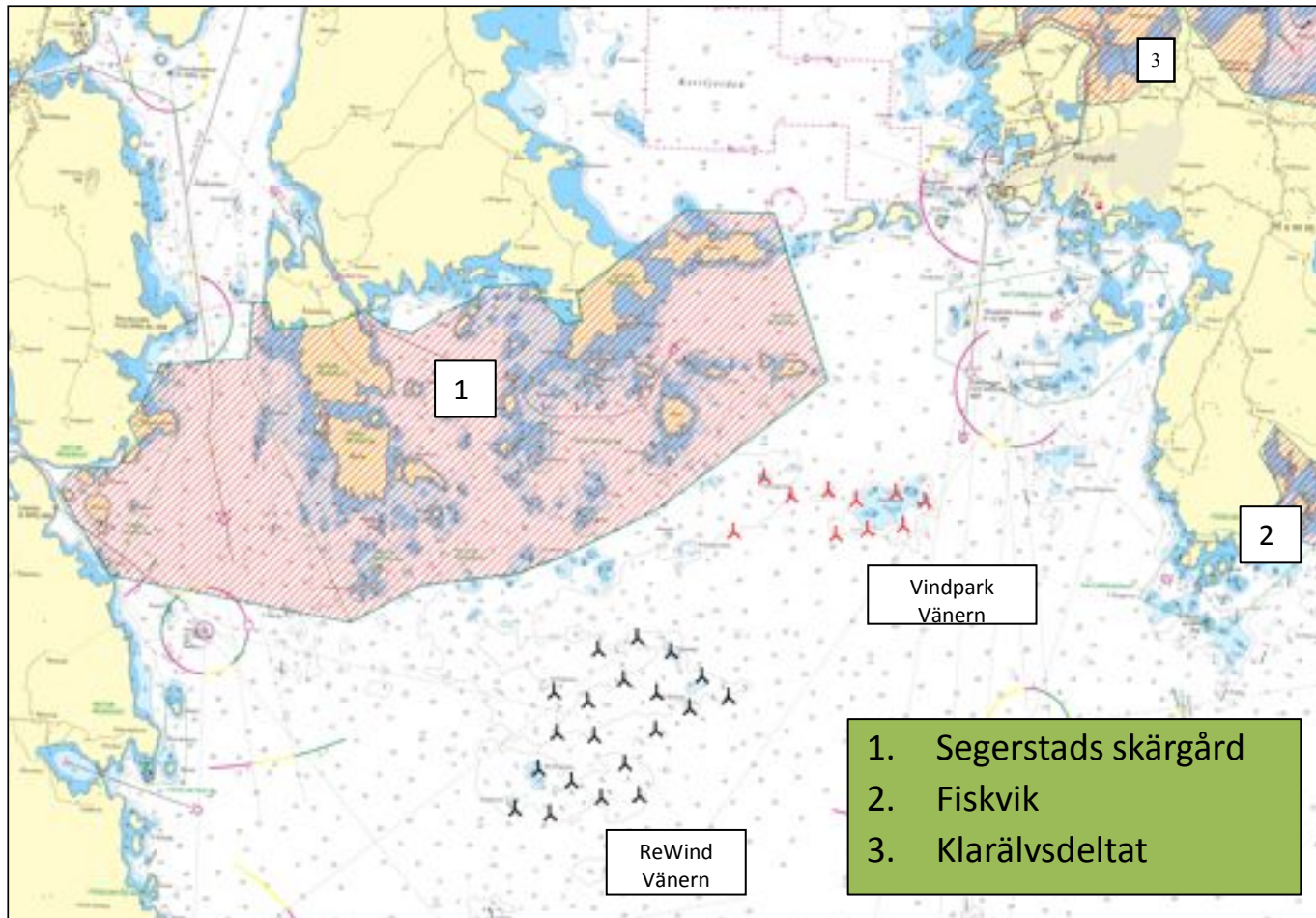


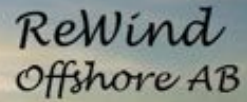
Windpower areas



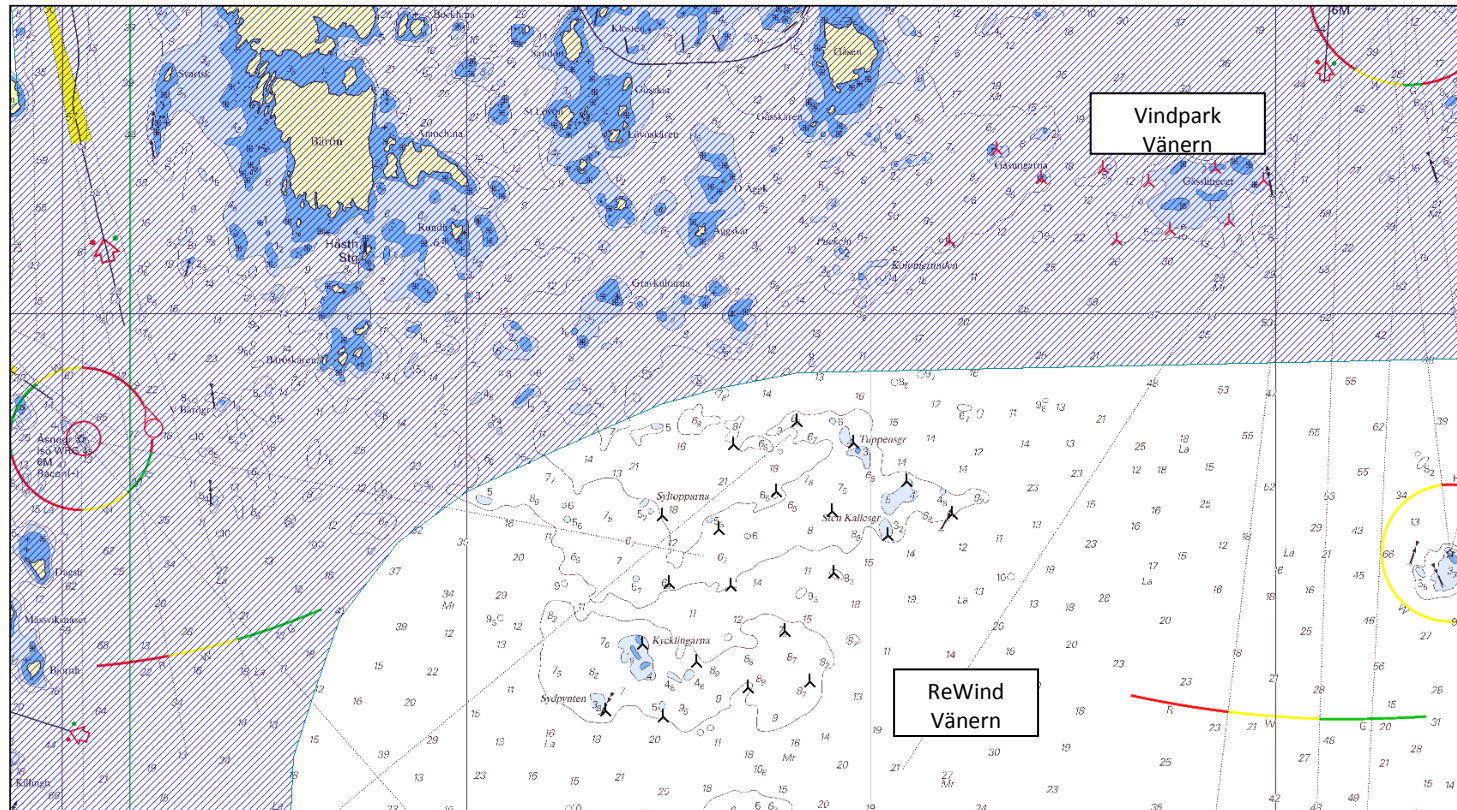


Nature areas



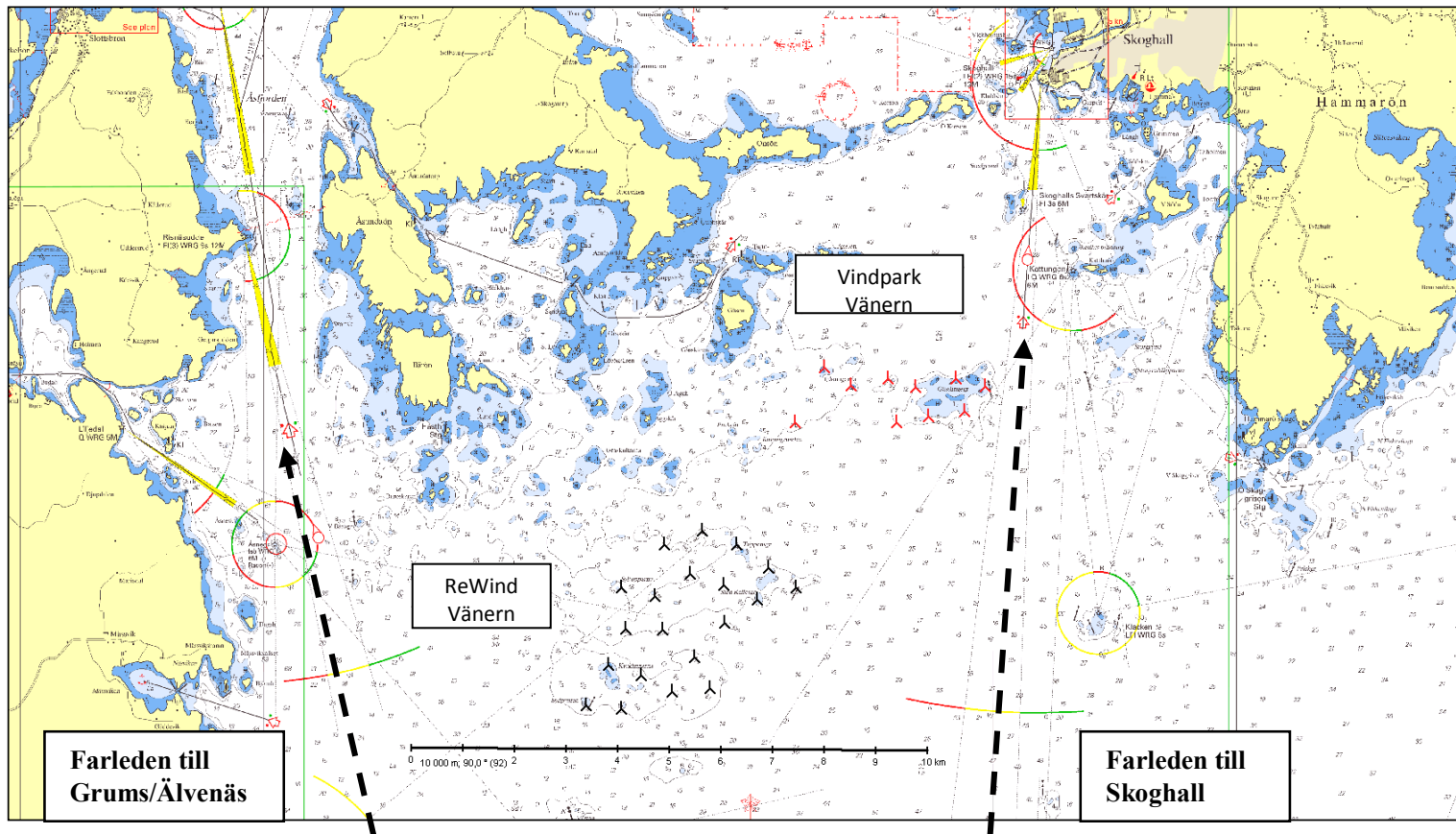


Recreation areas



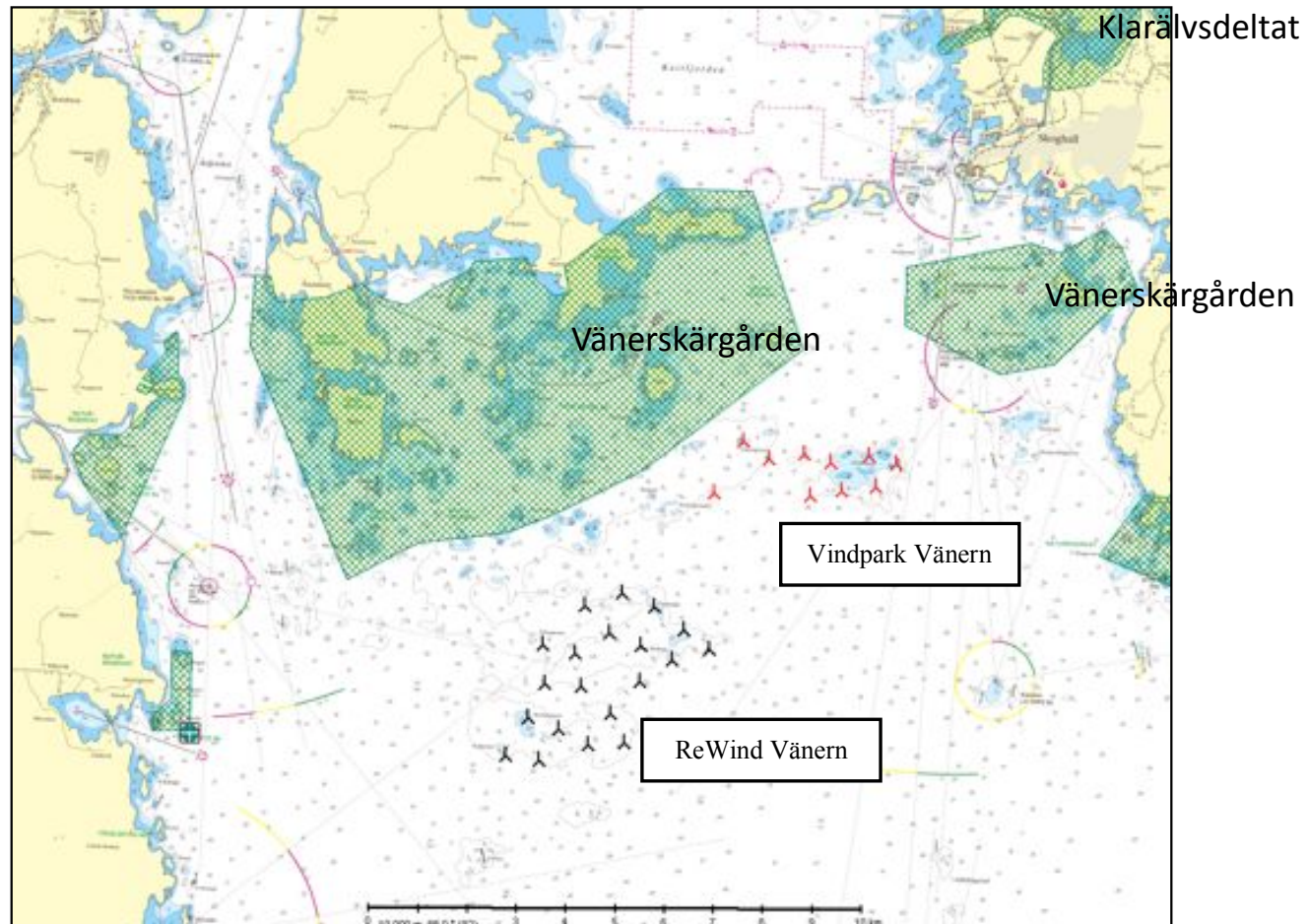


Shipping





Natura 2000





Flora and fauna

Impacts on aquatic life

- Results from coordinated recipient controls in northern Vänern, etc.
- Results from exploratory fishery
- Inventory of fauna, flora and fish by divers



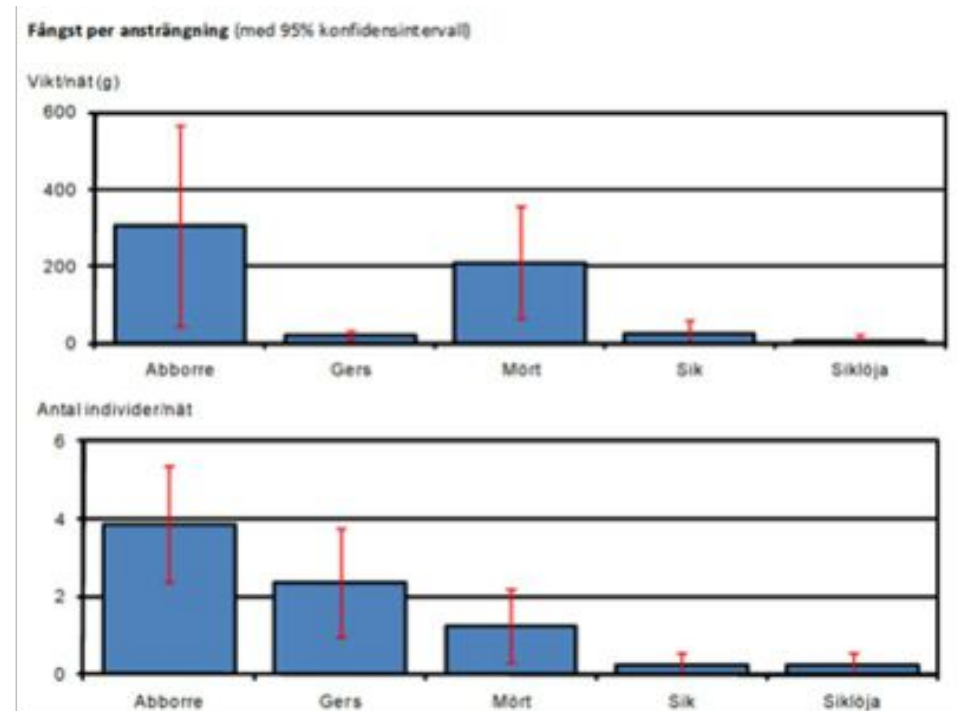
Exploratory fishery; results

Exploratory fishery was conducted during one night in september 2010 at Stenkalles grund with 8 seabottom nets.

