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Seatrack Web: A Numerical Tool to Protect the Baltic Sea Marine Protected Areas

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Shipping activities in the Baltic Sea, including oil transport and oil handled in harbors, have a number of negative impacts on the marine environment, marine protected areas (MPAs) and coastal zone. Oil discharges from ships cause the contamination of seawater, shores, and beaches, which may persist for a long time or several years and represent a threat to marine ecosystems in MPAs and marine resources.

One of the main tasks in the ecological monitoring of the MPAs in the European seas is an operational satellite and aerial detection of oil spillages, determination of their characteristics, establishment of the pollution sources and forecast of probable trajectories of the oil spill transport.

The interactive numerical model Seatrack Web SMHI is a powerful operational tool that can be used for a forecast of the oil spill drift in the vicinity of MPAs and for assessment of ecological risks related to potential oil pollution of every MPAs in the Baltic Sea. This version of a numerical model on the Internet platform has been developed at the Swedish Meteorological and Hydrological Institute in close co-operation with Danish authorities. The system uses two different operational weather models ECMWF and HIRLAM and a circulation model HIROMB (driven by the two weather models respectively), which calculates the current field. The model allows to forecast the oil drift for five days ahead or to make a hind cast (backward calculation) for 30 days in the whole Baltic Sea. Several examples of oil spill drift modelling and of calculation a probability of the oil drift for specific points along main ship routes in the Gulf of Finland and southward of Gotland for July and August 2007 are shown.

Table 1. Oil transportation volumes of certain Baltic oil terminals in 1997, 2000 and 2015 (Rytkonen et al., 2002).

Country/port/terminal	1997	2000	2015
Estonia/Muuga	9.2	17.8	24
Finland/Hamina	1.2	1.3	1.5
Finland/Porvoo	13,3 (other 5)	13.6	15
Latvia/Riga	1.3	3	5
Latvia/Ventspils	19.05	26.7	30
Latvia/Liepaja	–	0.1	0.5
Lithuania/Klaipeda	1.7	5.2	8
Lithuania/Butinge	–	3.5	8
Russia/St. Petersburg	3.5	7.5	10
Russia/Primorsk	–	–	24
Russia/Batareinaya	–	–	6
Russia/Kaliningrad	0.3	1.1	2
Total (million tons)	54.5	79.8	134

Table 2. Number of flight hours of aerial surveillance on oil spills in the Baltic Sea in 1989-2002 (HELCOM, 2002).

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Denmark	–	292	199	172	153	253	225	275	209	325	416	497	463	412
Estonia	–	–	–	–	40	420	420	305	284	236	268	212	161	153
Finland	2022	2191	1820	2733	2285	2313	355	400	355	649	603	660	567	605
Germany	142	168	129	267	201	290	291	313	288	206	286	439	466	469
Lithuania	–	348	78	133	–	–	–	65	–	–	–	250	300	–
Latvia	–	400	408	127	24	18	8	8	64	577	320	436	412	387
Poland	131	164	140	62	49	179	301	345	291	465	375	362	187	320
Russia	1618	–	629	32	–	–	–	–	–	–	–	–	–	–
Sweden	1600	1600	1600	1700	1900	2038	1953	1763	2189	2544	2565	2374	2281	2518
Total number	**5513**	**4815**	**5273**	**5171**	**4785**	**5511**	**3553**	**3474**	**3680**	**5002**	**4833**	**5230**	**4837**	**4864**

Table 3. Number of approved oil spills in the Baltic Sea in 1989-2002 (HELCOM, 2002).

