Spatial and temporal variability of marine life: importance for understanding of ecosystem spatial organisation

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TALK OUTLINE

- importance of small spatial scales in detection of marine values;

- temporal variability – what it may tell about spatial connectivity?

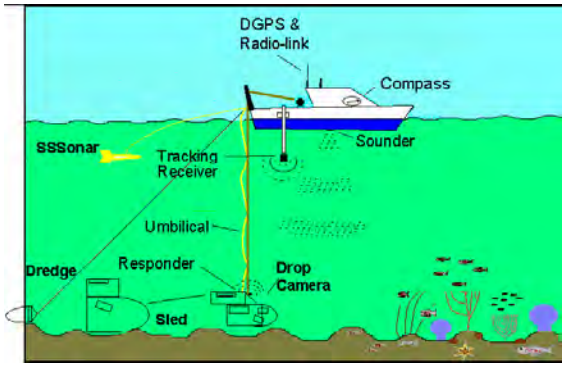
- large scale movements of marine birds – importance of a broader regional context in understanding of marine values;

- complex interactions in marine fauna and their reflection in spatial distribution of protected species.

GEOREFERNCED DATA AND MAPS

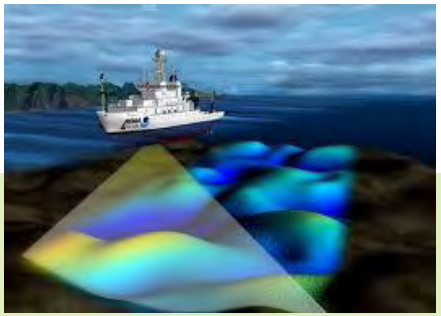
Distribution maps are the most important sources of information for MSP

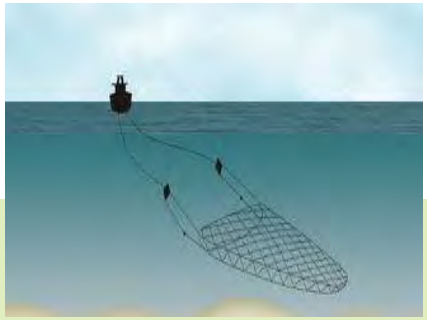
Numerous techniques to produce spatial data: point samplings, transects, polygon data, consecutive point records – satellite tracking, interpolations, modeling, etc.

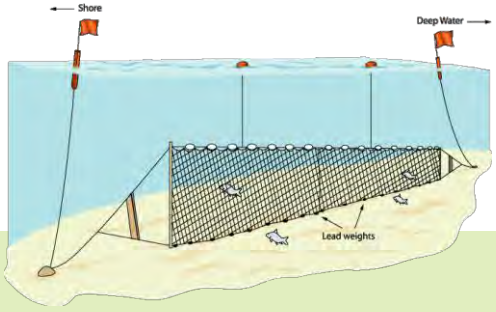


Source: *Review of standards and protocols for seabed habitat mapping, 2005*

Although mapping techniques have been considerably improved (acoustic methods, satellite and radio telemetry, underwater observation laboratories etc.), spatial resolution and temporal variability of attributes in the maps are still of crucial importance.





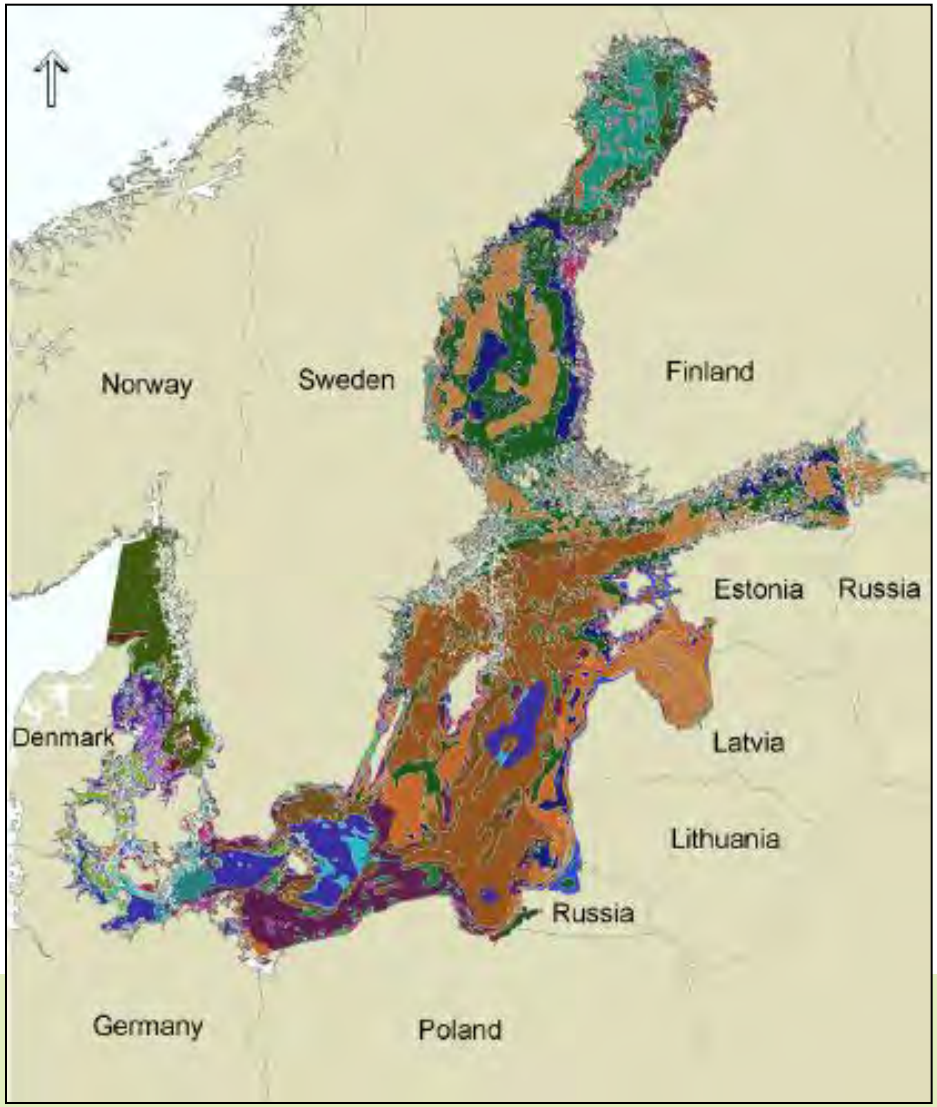


MARINE LANDSCAPES OF THE BALTIC SEA (2007)

A total of 60 benthic marine landscapes were identified based on sediment composition, light regime and bottom salinity regime

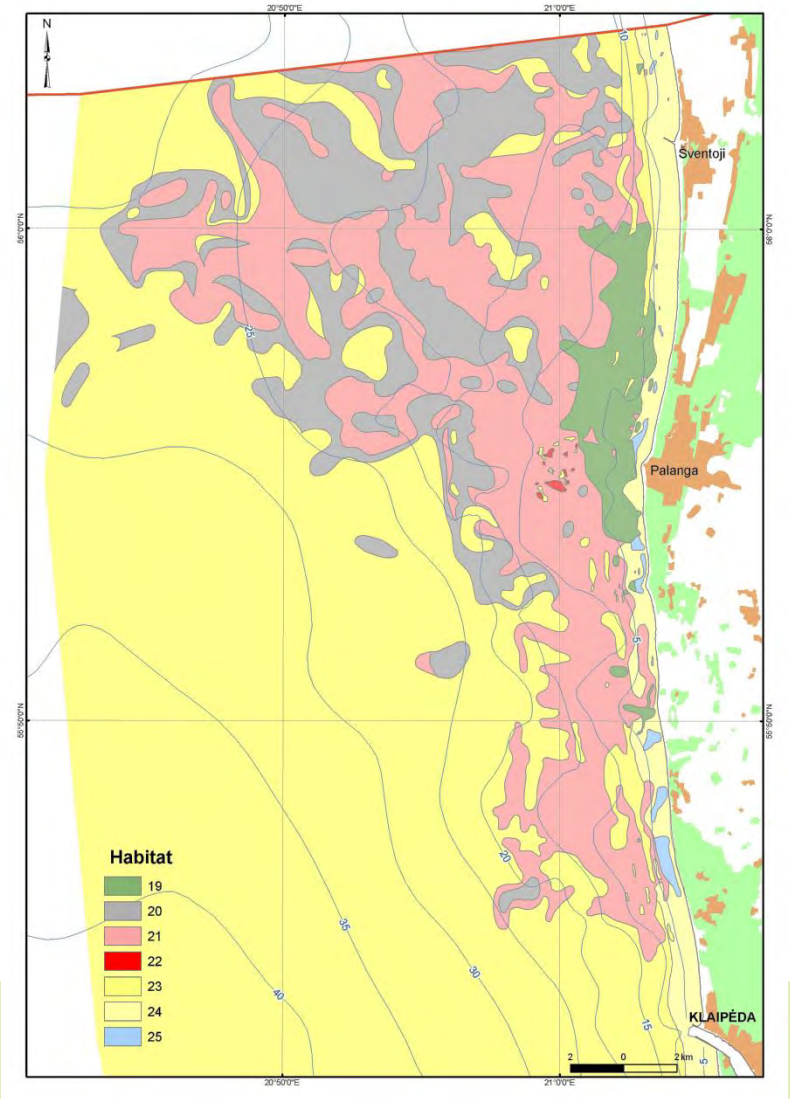
The most common marine landscape present - non-photic mud with a salinity regime of 7.5-11 psu, (app. 14.3% of the seabed within the Baltic Sea).

Out of the 60 benthic marine landscapes **40 covered less than 1% (and 12 cover between 1-2%) of the total seabed area**, while the remaining 8 cover approx. 90.7% of the Baltic Sea seabed.



From: Al-Hamdani et al., 2007: Geological Survey of Denmark and Greenland Bulletin 13, 61–64.