Results: few fish species with low population densities and biomass. Catch dominated by perch. Other species: Roach, ruffe, common whitefish, vendace.

The ecological status of the area was classified according to the index EQR8 as unsatisfactory.

Results were compared with exploratory fishery from 1999 and 2005, which confirmed the results.

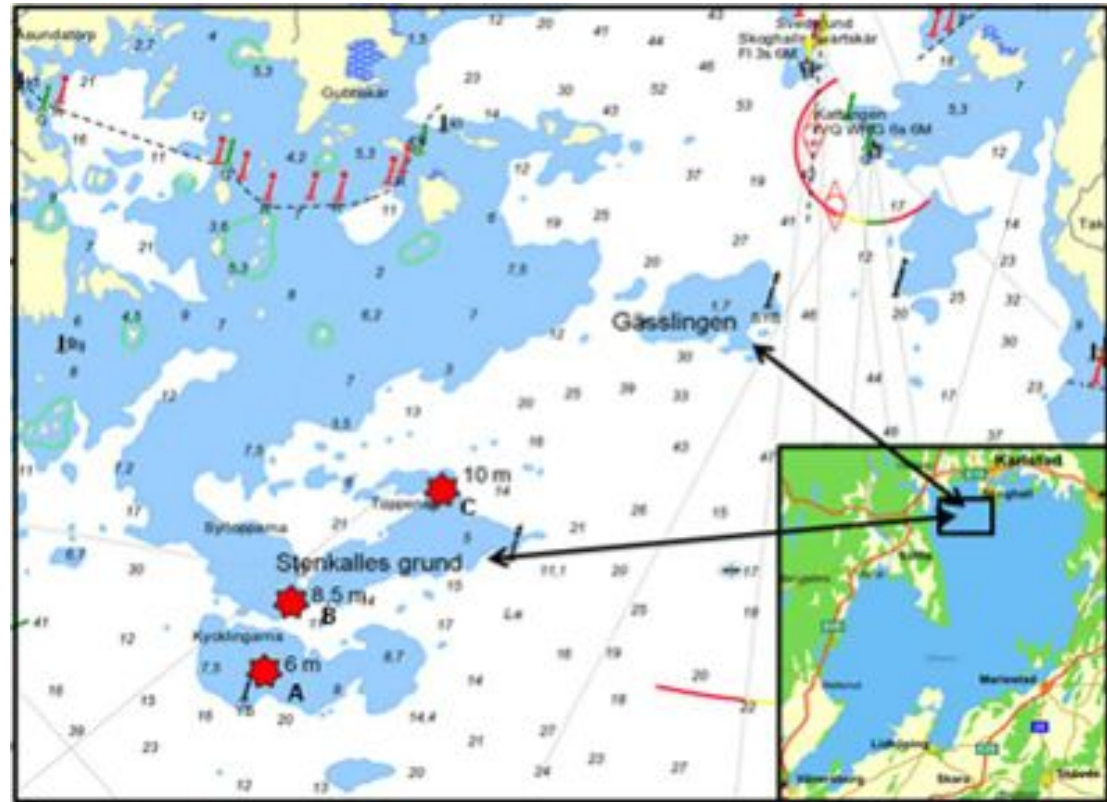




Inventory of fauna, flora and fish by divers

An inventory of seafloor fauna at Stenkalles grund was conducted in the fall 2010.

Three sites with 6 m, 8,5 m and 10 m depth were investigated.