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Denmark	159	34	46	18	17	30	48	36	38	53	87	68	93	54
Estonia	–	–	–	18	7	4	3	–	3	10	33	38	11	9
Finland	–	–	–	–	–	–	26	42	104	53	63	89	107	75
Germany	139	45	85	76	43	75	55	44	34	23	72	51	51	44
Lithuania	–		8	34	28	–	–	65	–	–	–	–	0	–
Latvia	–	73	20	15	6	–	–	–	–	33	18	17	6	21
Poland	69	88	14	92	110	104	72	50	25	33	18	51	24	25
Russia	184	–	3	13	–	–	–	–	–	–	–	–	–	–
Sweden	212	184	197	278	250	375	445	241	234	249	197	158	98	117
Total number	**763**	**424**	**373**	**544**	**461**	**588**	**649**	**478**	**438**	**454**	**488**	**472**	**390**	**345**

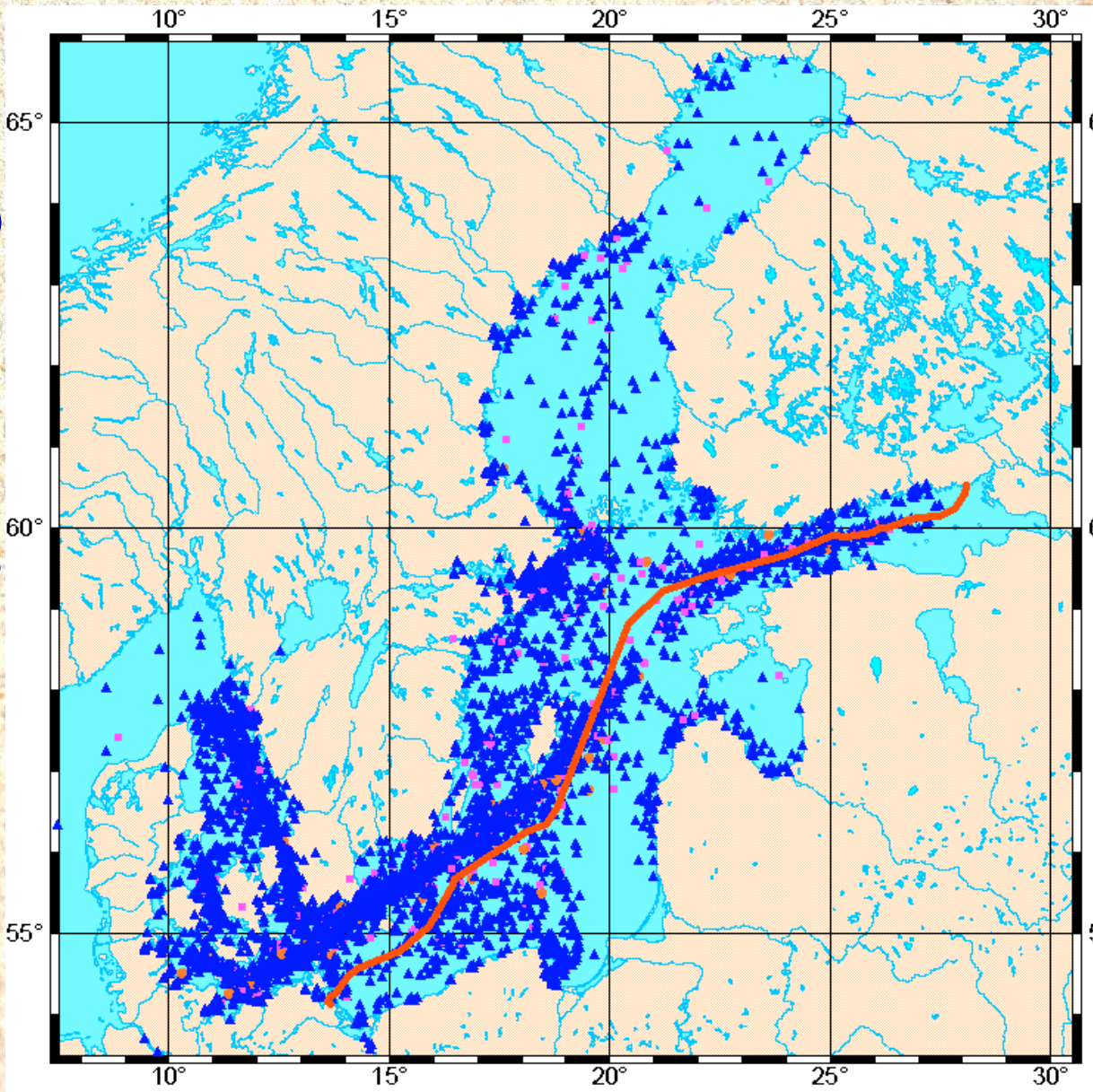
Oil spills in the Baltic Sea (1989-2002)