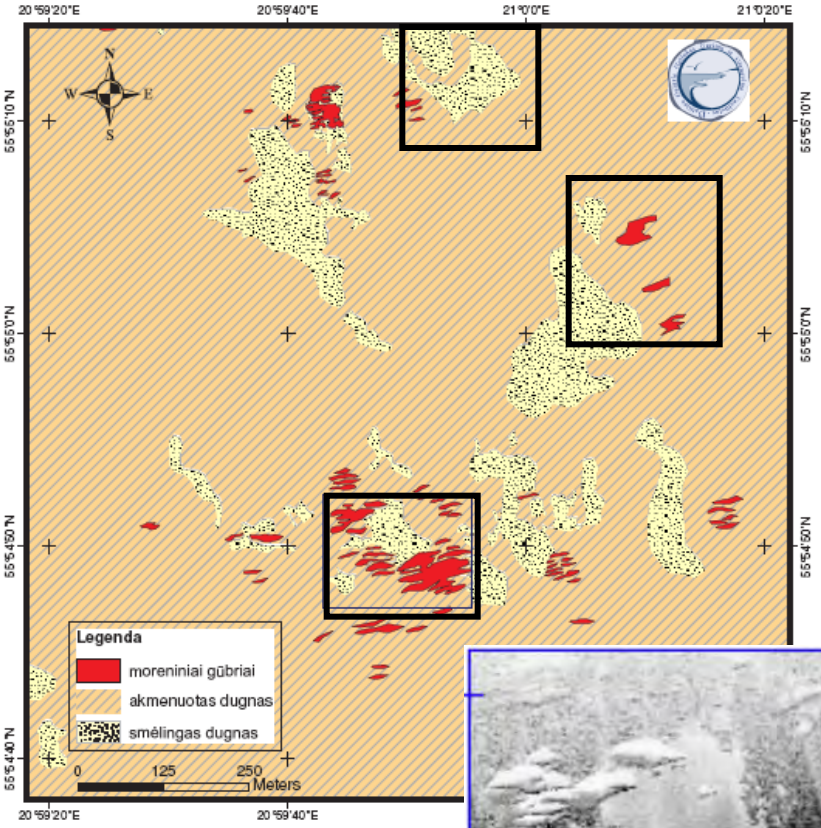
Habitat map for the Lithuanian teritorial sea along the mainland coast

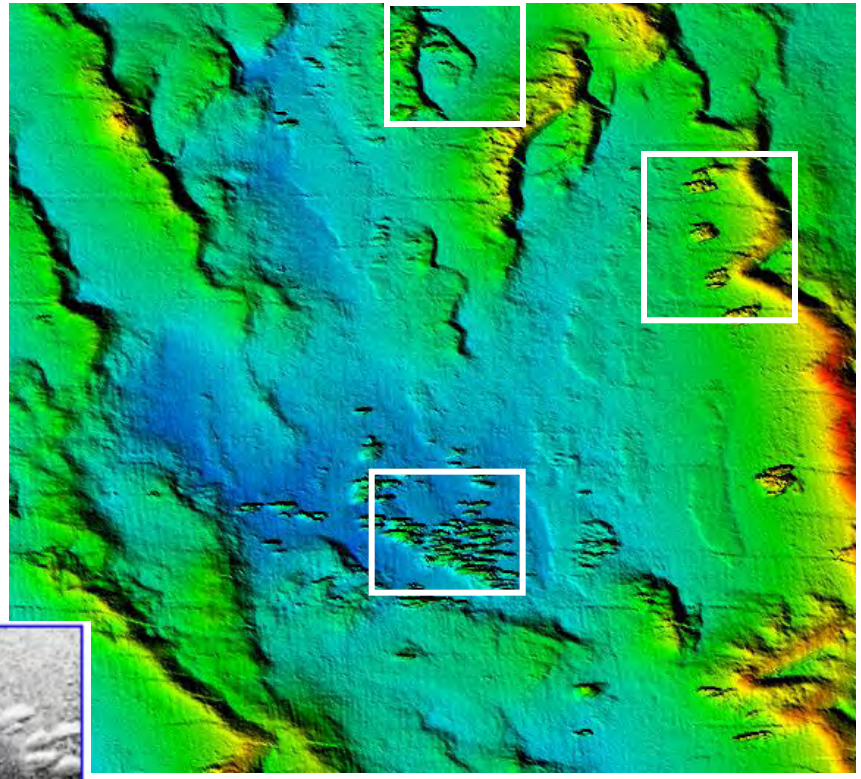


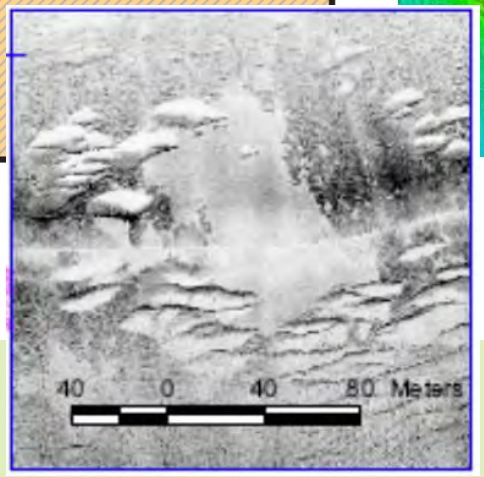
Habitat	Area, km²	%
19: Hard bottoms with perrenial red algae *Furcellaria lumbricalis*	23,4	1,3
20: Gravel bottoms with barnacles *Balanus improvisus*	107,6	5,8
21: Hard bottoms with mussels *M. edulis* and barnacles *B. improvisus*	174,9	9,5
22: Moraine ridges with mussels *M. edulis*	0,4	<0,1
23: Fine sand with *Macoma balthica*	1457,7	78,8
24: Fine sand with polychaetes *Marenzelleria neglecta* and *Pygospio elegans*	82,4	4,5
25: Mixed bottoms dominated by mobile amphipods	3,8	0,2
TOTAL:	830,35	

Total area of reefs: 198,8 km² (10,8%)
The most valuable reef area: 23,9 km² (1,3%)

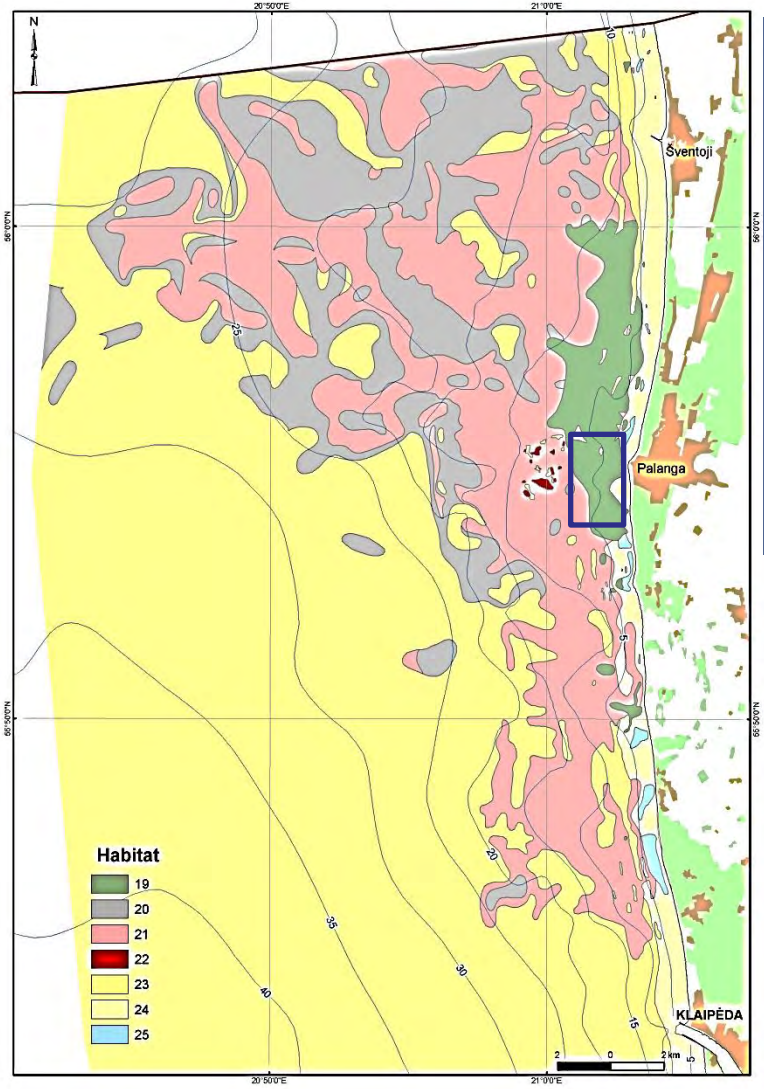
Moraine ridges: side-scan and multibeam maps (2 x 2 km)



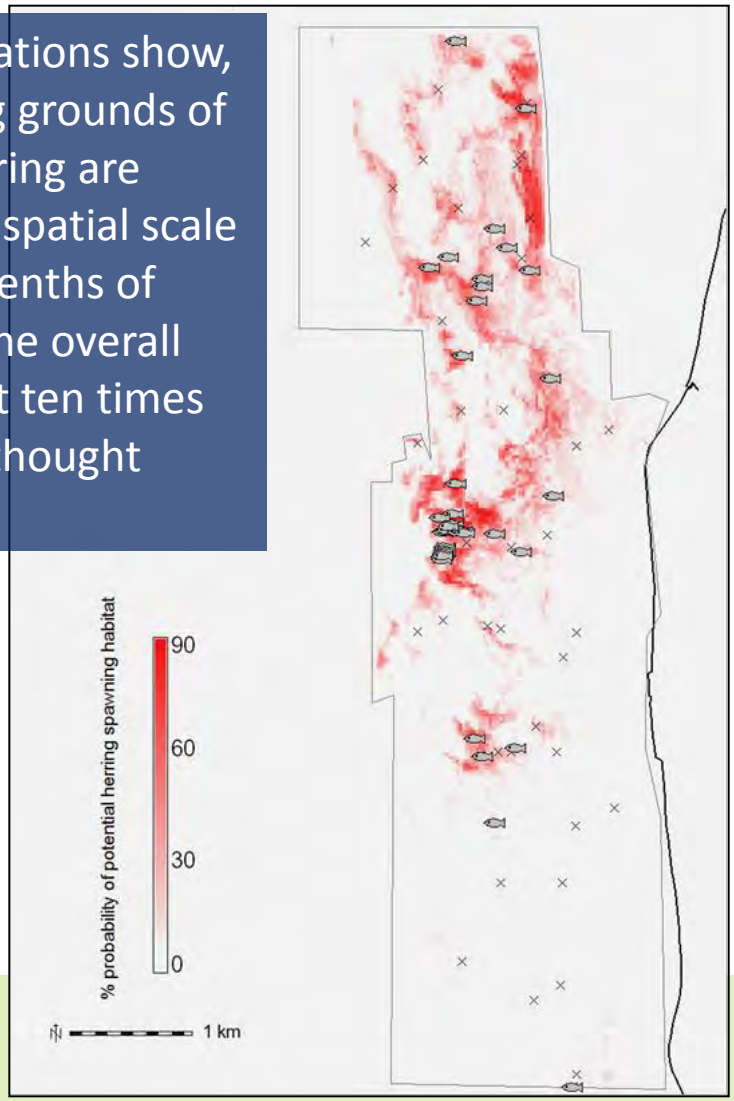




Herring spawning grounds in the Lithuanian coastal waters



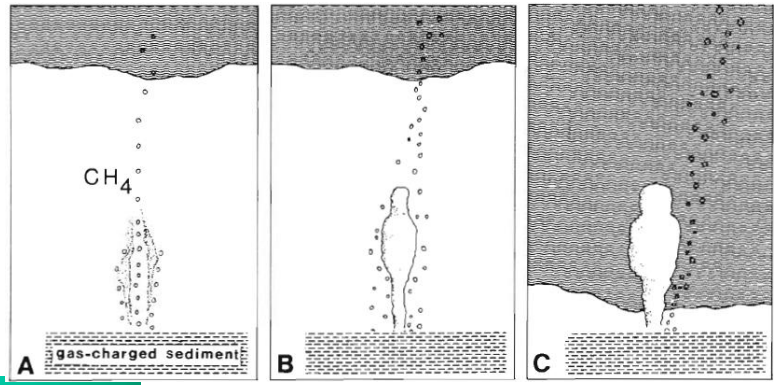
In situ observations show, that spawning grounds of the Baltic herring are distributed in spatial scale of meters to tenths of meters, and the overall area is at least ten times smaller then thought previously.