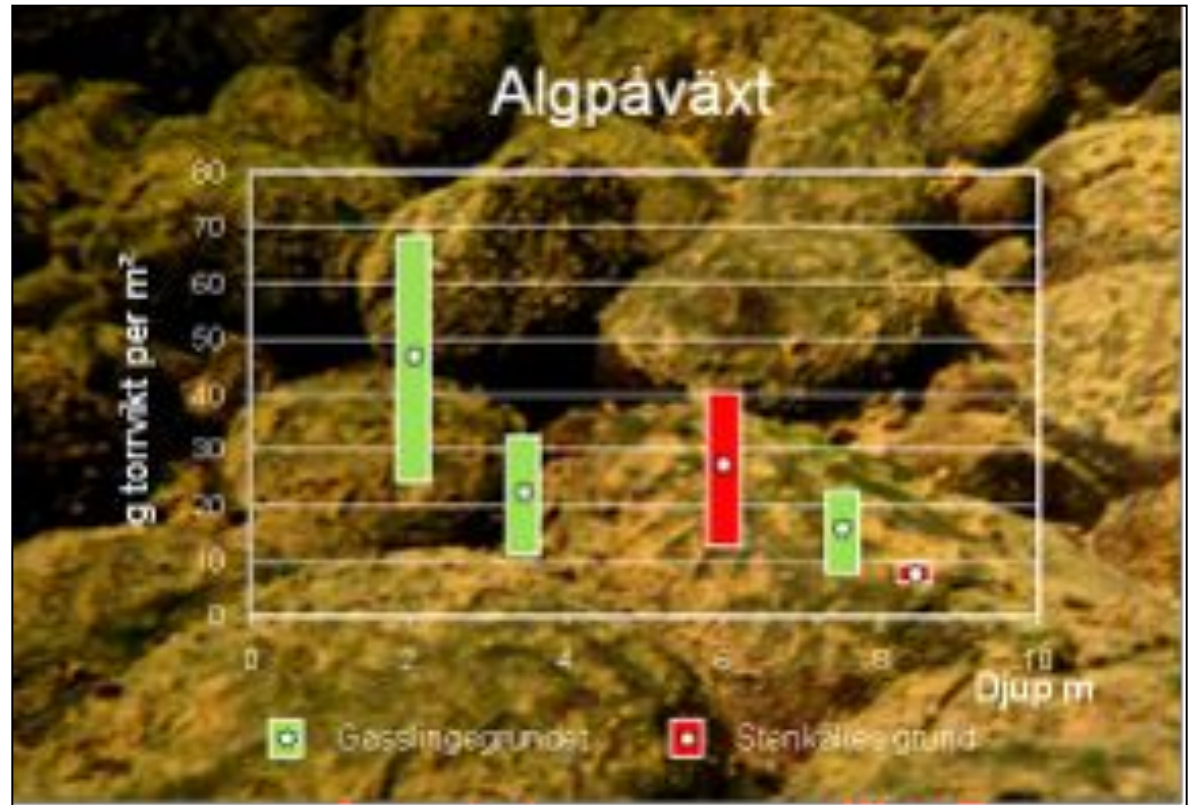




Algae at Stenkalles grund

The total biomass was generally low and decreases fast with increasing depth.

The low biomass indicates sites with low nourishment.



Biomass of algae at Gäslingegrundet 2005 and Stenkalles grund 2010 (g dry weight per m², average \pm stddev).

Seafloor fauna




Seafloor fauna biomass was very low; ca 2 ton per km² (dry weight) for the whole project area.

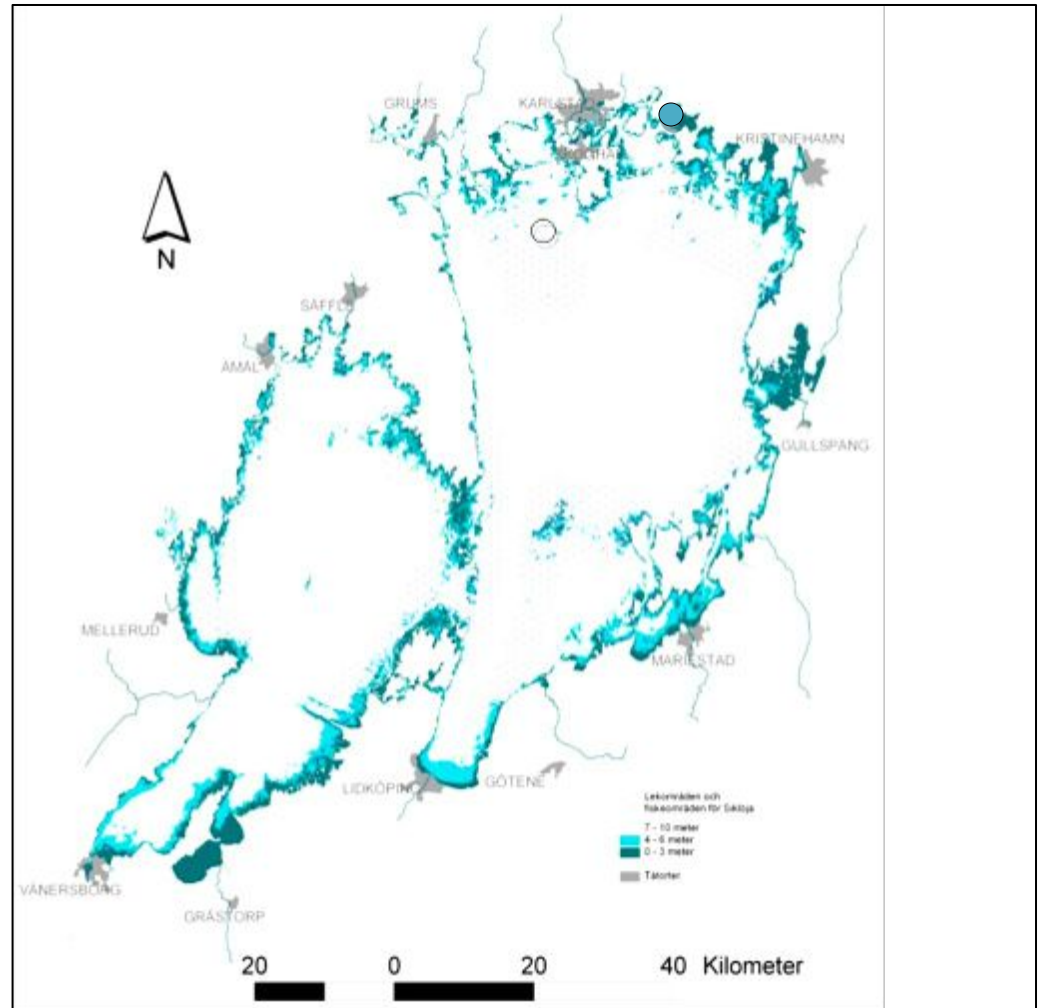


Spawning grounds for vendace (*Coregonus albula*)

Stenkalles grund borders to a fishing area for vendace.

Fishing starts in mid-october and ends mid-december, during the spawning season which can continue until january.

Spawning and fishing areas for vendance in lake Vänern. Stenkalles grund 





Foundations as artificial reefs

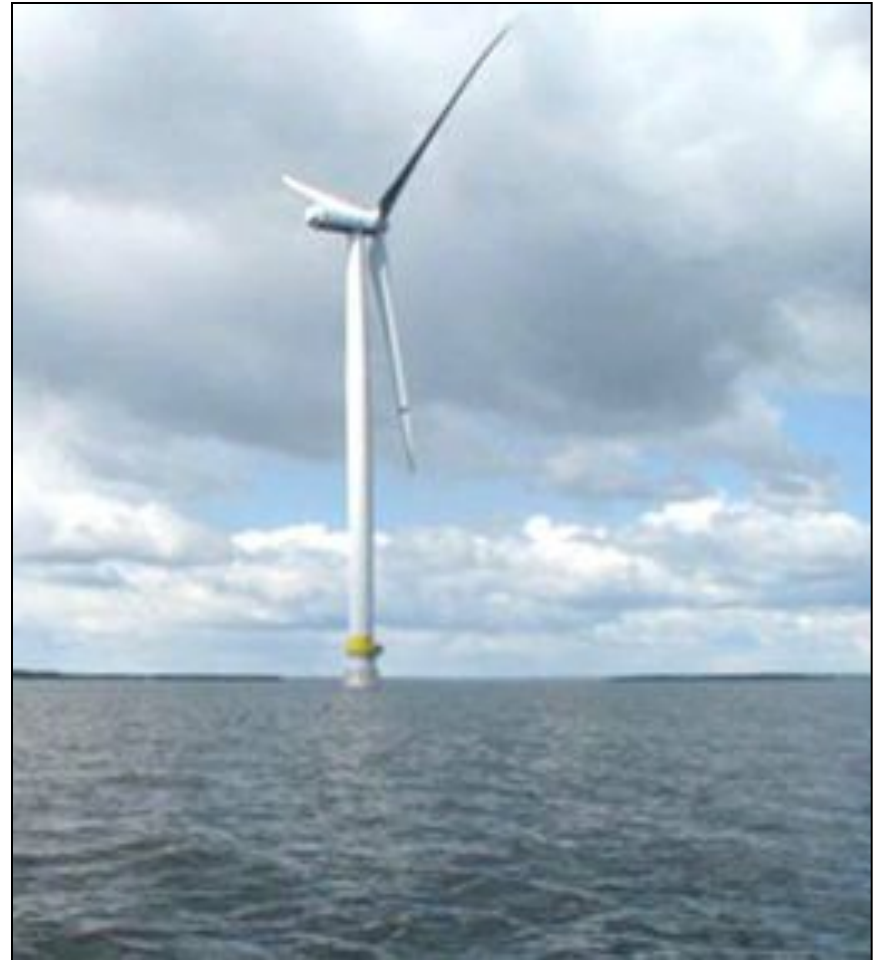
Around the foundations at the operating Vindpark Vänern at Gässlingegrundet a lot of small fishes have been observed.

The foundations attract fish, just like rocks and small islands.

Fish look for shadow and lee from wind, waves and streams.

On the upper parts of the foundations close to the surface a lot of algae have grown which give nutrition to fish and marine fauna.

European
bullhead
(*Cottus
gobio*)





Impacts on environment during building phase

Impacts from opacification

Impacts will be very limited in time and space due to the hydrodynamic conditions in the area where particles will be diluted very fast. As a precautionary measure, these kinds of work can be done outside the spawning seasons of vendace and pikeperch.

Installation of electric cables

No blastings will be used. The cable will be buried to protect it from mechanical wear, ice etc. and to minimize impact close to shore. In shallow waters the cables will be buried by milling, prouging or drilling.

Effects on sea bottom fauna and vegetation

It will be noticeable in areas where digging takes place. A recolonization can however be expected within a few years. Impacts on phyto- and zooplankton is assessed as negligible.



Ecological effects

Fish

Opacification is a natural process which happens every time the wind blows hard.

Fish are generally relatively insensitive to suspended particular materials (SPM) and also have the ability to move away from areas with high concentrations of particles.

Fish larvae

These are often more sensitive to SPM than eggs and adult individuals , but also for these concentrations have to be high to reduce survival rates.

Mortality for fish eggs can increase if they are covered by a layer of sediment. This can be avoided if work that causes opacification is done outside the spawning seasons of these fish species.



Fishery

Lake Vänern is classified as a ***national interest for fishery***.

There are 73 licenses for professional fishery for lake Vänern, which is adapted to the fish stocks of the lake.

Commercial species are *vendace, salmon, pikeperch, common whitefish, pike, burbot* och *eel*. Fishery is conducted with fishing nets. Trawl fishing is prohibited in Vänern.