HELCOM (1989-2002)

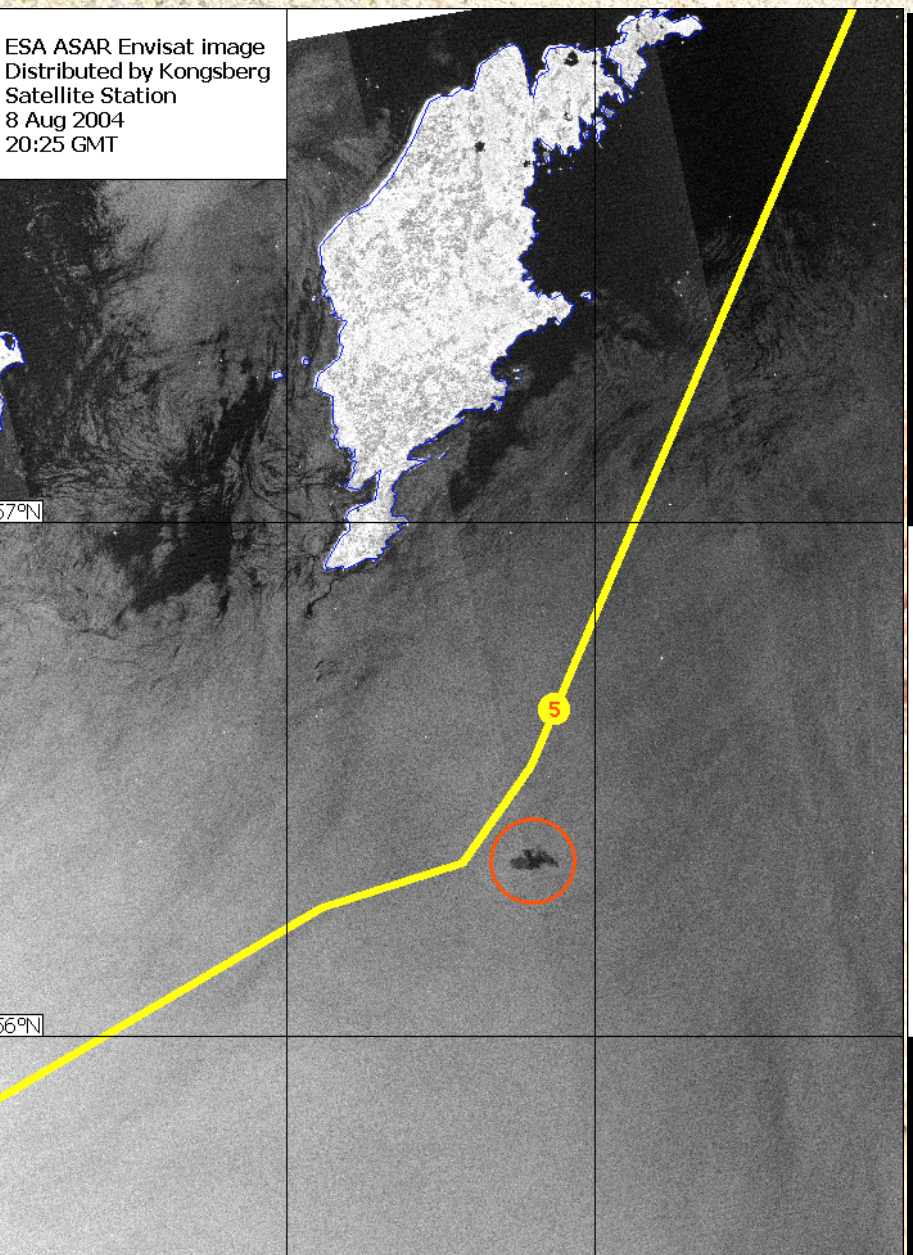
Along the main ship routes we yearly observe the maximum of oil spills discharged from ships.