Bubbling reefs - up to 100 m^2 structures consisting of arches, complex formations and pillars up to 4m high, approx. 40 sites in Danish waters

From: Jensen et al., 1992: MEPS, 83: 103-112.

- originate from microbial decomposition of plant material deposited approx. 100 to 125 thous. years B.P.

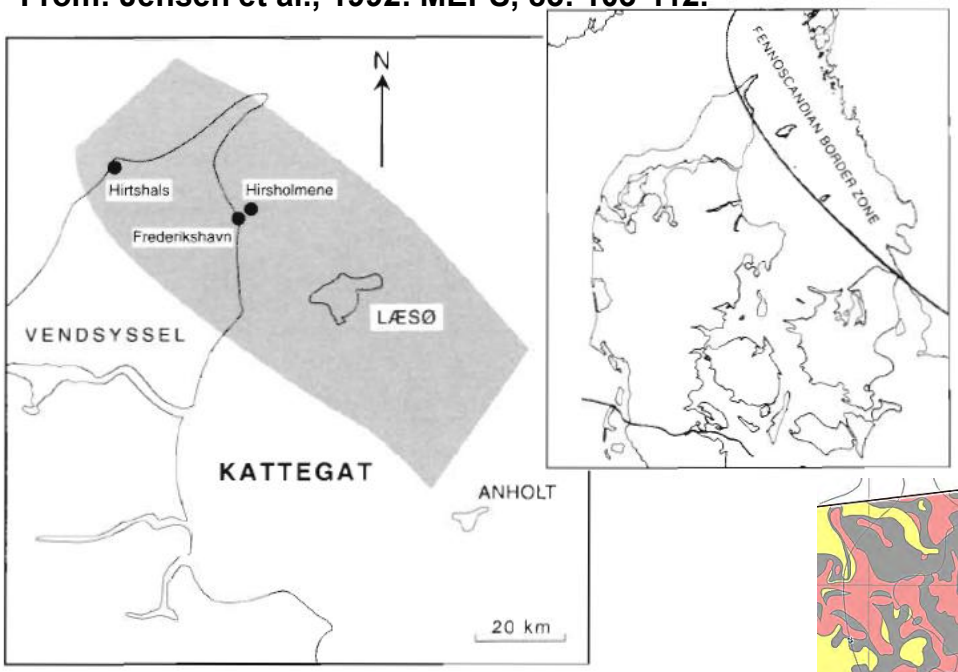


- when surrounding sand was later washed away by changing currents, the solidified sandstone structures were exposed as a sculpture garden.

- methane gas seeps up through the sandy seabed and during its oxidation by aerobic microbes the loose sand in the upper layers is turned into carbonate cemented sandstone structures.

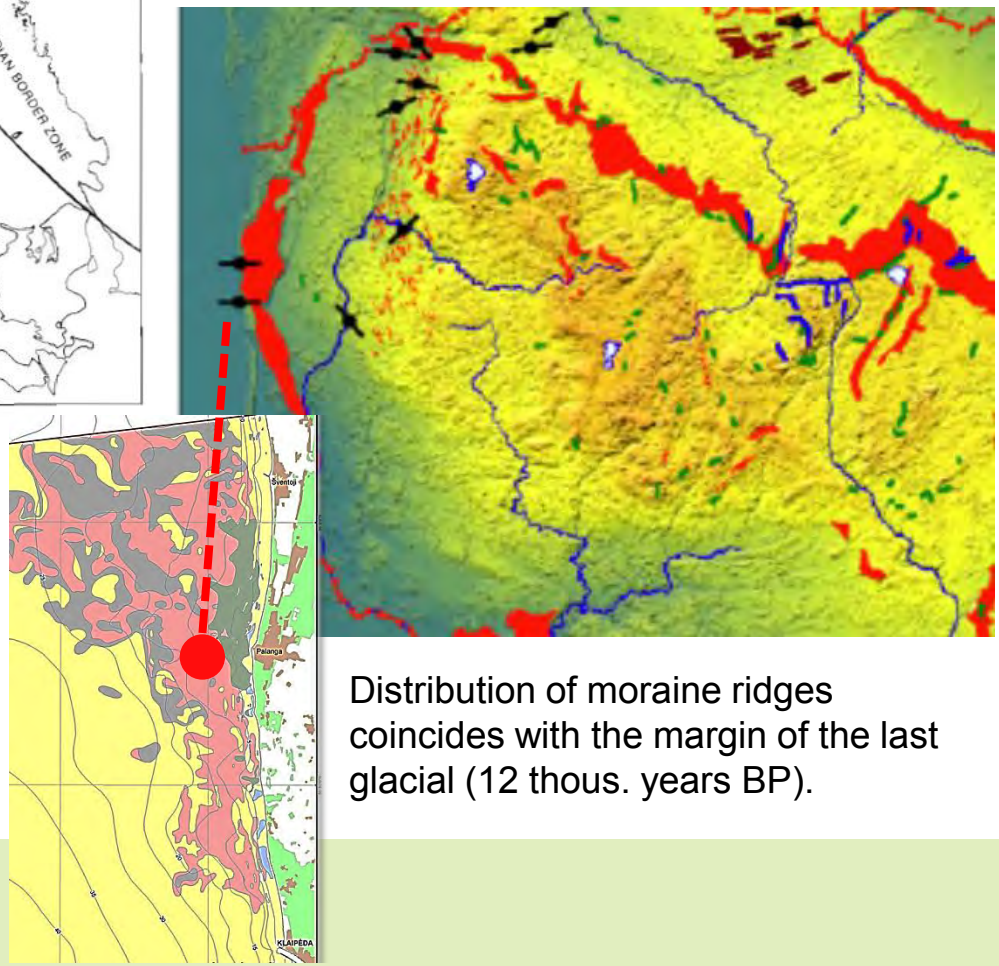
Geological history can be of crucial importance for discovery of at least some small-scale features

From: Jensen et al., 1992: MEPS, 83: 103-112.



Distribution of 'bubbling reefs' and gas wells (shaded area) follow a NW-SE direction along the border of Fennoscandian Shield of Norway, Sweden, Finland (over 3.1 billion years old).

From: Guobytė (2003). Lithuanian Geological Survey Activity Report, 53 p.



Distribution of moraine ridges coincides with the margin of the last glacial (12 thous. years BP).

Twait Shad (*Osmerus eperlanus*) dynamics in the Baltic Sea

Two individuals of twait shad fighting over a baby smelt (Jeroen Verhoeff, Wildlife Images, 70 x 35 cm – acrylics on panel – 2009 – sold)

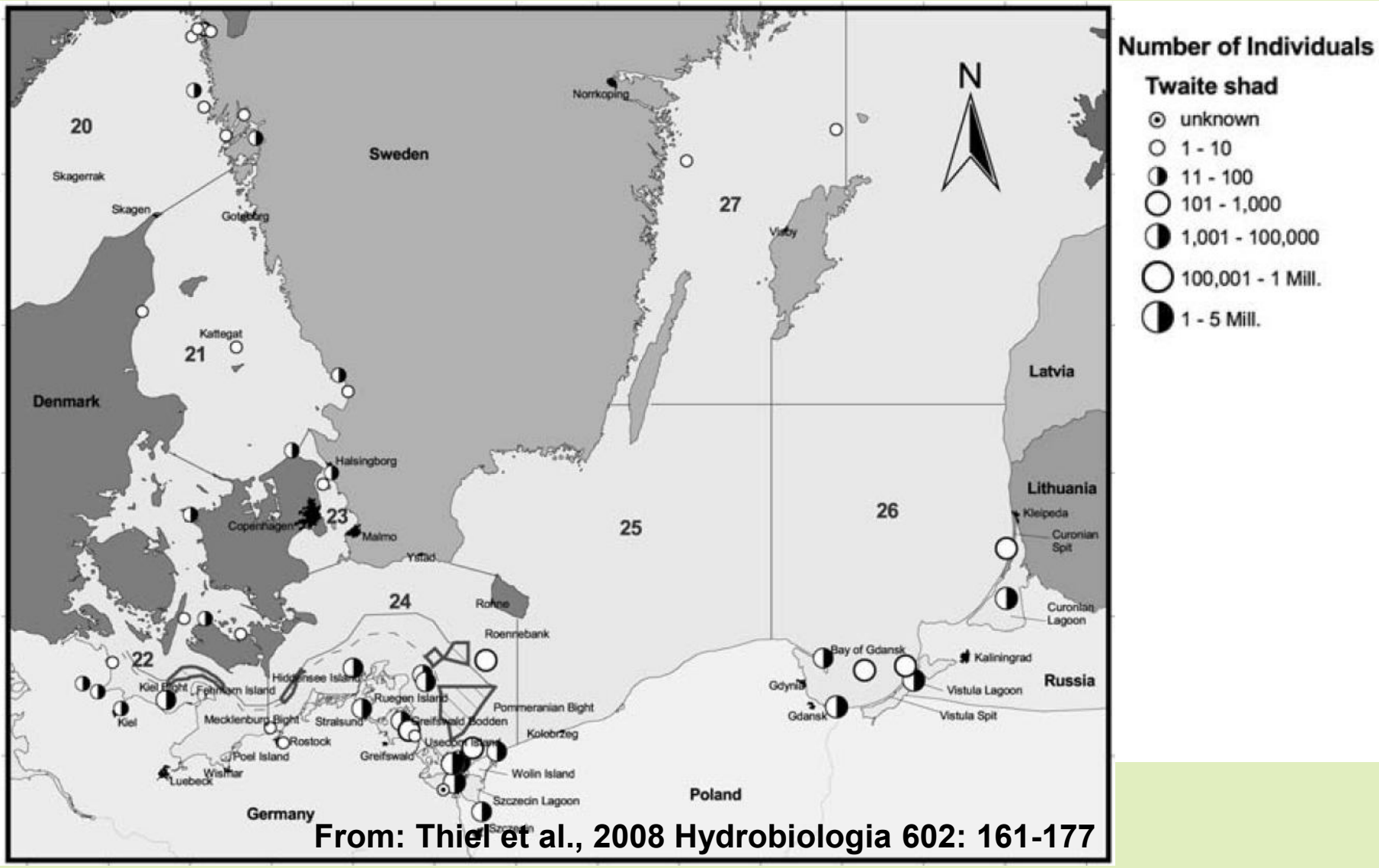
- common in a number of Baltic and other European waters about 100 years ago (Quignard & Douchment,1991a)