Ten licensed fishers use fishing waters in northern Vänern.

The assessment of the County administration is that the windpower project does not have any substantial impacts on the national interest for fishery.



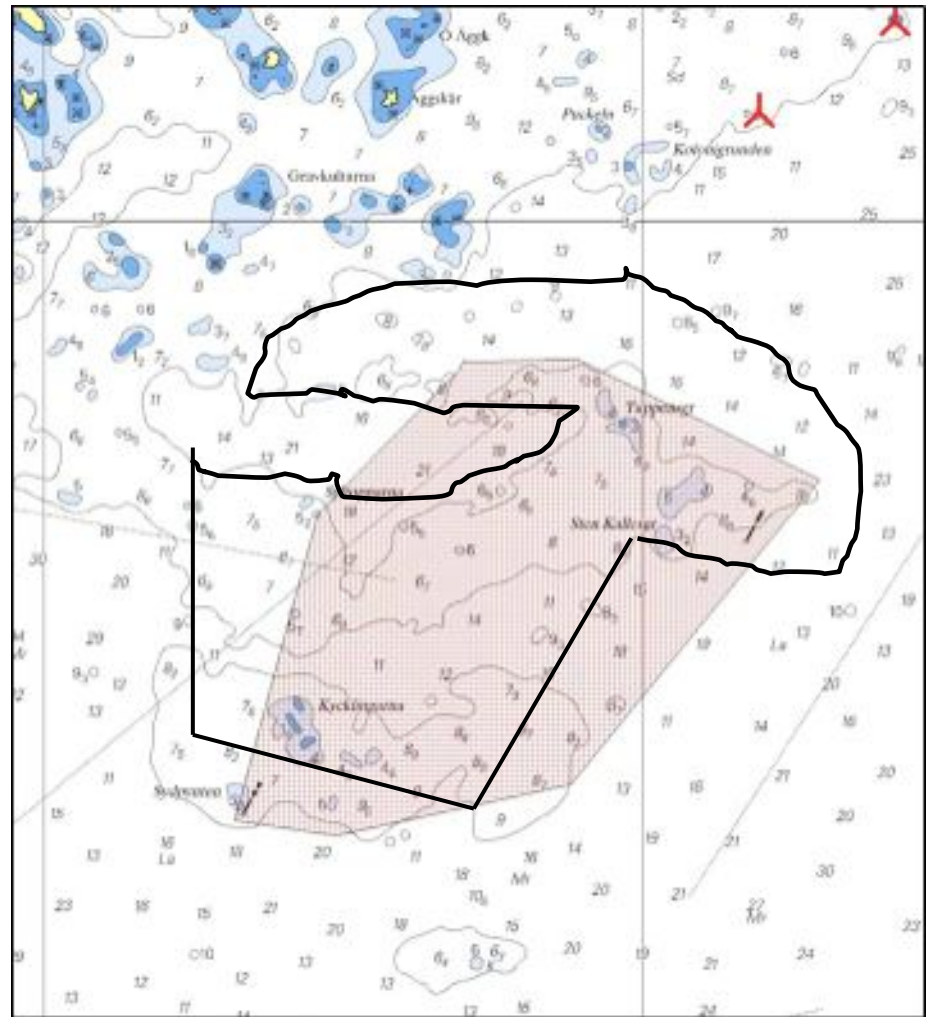
Fishermen

During the project development a consultation with the fishermen has been held. In this dialogue it was stated that almost no professional fishery was conducted within the project area, see map.

In this area there is a rather intensive fishery for vendace, which swim from deep waters to the spawning ground in shallower waters near the coast. They are caught on the way from deep to shallow waters.

The project area has been modified to avoid conflicts with this fishery. Later the area was modified another time to increase the distance to certain small islands with nesting birds.

*Map made in dialogue with local fishermen.
Fishery is conducted outside the black line.*





Impacts on fishery

The availability to the fishing area for vendance will not be restricted by the windpower plant, except during the building phase. There will be no major impacts on fishery.

After the application had been submitted, the fishermens association claimed that the windpower plant would indeed restrict their fishing seriously, and claimed compensation for this.

They argued that restrictions to anchor as well as restrictions of access to the area during the building phase would cause problems (economic losses) for them.



Access restrictions

During the building phase access to the area will be forbidden due to security. However, only max ten turbines can be installed during one year, which means that only half of the area will have restricted access for fishery.

The installation will be made during summer, when no vendace fishing occurs.

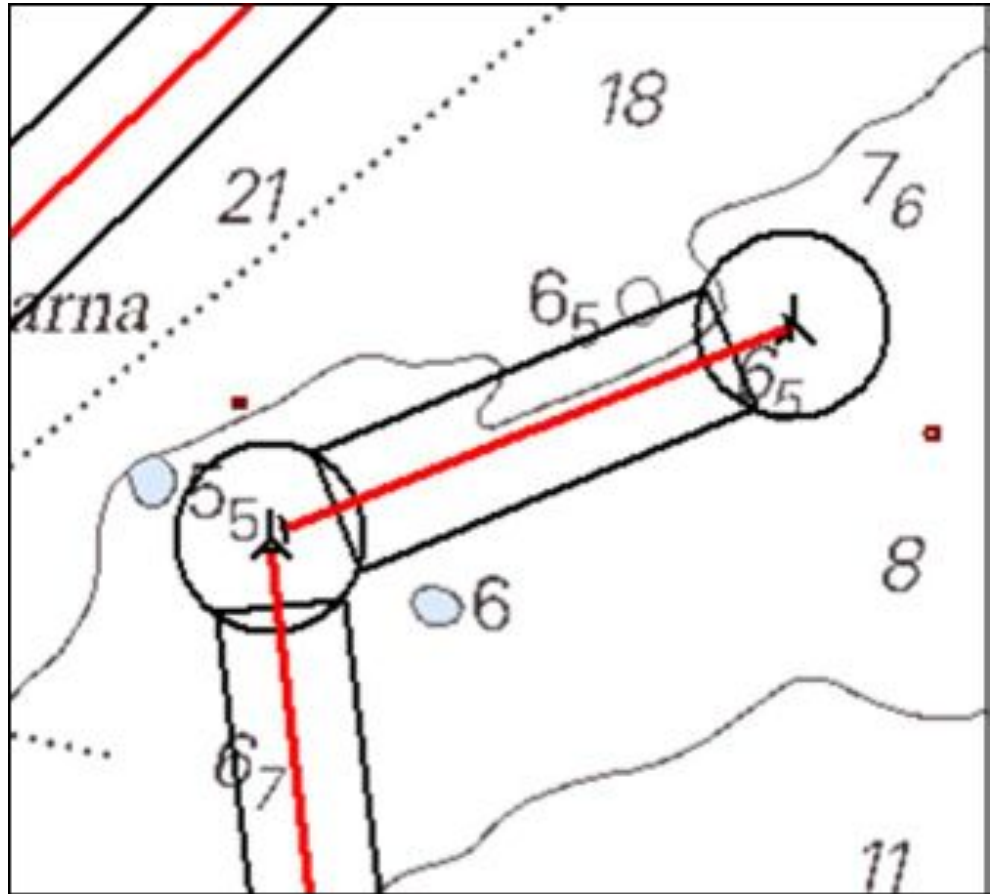
The project area is 11,5 km². The wind turbines will be very big, and thus the distance between foundations and cables long. Access restrictions will be applied only to those areas where work actually takes place.



Restricted work area

Definition of work area

1. Circle with 150 m radius around each foundation
2. Rectangle with 200 m width along cable routes.

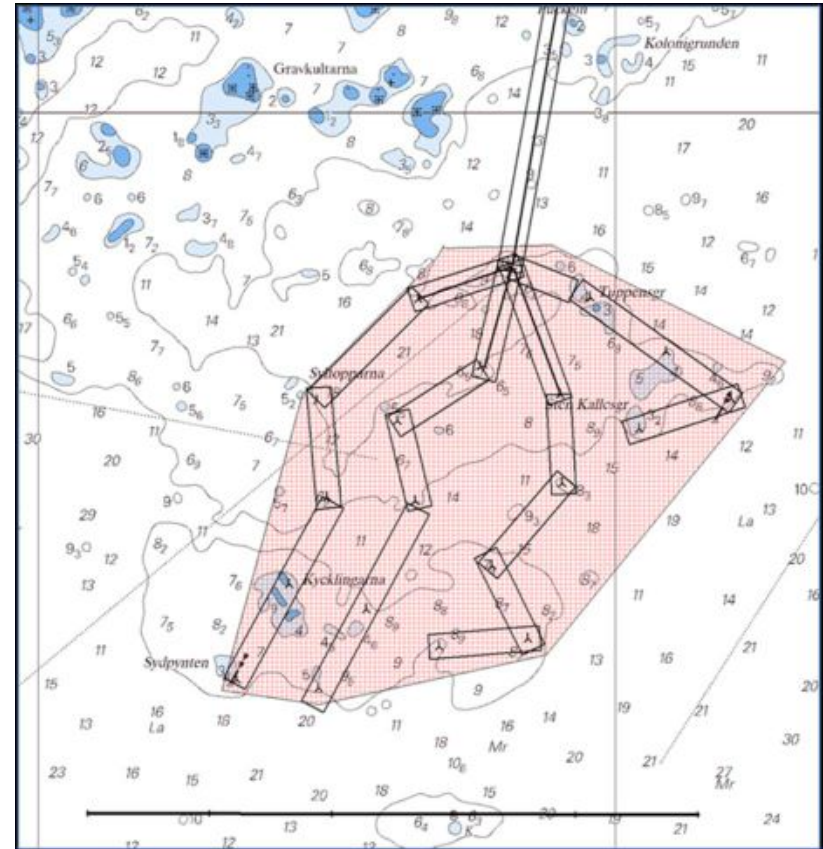




Area with restricted anchoring

Within the area where a windpower plant is operating, there will be restrictions for anchoring, to protect the cables.

ReWind Vänern has proposed that the same model as for work areas could be used, so that not all of the 11,5 km² area will have anchoring restrictions, but only the areas along cable routes, which will minimize impacts on fisheries.





Impacts on bird life

- There are no bird habitats far offshore
- The windpower plant could have some impact on *migrating* birds
- The main concern is impacts on "red-listed", i.e. protected bird species.