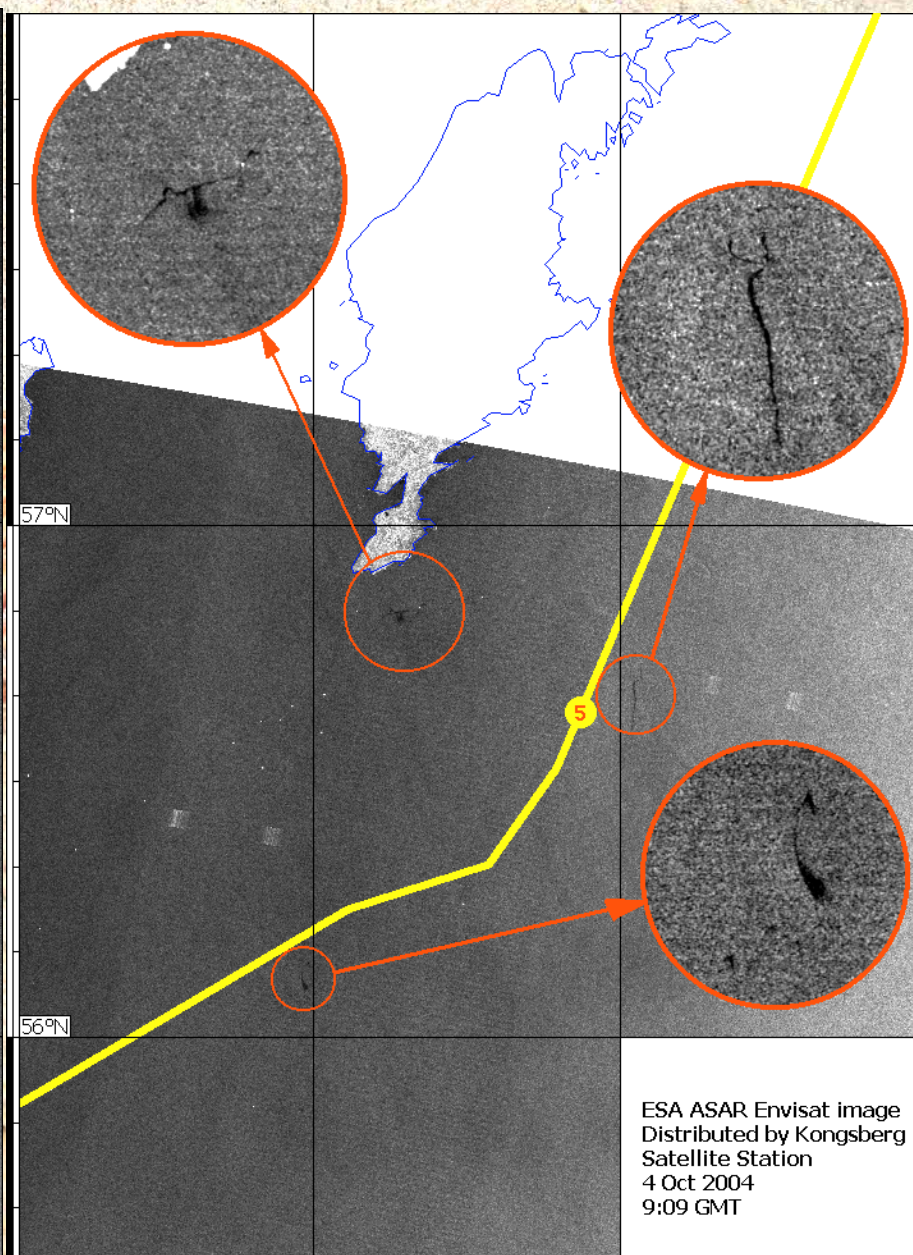
Total yearly number is 400-600.