- highly vulnerable in population size an distribution (higher population size left in few rivers in France and Elbe River during 1980s)

- Bern Convention (Appendix III)
- EC Habitats Directive (Annexes II, V)

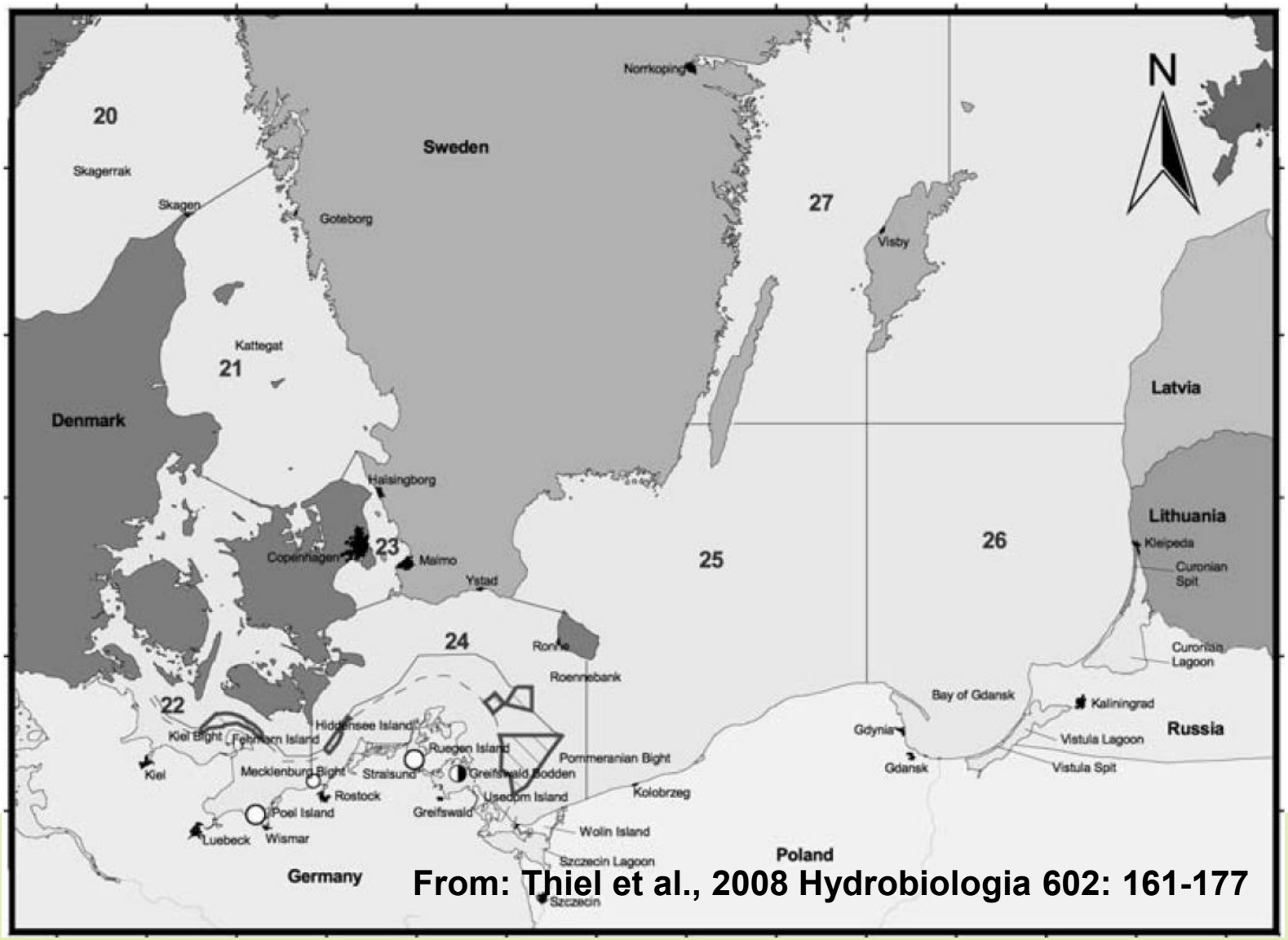
- obligation of EU members to assess numbers and exploitation of the populations and to designate special areas for conservation to safeguard populations.

Distribution of Twait Shad in the Baltic Sea until 1959



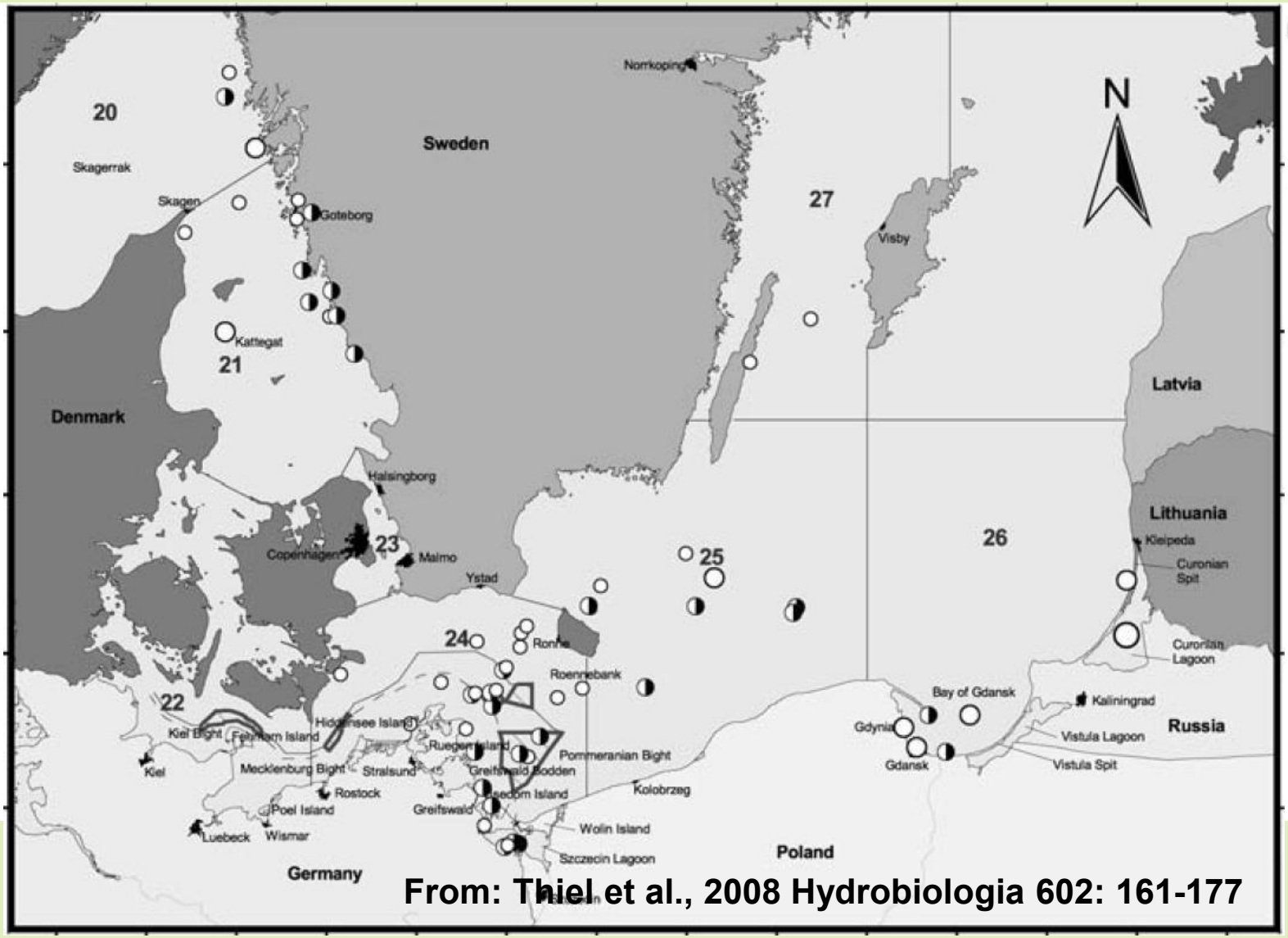
From: Thiel et al., 2008 Hydrobiologia 602: 161-177