Investigations of birds

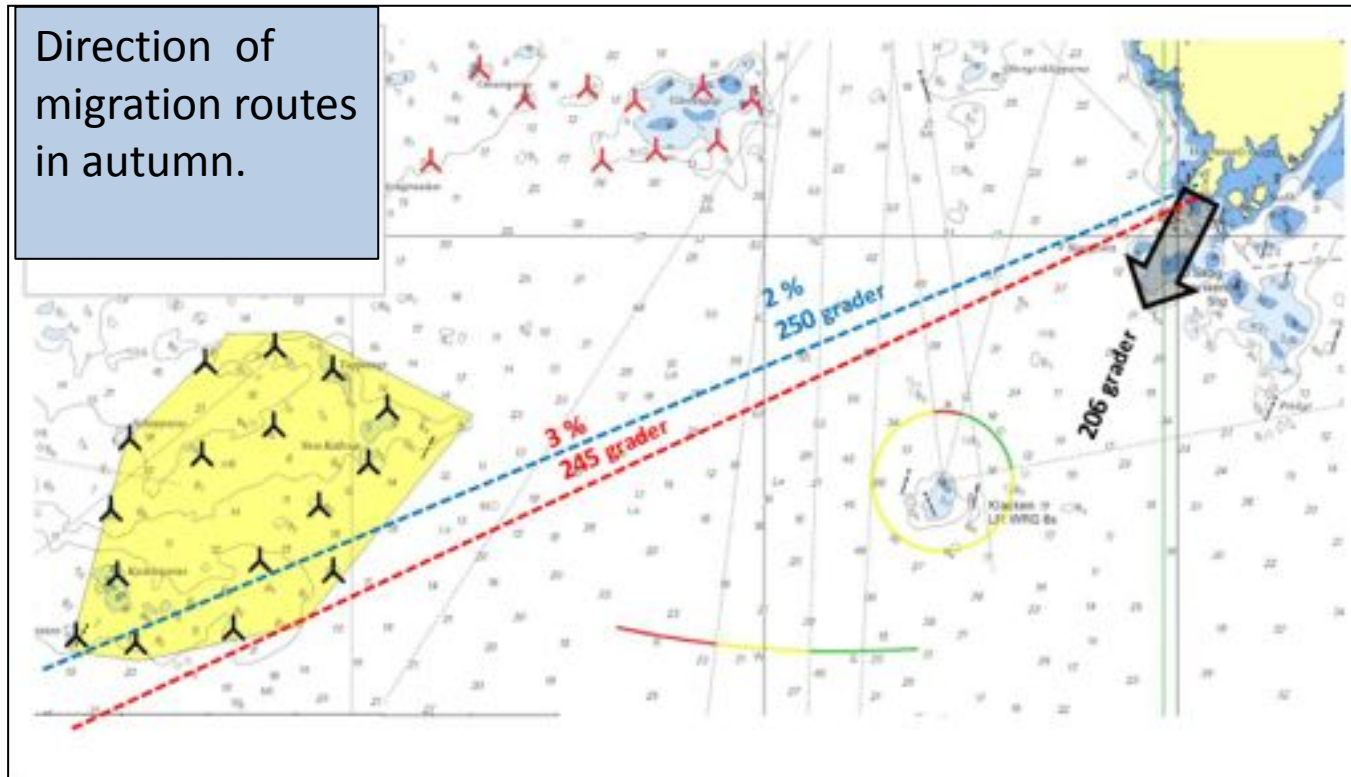


Migrating birds were observed from Hammarö in the autumns 2006 och 2007. Observations were made almost daily from August to early November. This was made for the EIA for Vindpark Vänern. These data were then reanalysed for the project at Stenkalles grund.



Direction of migration routes

Direction of migration routes in autumn.

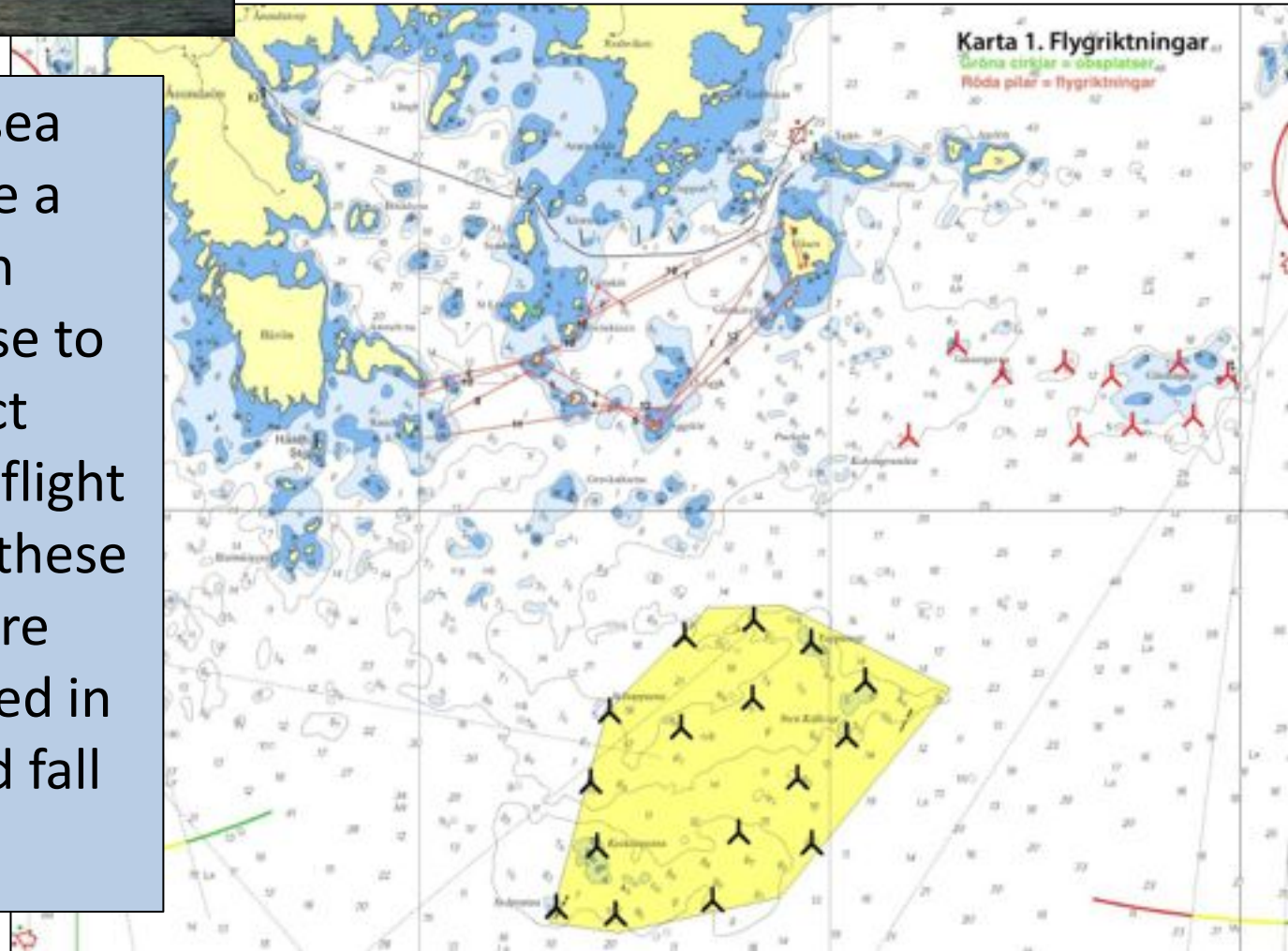


The average direction of migrating birds is 206 degrees. Only 3 % of the birds take a route west of 245 degrees, and would pass over or through the windpower plant.



Sea eagle

A pair of sea eagle have a nest on an island close to the project area. The flight routes of these eagles were investigated in spring and fall 2012.





Bats



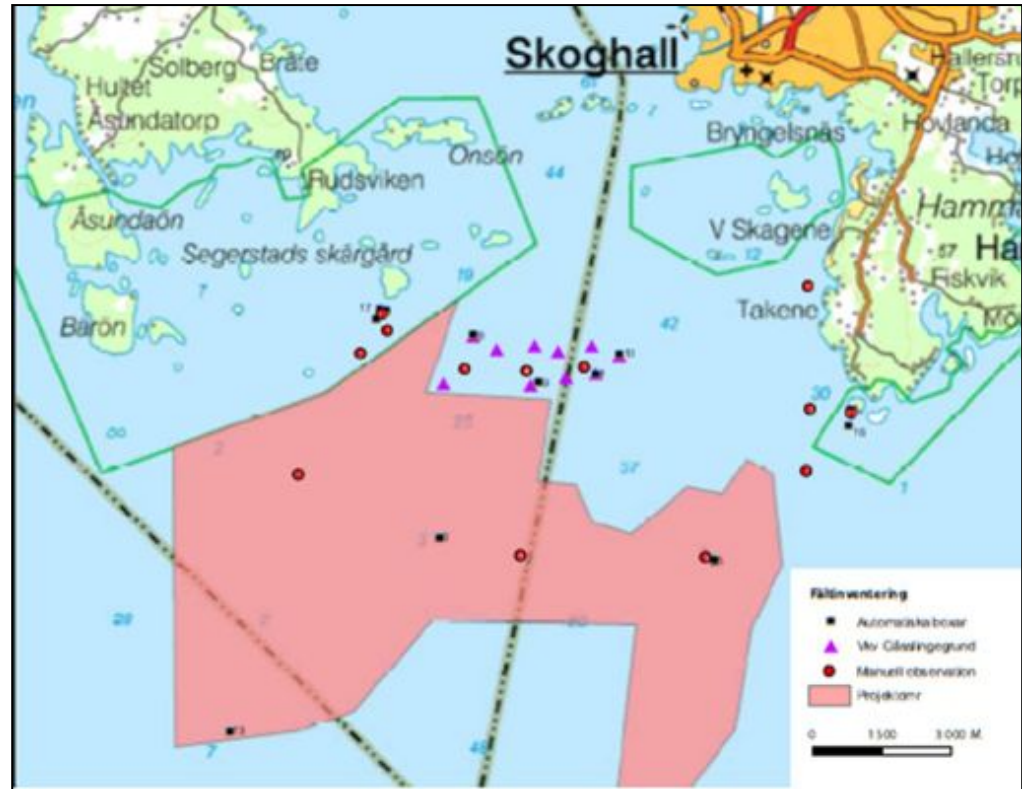


Observation of bats

The investigation showed that there is some bat activity at sea, but that it is far less than at the coasts.

At the point closest to the Rewind offshore project, only two observations (recordings) were made, both of Nordic bat. This species is not endangered in Sweden.

No indications of migration routes within the area were observed.