Estimates: 10,000

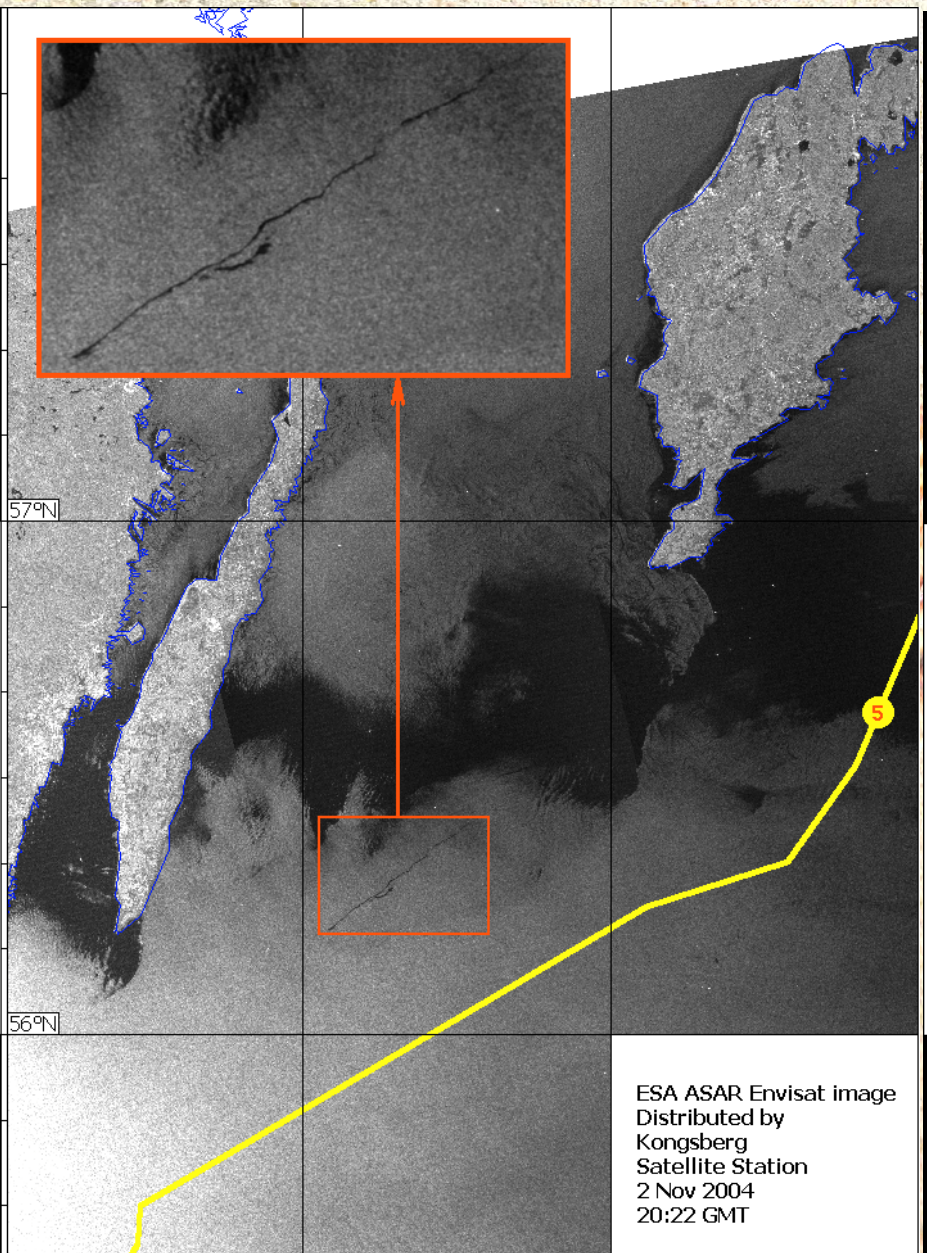