Distribution of Twait Shad in the Baltic Sea in the period of 1960-1989



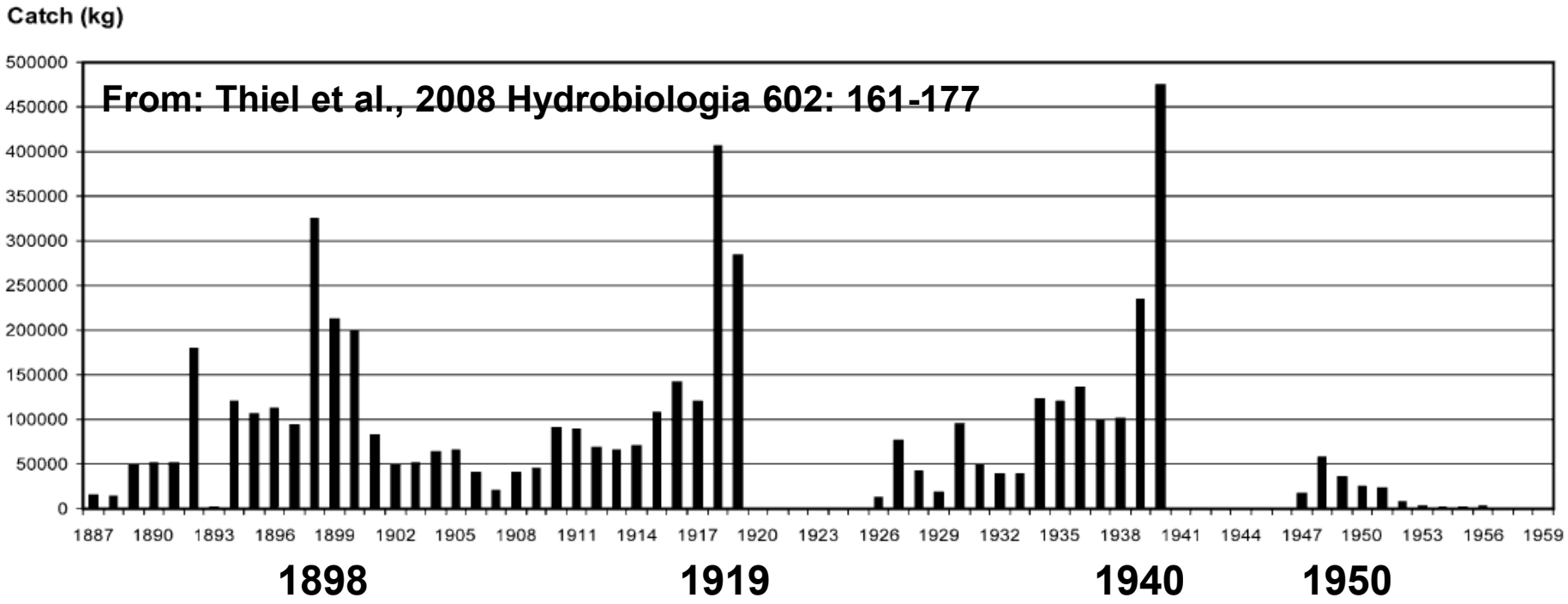
From: Thiel et al., 2008 Hydrobiologia 602: 161-177

Distribution of Twait Shad in the Baltic Sea in the period of 1990-2005



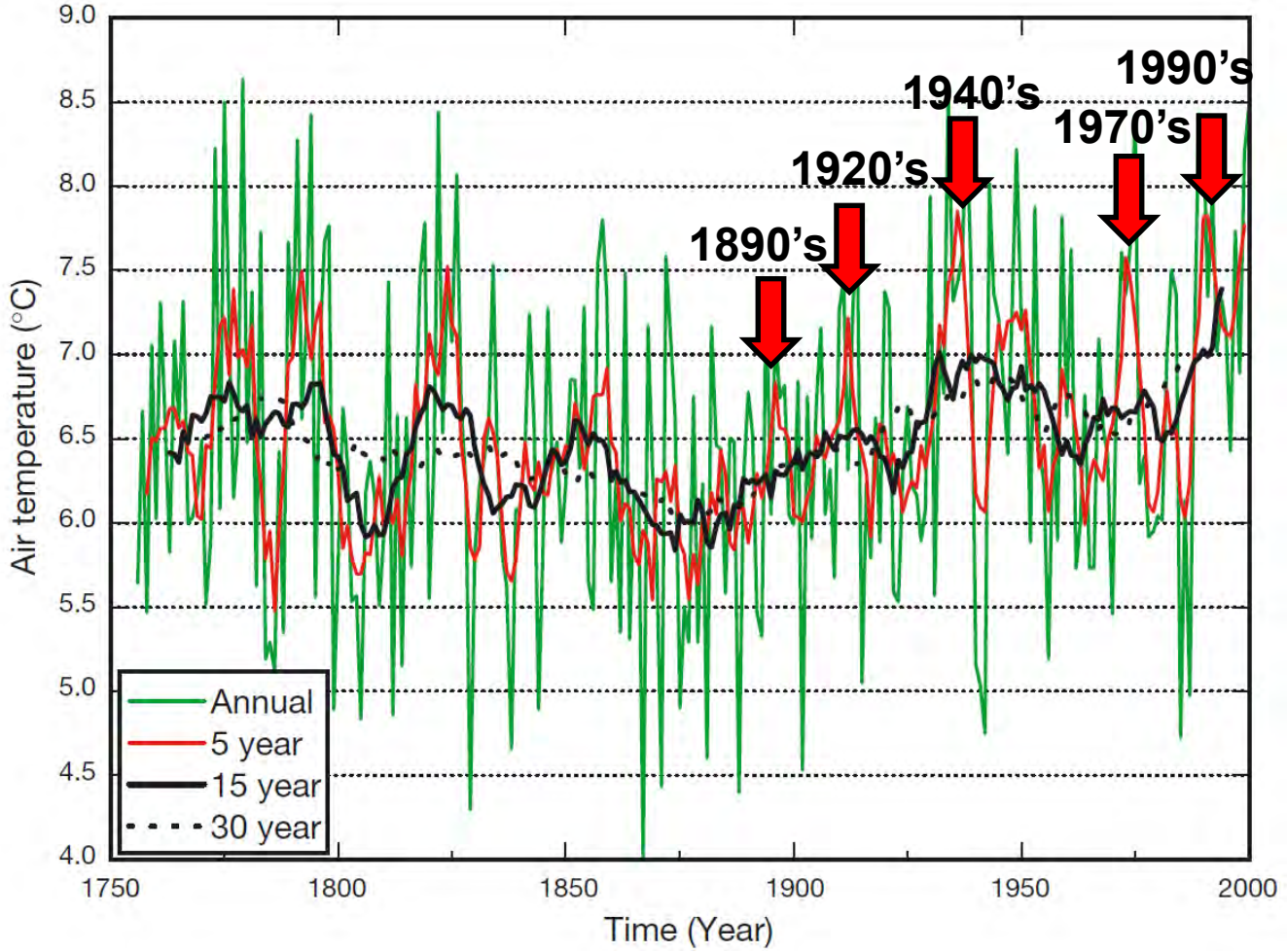
From: Thiel et al., 2008 Hydrobiologia 602: 161-177

Total landings of twaite shad in the southern Baltic Sea (1887-1959)



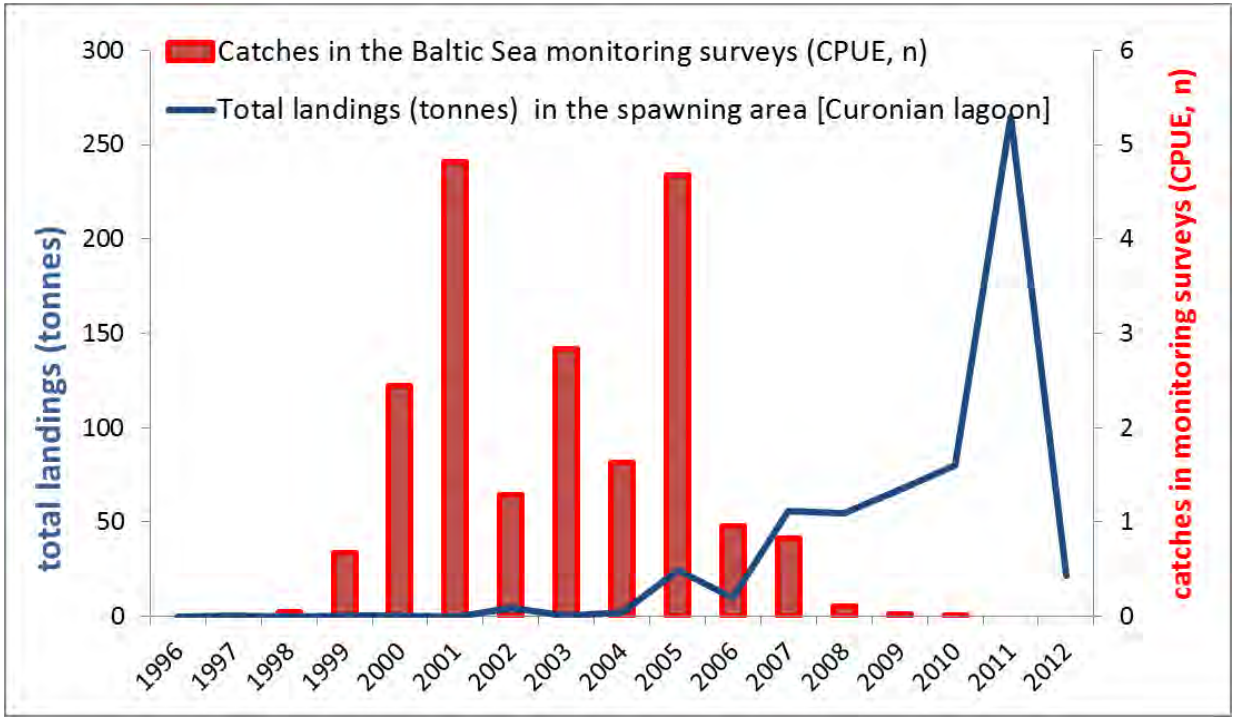
Approx. 20-years cycles – result of changing annual mean surface air temperatures

Averaged air temperatures from the Stockholm record (running means)