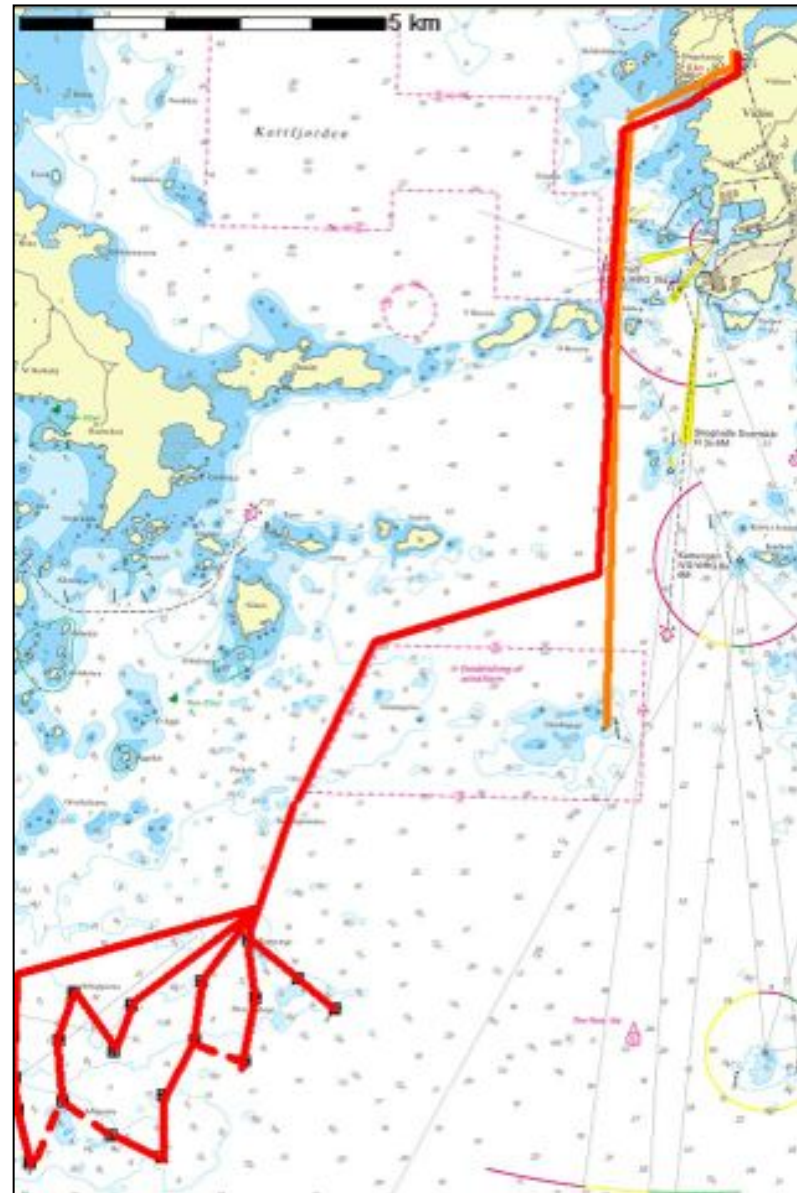
Observations of bats in northwestern part of lake Vänern. Black boxes: automatic registrations, red circles: manual observations.



Cable routes:

Preliminary route to land from Stenkalles grund (red line)

Existing cable from Vindpark Vänern (orange line)

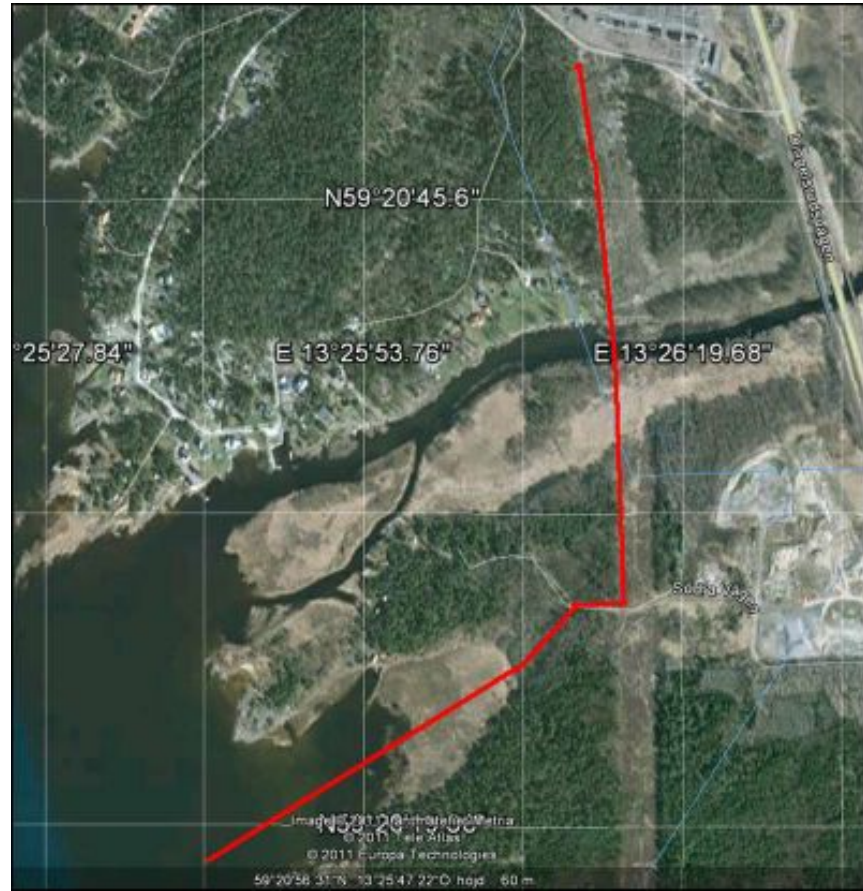




Cable connection to land and power grid

The cable will be installed at least 70 cm below ground level.

The area on land is a so called Natura 2000 area. This is an EU-classification to protect valuable nature areas. Some extra investigations have to be made to get permission to exploit such areas.





Power line



Gravel road

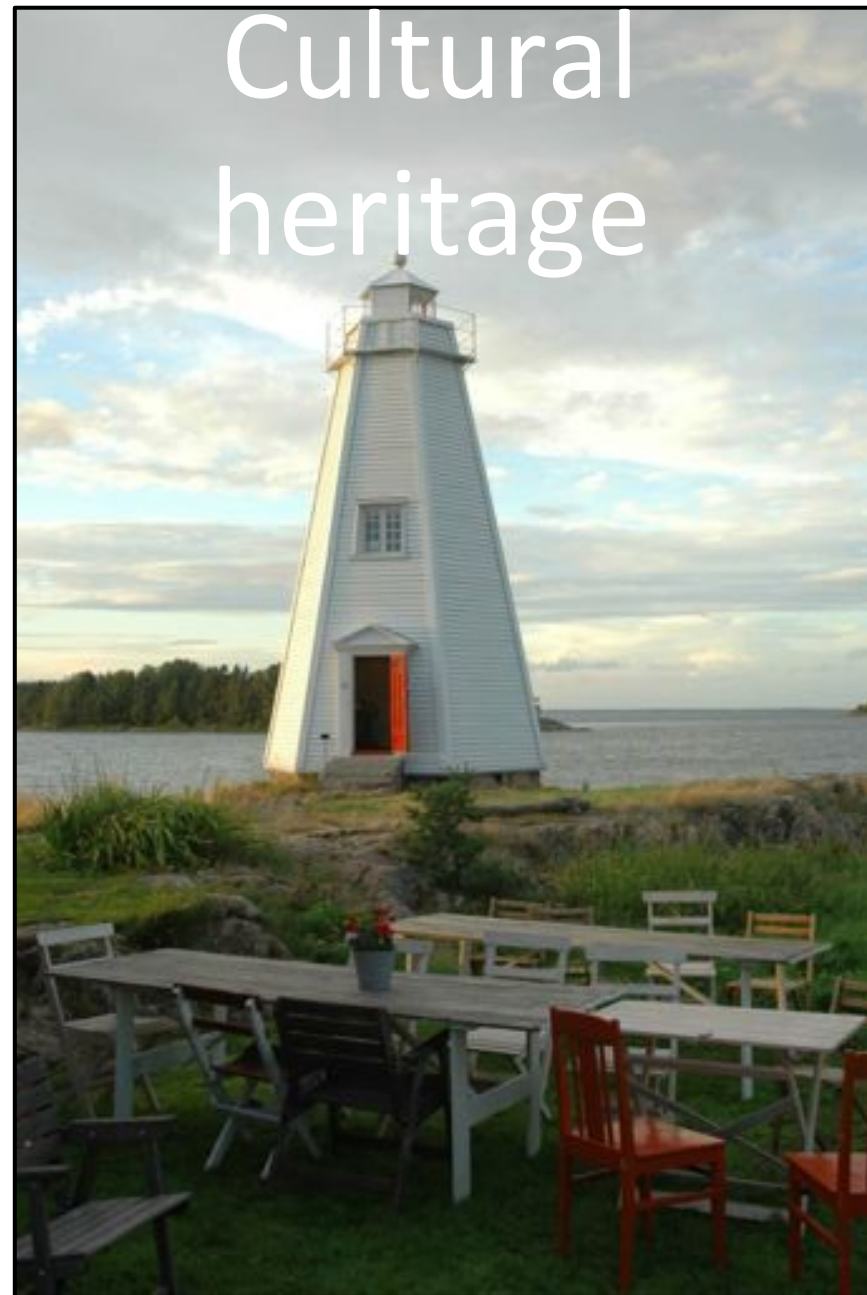


Power line. Cable will be installed along the forest edge, minimum 70 cm below ground and connected to the transformer station.



The coastal area around the Lake is an old cultural district.

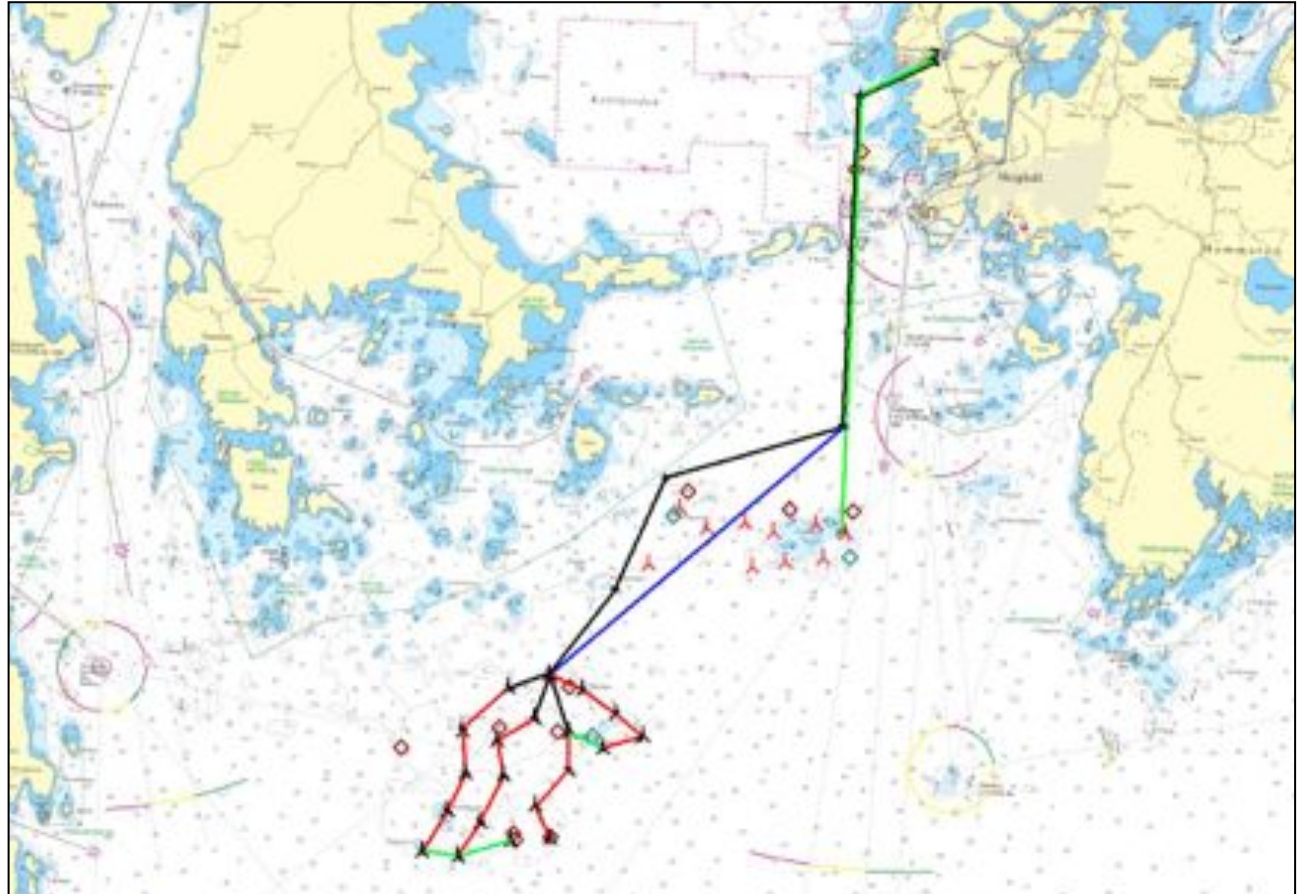
In the coastal area and Islands around the planned windpower plant there are about 150 registered ancient remains on land from the iron age and later. On the bottom of the lake there are many wrecks.





Wreck indications

Wreck indications according to Swedish Maritime Museums are shown with blue symbols, indications from Bohuslän's museum are shown with brown symbols.



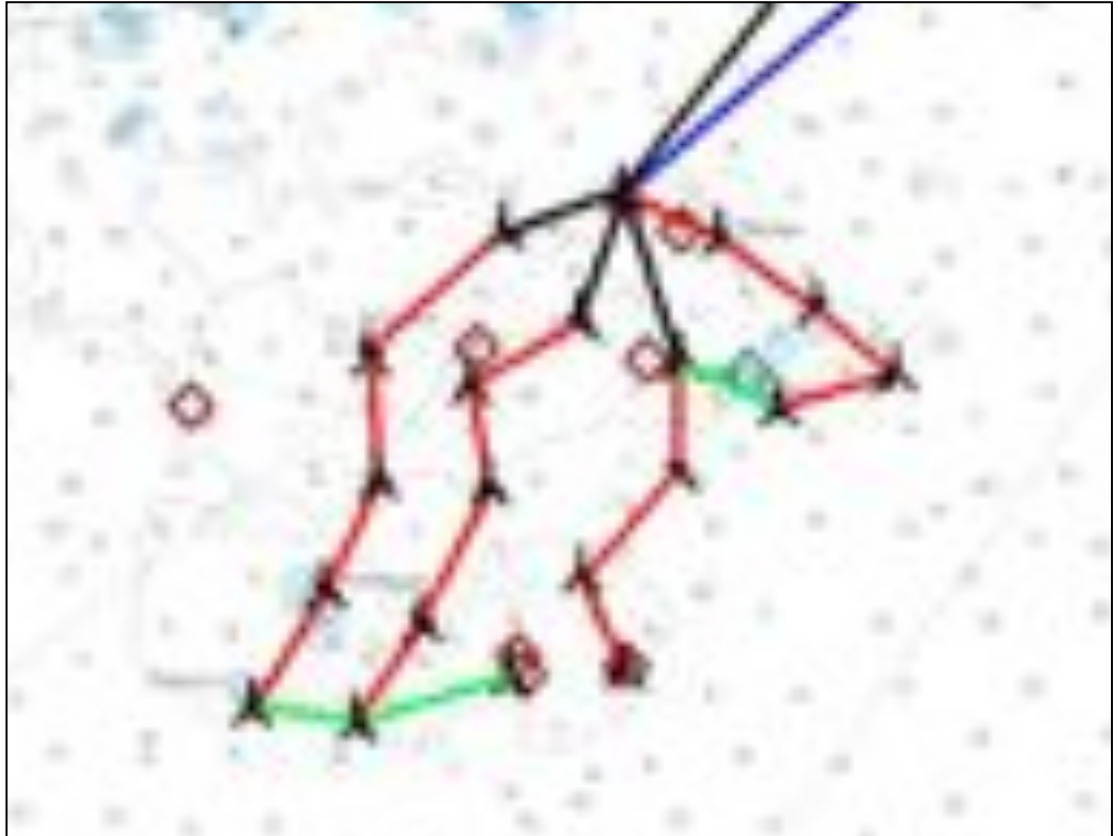


Mitigating measures

All marine archeological remains have been mapped.

Wind turbines and cables will be installed so that these remains are avoided.

The **work area** will have a buffer zone of min 100 m to the indicated remains.



Conclusion

Impacts on wrecks and other marine archeological remains can be avoided.



Sound and shadows

Sound :Wind turbines emit sound to the air as well as to the water. The greatest impact occurs during the building phase.

Shadows: In sunny weather the rotors of wind turbines create moving shadows (flicker). The distance between the wind turbines and land is however so big that neither noise nor shadows can reach land.



Sound propagation

Calculations have been made for:

1. Windpower plant at Stenkalles grund

20 wind turbines

Hub height 100 m

Sound effect 107,5 dBA.

2. Vindpark Vänern

3. Stenkalle + Vindpark Vänern

total sound emission from both windpower plants

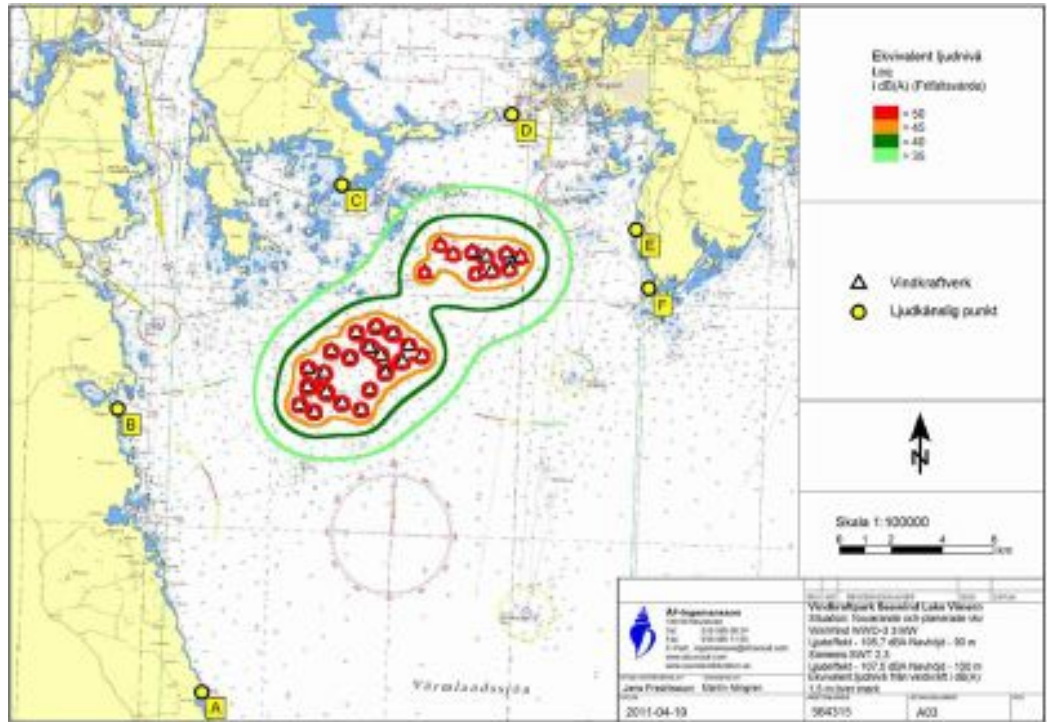
Calculation model: Nord2000



Sound immission on land

Conclusion

For all dwellings and noise sensitive areas the sound immission falls well below the recommended value of 40 dBA.



Beräknings- punkt	X (m)	Y (m)	Ekvivalent ljudnivå [Situation] _{Leq} (dBA)		
			VPV	SK	VPV+ SK
A - Örö Kl fritidsomr/småbåtshamn	397497	6553633	11	13	15
B - Gäddevik fritidsomr/småbåtshamn	394120	6564542	14	20	21
C - Arnäs udde	402666	6573299	26	23	28
D - Ö Korsön	409209	6576087	25	18	26
E - Takene, Hammarön bostad	414070	6571700	25	15	26
F - Hammarö Skage - Bostäder	414589	6569433	24	16	25



Obstruction lights

Light sources

Light sources adapt the intensity (lumen) to the surrounding light,

In the nighttime the obstruction lights will hardly be visible from land.

Lågintensiva hinderljus



Art.nr: OL1VBH34LED2



Art.nr: L75SA-R-AC-32

Medelintensiva hinderljus



Art.nr: L450-63B-F(-G)