From: Omstedt et al., 2004: Climate Research, 25: 2005-2016

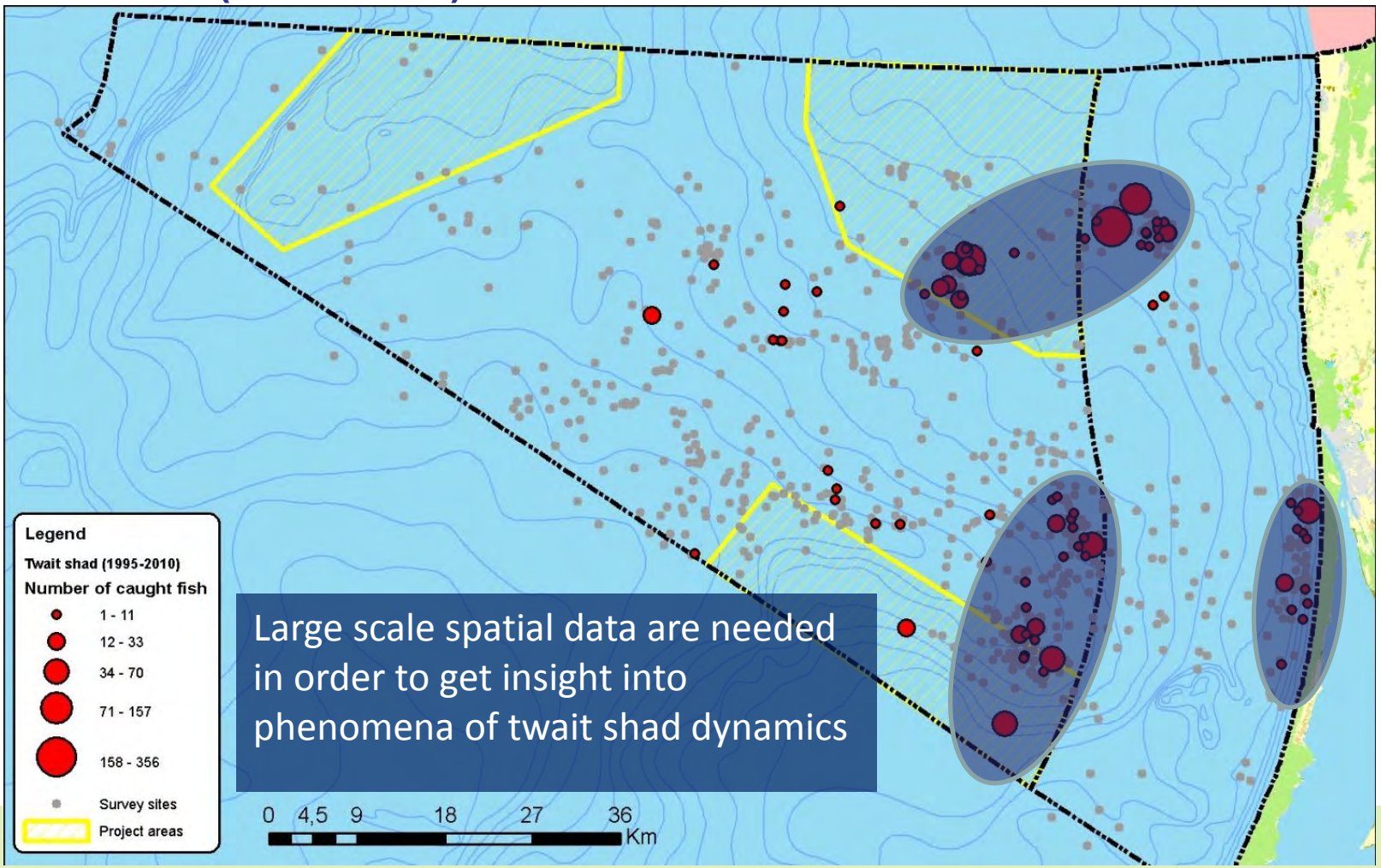
TWAIT SHAD DYNAMICS IN THE SOUTH-EASTERN BALTIC (1995-2010)



Unpublished monitoring data, Fishery Service under the Ministry of Agriculture of the Republic of Lithuania

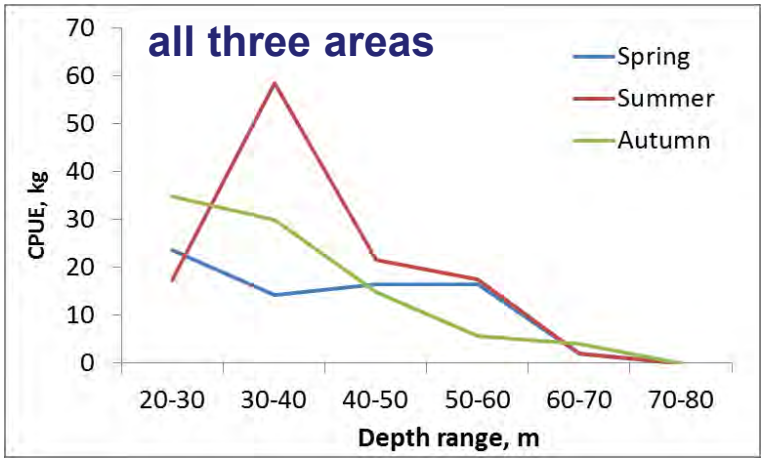
Major part of landings in the spawning area were recorded five years after the species disappeared from monitoring catches – this demonstrates that there is little known on important species areas in the south-eastern Baltic Sea

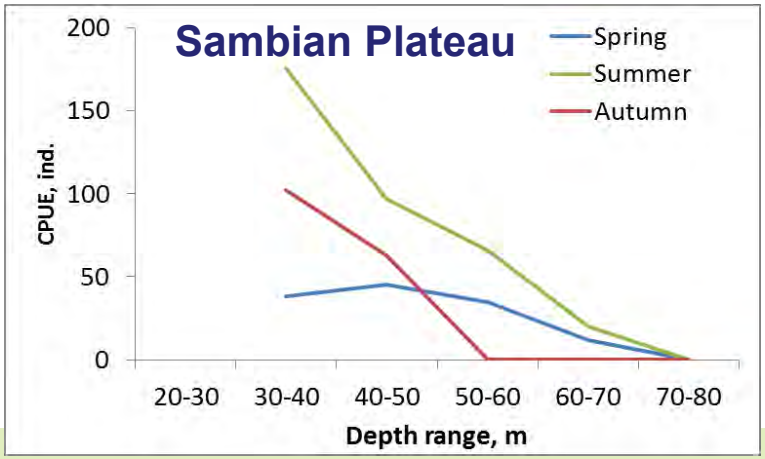
DISTRIBUTION OF TWAIT SHAD CATCHES IN THE LITHUANIAN WATERS (1995-2010)

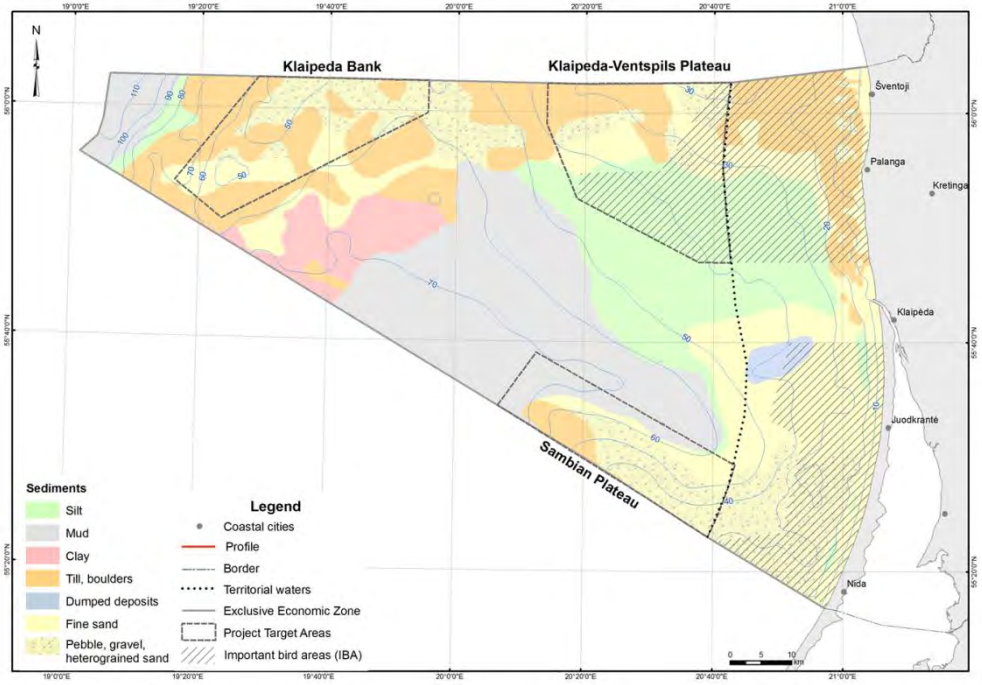


Unpublished monitoring data from Fishery Service under the Ministry of Agriculture of the Republic of Lithuania

DISTRIBUTION AND SEASONAL CHANGES OF FISH CATCHES AT THREE BANKS IN THE LITHUANIAN WATERS





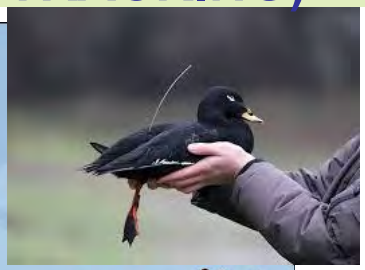


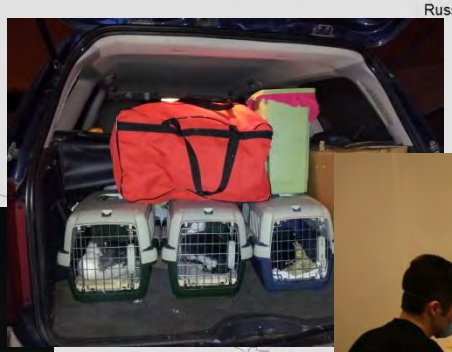
Data on fish migration along the underwater slope may provide important information on seasonal importance of 30-40 m depth range (just below thermocline) during summer months

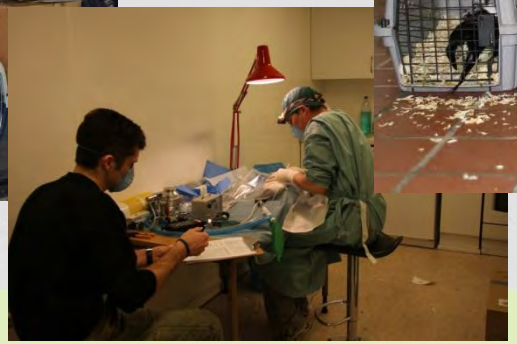
MIGRATIONS OF WINTERING BIRDS (SATELLITE TRACKING)

Velvet Scoters (*Melanitta fusca*)
12 individuals (2012-2013)

Red-throated Divers (*Gavia stellata*)
6 individuals (2012-2013)







MIGRATIONS OF WINTERING BIRDS (SATELLITE TRACKING)

Red-throated Diver (*Gavia stellata*): ID112113
19 March 2012 – 16 February 2013

2012/09/11 – 09/24

2012/05/09 –05/18

2012/08/24 – 09/10

2012/05/20 – 08/23

2012/04/24 – 05/07

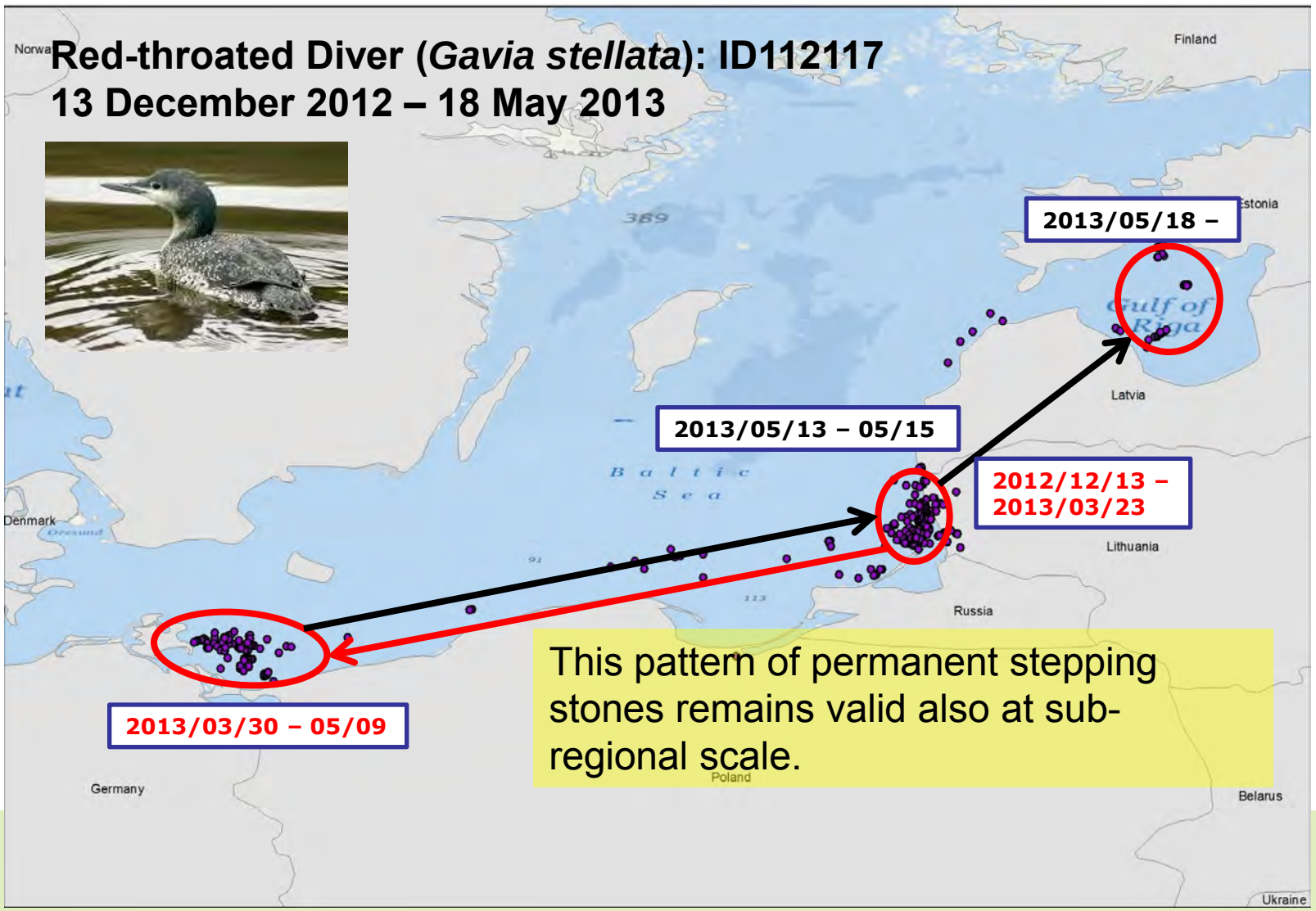
2012/09/28 – 11/30

2012/03/19 – 04/23

2012/12/02 – 2013/02/16

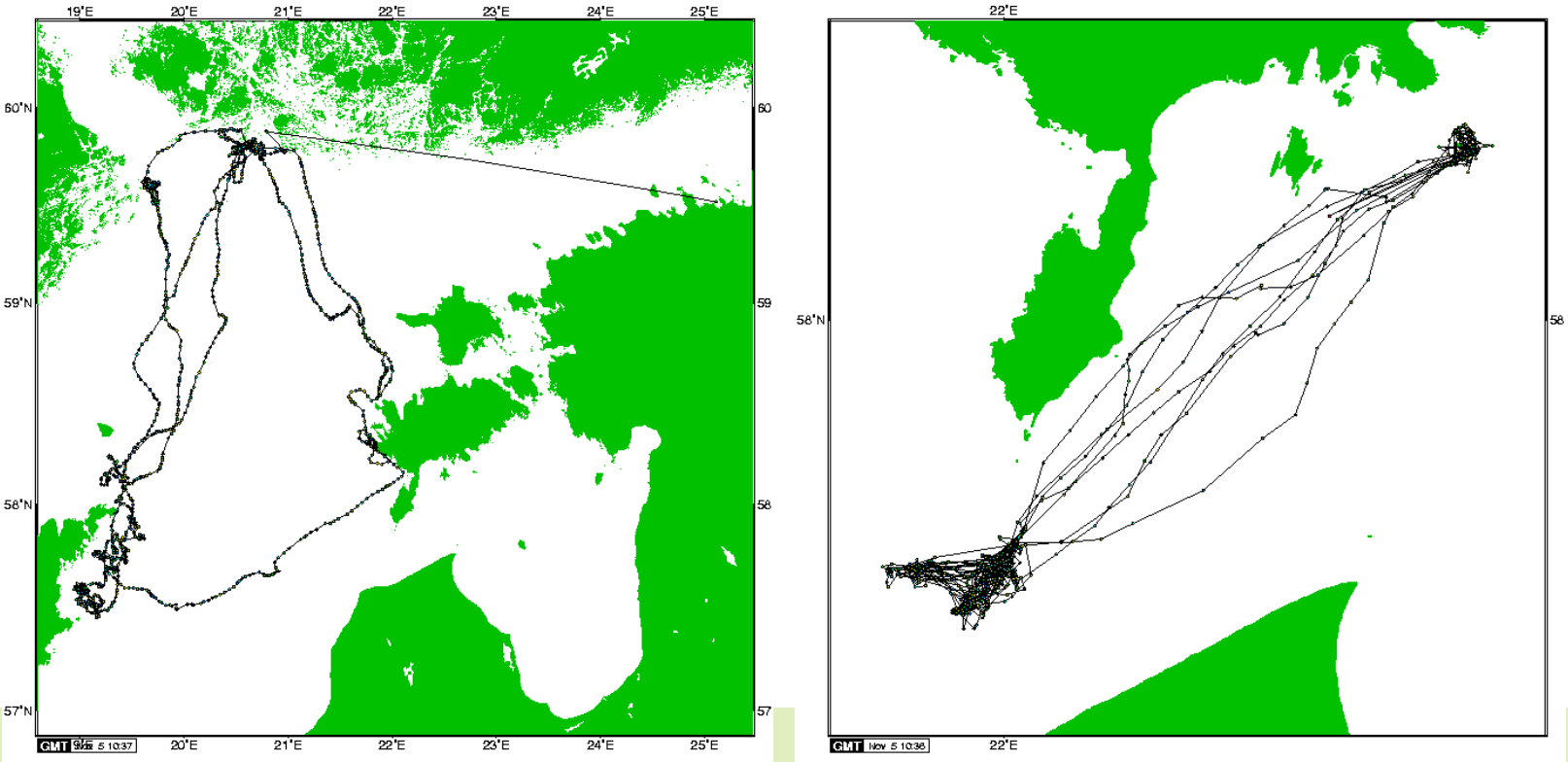
There is a regular large-scale movement of marine life across regions. Although its timing is climate dependent, migration route and stepping stones used during travel remain constant.

MIGRATIONS OF WINTERING BIRDS (SATELLITE TRACKING)



MIGRATION ROUTES OF GREY SEALS IN THE NORTHERN BALTIC (SATELLITE TRACKING)

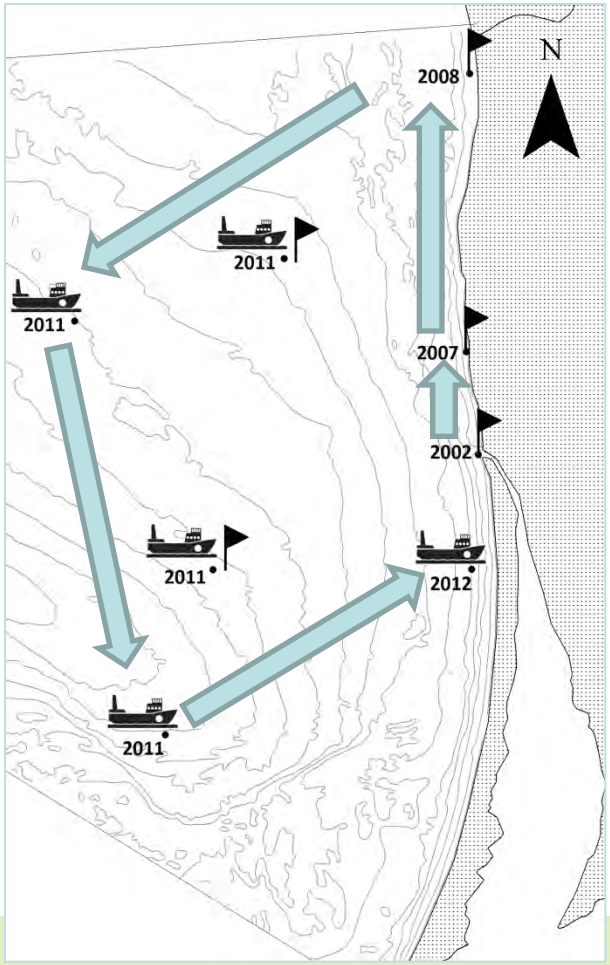
Stepping stones and corridors can be reflected in small scale movements as well, but this phenomena has not been found to be characteristic for inshore/offshore migrations of wintering birds.