Högintensiva hinderljus



Art.nr: L1000-xxx



Art.nr: L500-63B-B

INKOM, Industrikomponenter AB

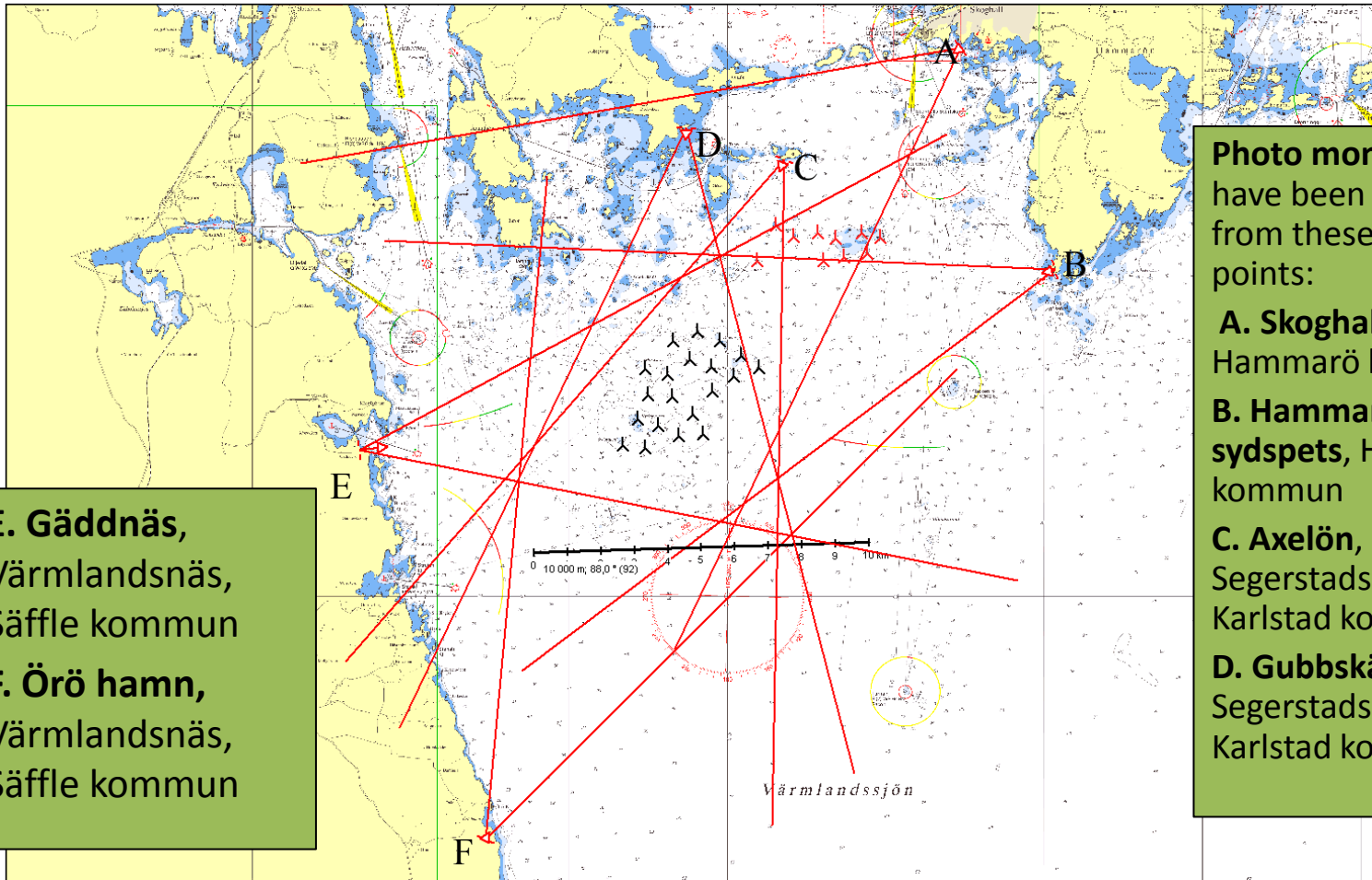


Visual impact





Visualisations



E. Gäddnäs,
Värmlandsnäs,
Säffle kommun
F. Örö hamn,
Värmlandsnäs,
Säffle kommun

Photo montages
have been made
from these view
points:

A. Skoghall,
Hammarö kommun

**B. Hammarö
sydspets,** Hammarö
kommun

C. Axelön,
Segerstads skärgård,
Karlstad kommun

D. Gubbskären,
Segerstads skärgård,
Karlstad kommun

Hammarö sydspets

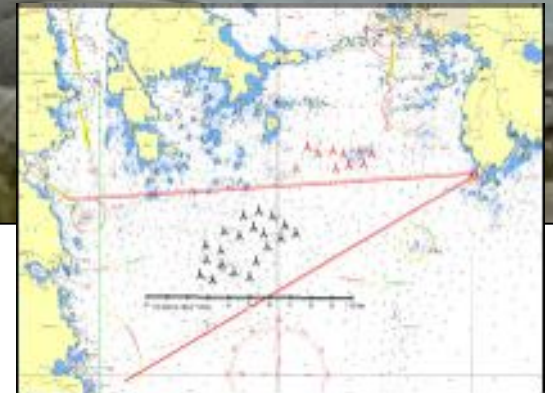


Fotomontage:

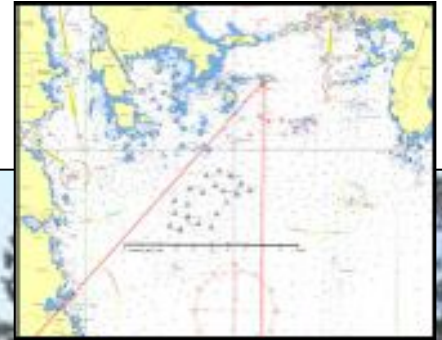
20 st G128 wind turbines

120 m hub height

128 m rotor diameter



Axelön



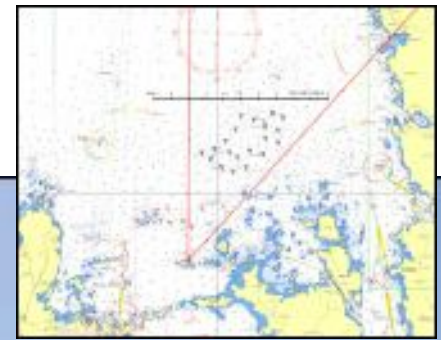
Fotomontage:

20 st G128

120 m hub height

128 m rotor diameter

Axelön



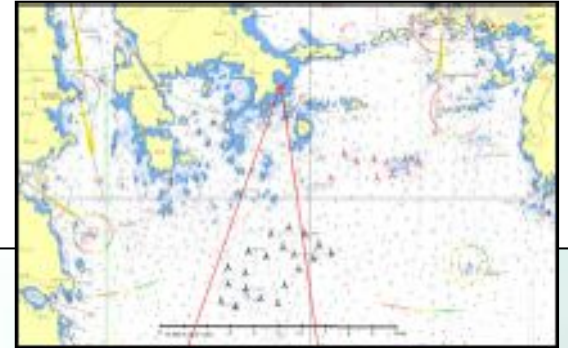
Fotomontage:

20 st G128

120 m hub height

128 m rotor diameter

Gubbskären



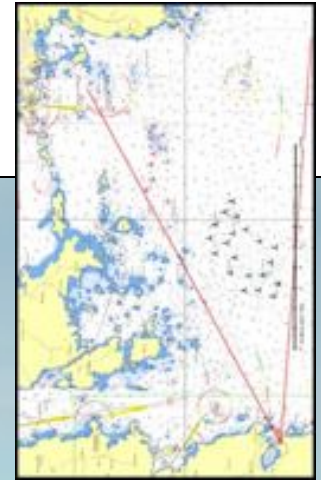
Fotomontage:

20 st G128

120 m hub height

128 m rotor diameter

Gäddnäs, Sjöfjärde



Fotomontage:

20 st G128

120 m hub height

128 m rotor diameter

Örö, Säftele



Fotomontage:

20 st G128

120 m hub height

128 m rotor diameter



Visibility zones

In the Danish report
Fremtidens Havvindmølleplaceringer 2025
the following zoning criteria are used for wind
turbines with total heights of 160 m and 187,5 m:

Total height	Near zone	Middle zone	Distant zone	Max visibility
160 m	0-11 km	11-25 km	>25 km	50 km
187,5 m	0-13 km	13-28 km	>28 km	53 km



Visibility zones, definitions

Near zone: Wind turbines are clearly visible.

Middle zone: Wind turbine towers and rotors blend and lose their shape and turbines seem to be far away.

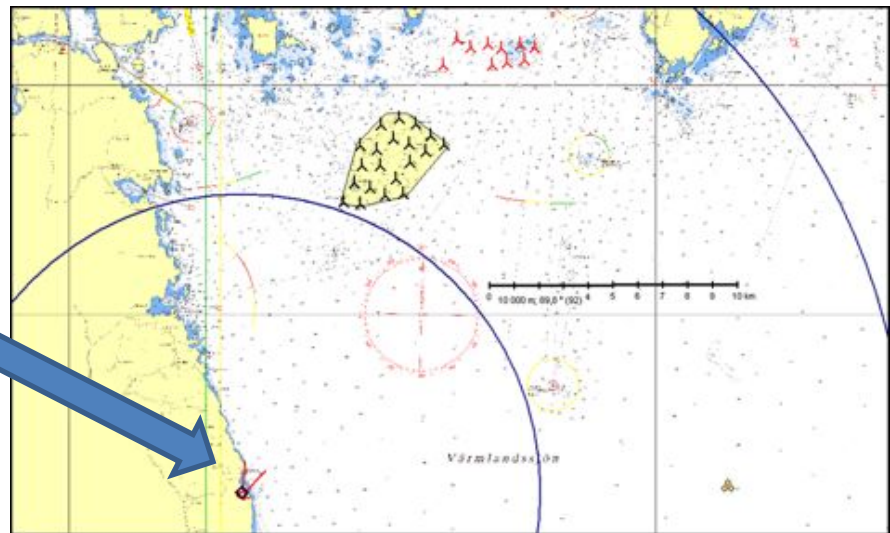
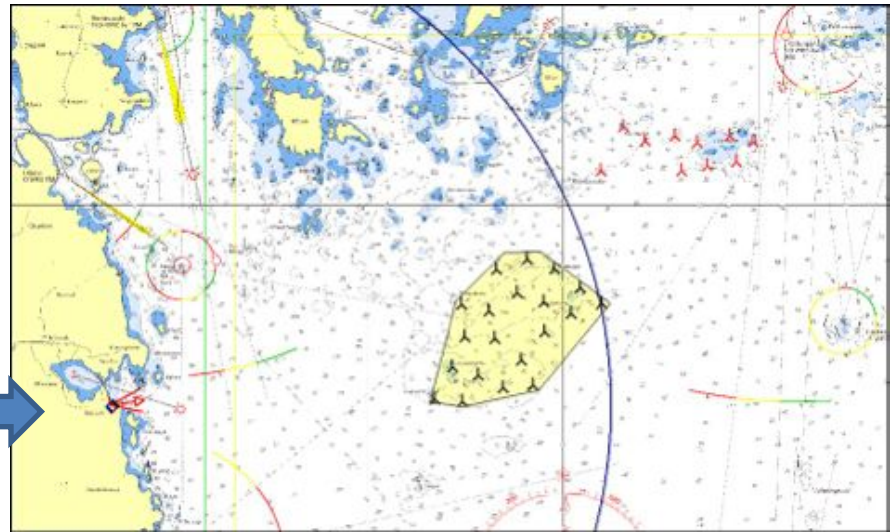
Distant zone: Hard to distinguish individual turbines and they partly disappear below the horizon. Impact on landscape is negligible.

Max visibility: A distance of 55 km is an upper limit for the visibility of wind turbines.

Gäddnäs, Örö, Sjöfjärde

From **Gäddnäs**, the wind turbines at Stenkalles grund will be in the near zone, and Vindpark Vänern in the middle zone.

From **Öröhamn** both Stenkalles grund and Vindpark Vänern are in the middle zone.



Conclusions on visibility



The visual impact from the windpower plant at Stenkalles grund will be less than from Vindpark Vänern.

The windpower plant at Stenkalles grund ***will be invisible during significant parts of the year*** from these view points, due to sight conditions, air humidity and long distances.



Environment policy

There are environment policy targets on several levels:

National (Parliament, government)

- 17 Environment quality targets
- Generation target

Regional (County administration)

- Environment quality norms
- Environment and Climate strategy

Local (Municipality)

- Policies for a sustainable municipality
- Environment and Climate strategy

ReWind has to prove that the proposed windpower plant promotes these policies



Environment impact

A windpower plant at Stenkalles grund will annually reduce emissions harmful for the environment with:

Carbon dioxide	186 000 ton
SOx	200 ton
NOx	160 ton
Dust	22 ton
Ashes	1444 ton

A windpower plant at Stenkalles grund will thus have a **significant positive impact** on the environment

This will promote all national, regional and local environment policies

Thank you