Baltic Sea Portal: based on information from I. Jüssi and U.Käärt, Eesti Päevaleht, 22.11.2007

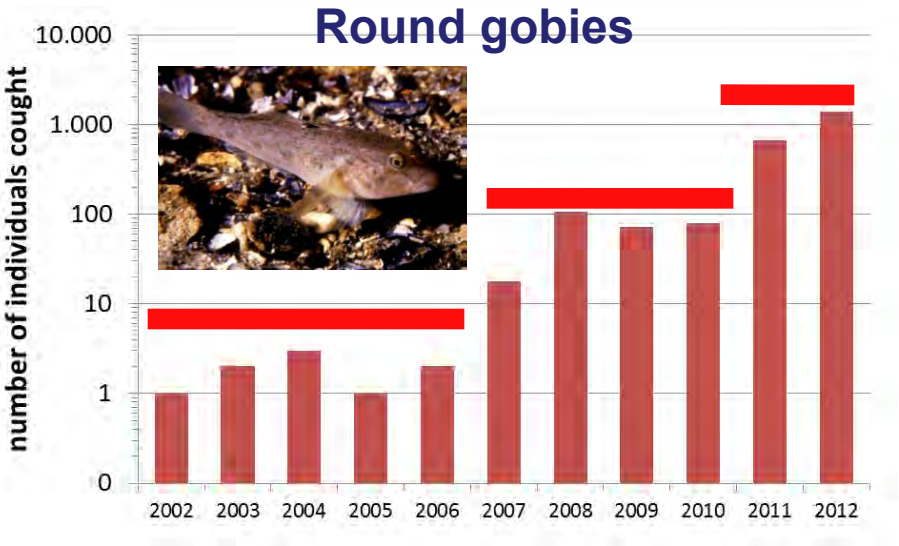
COMPLEX INTERACTIONS BETWEEN ECOSYSTEM COMPONENTS: INTRODUCTION OF ROUND GOBY

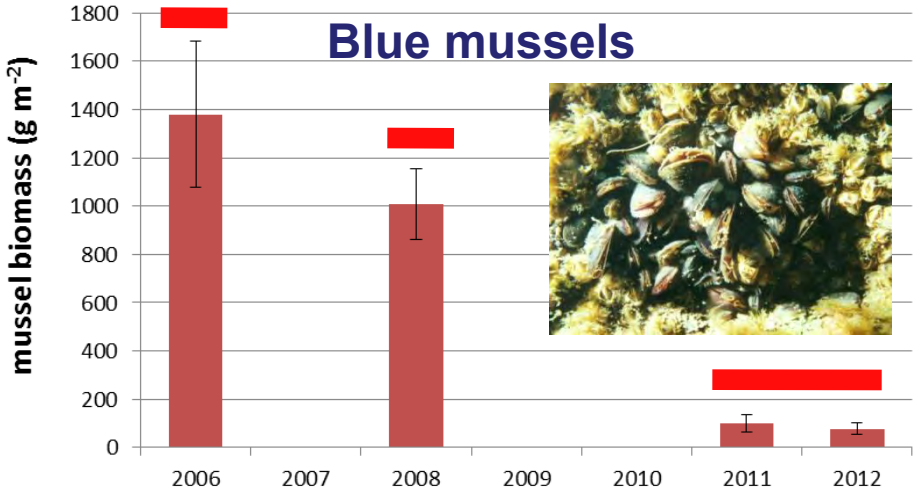
Pictures: Wikipedia, J. Samsel, E. Engbretson



- First observed in the Gulf of Gdańsk, Baltic Sea, in 1990.
- First record in the Lithuanian waters in 2002.
- 10 years lag period for the species migration few nm southwards.

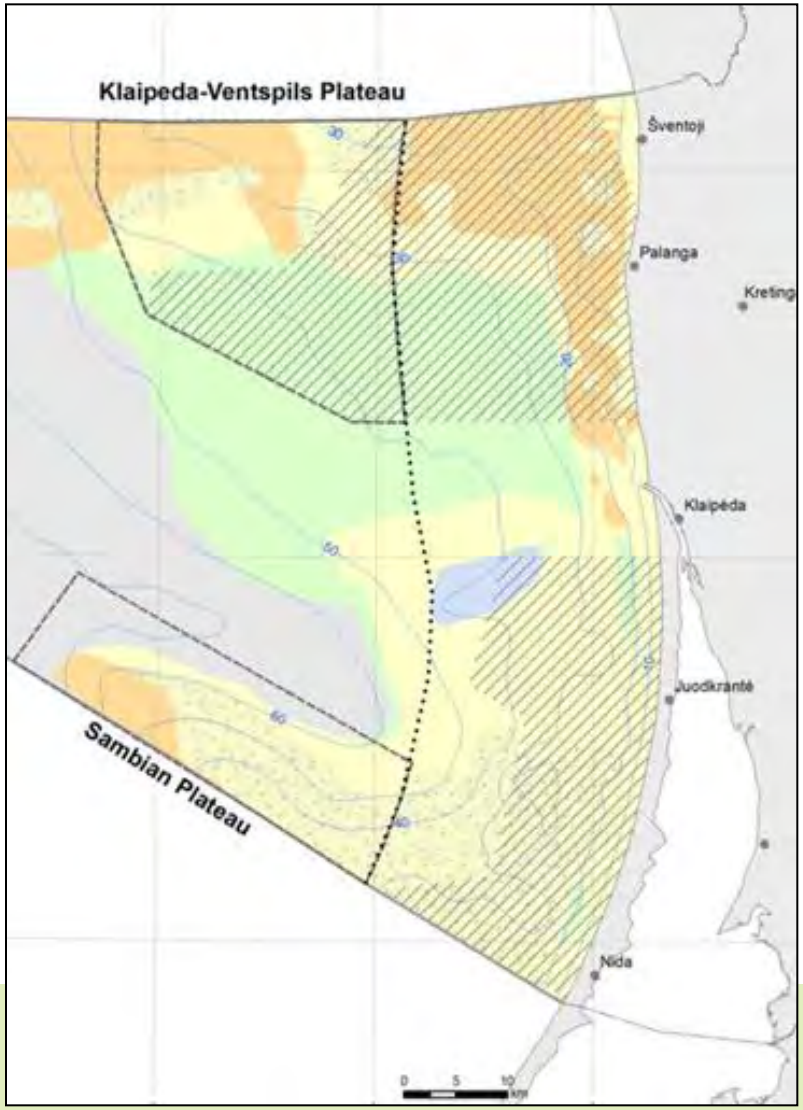
ECOSYSTEM SCALE EFFECTS OF ROUND GOBIES

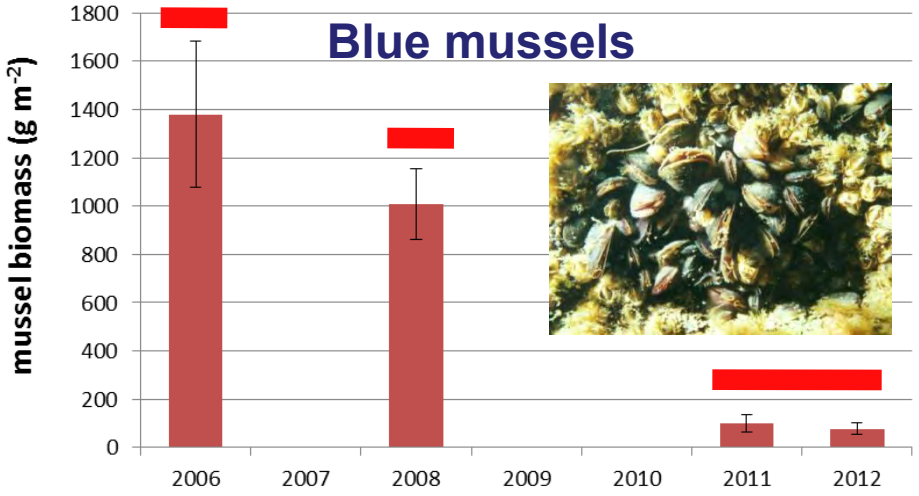


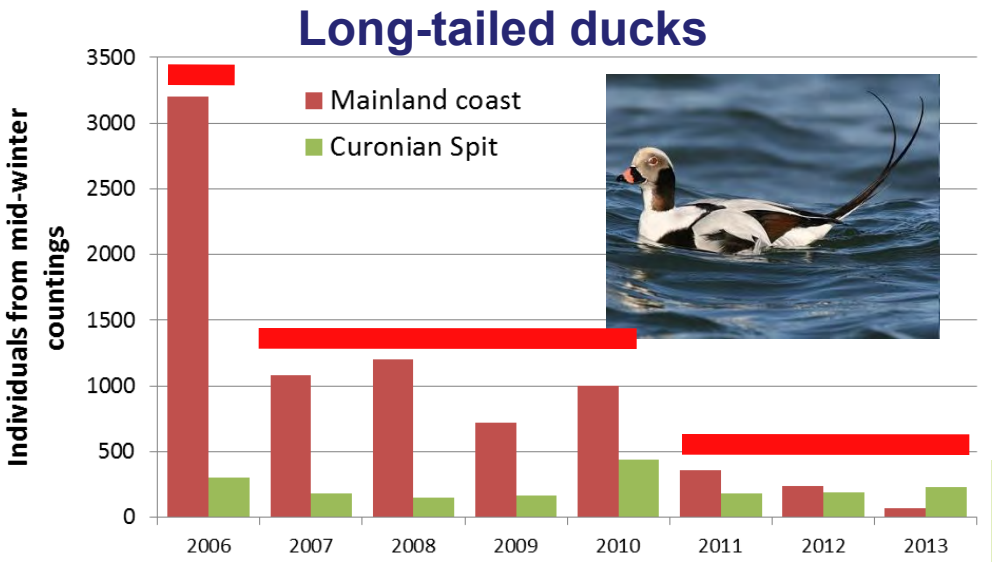


Unpublished monitoring data, fishery Service under the Ministry of Agriculture of the Republic of Lithuania

ECOSYSTEM SCALE EFFECTS OF ROUND GOBIES







RESPONSE OF STELLER'S EIDERS TO THE HERRING SPAWNING

Maps: Žydelis, Esler 2005. Photo: T. Kolaas, J. del Hoyo

CONCLUDING REMARKS

Existing knowledge suggest, that small-scale features may account for the large part of the underwater diversity. Although mapping techniques have improved considerably, we're still lacking both skillful attempts to discover these spatially limited spots and adequate funding for their *in situ* mapping.

Temporal variability is of crucial importance in understanding spatial organisation and connectivity of marine sites, however large spatial scale data might be needed to provide meaningful explanations for the long-term data series.

Large spatial scale data provide a context for regional importance of given sites.

Relatively small scale interactions among marine species may lead to fast shifts in species distributions which occur at much larger spatial scales than original overlap of interacting species.

This study was partly funded by LIFE+ Nature project "Inventory of marine species and habitats for development of NATURA 2000 network in the offshore waters of Lithuania" (DENOFLIT)