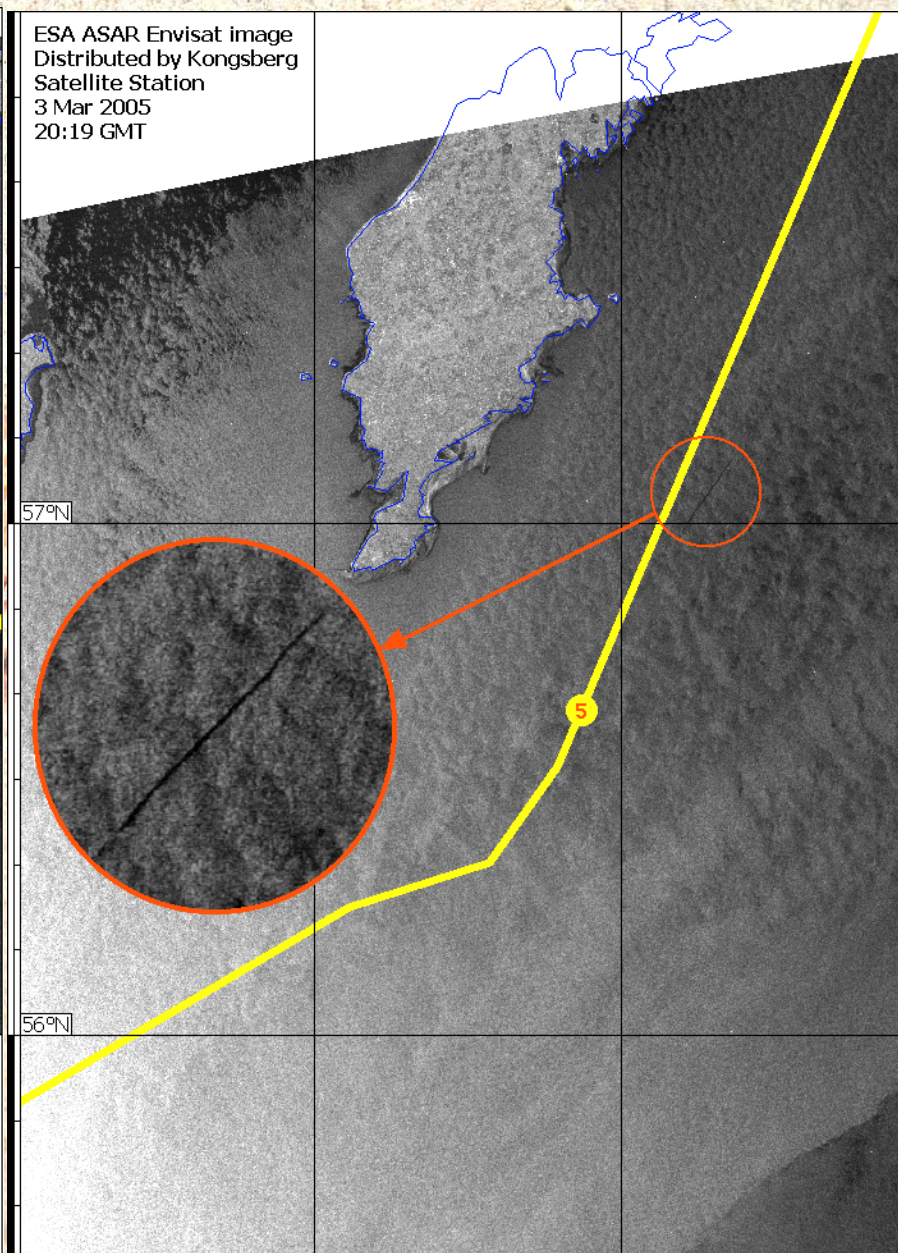
Oil spill gallery in the Baltic Sea



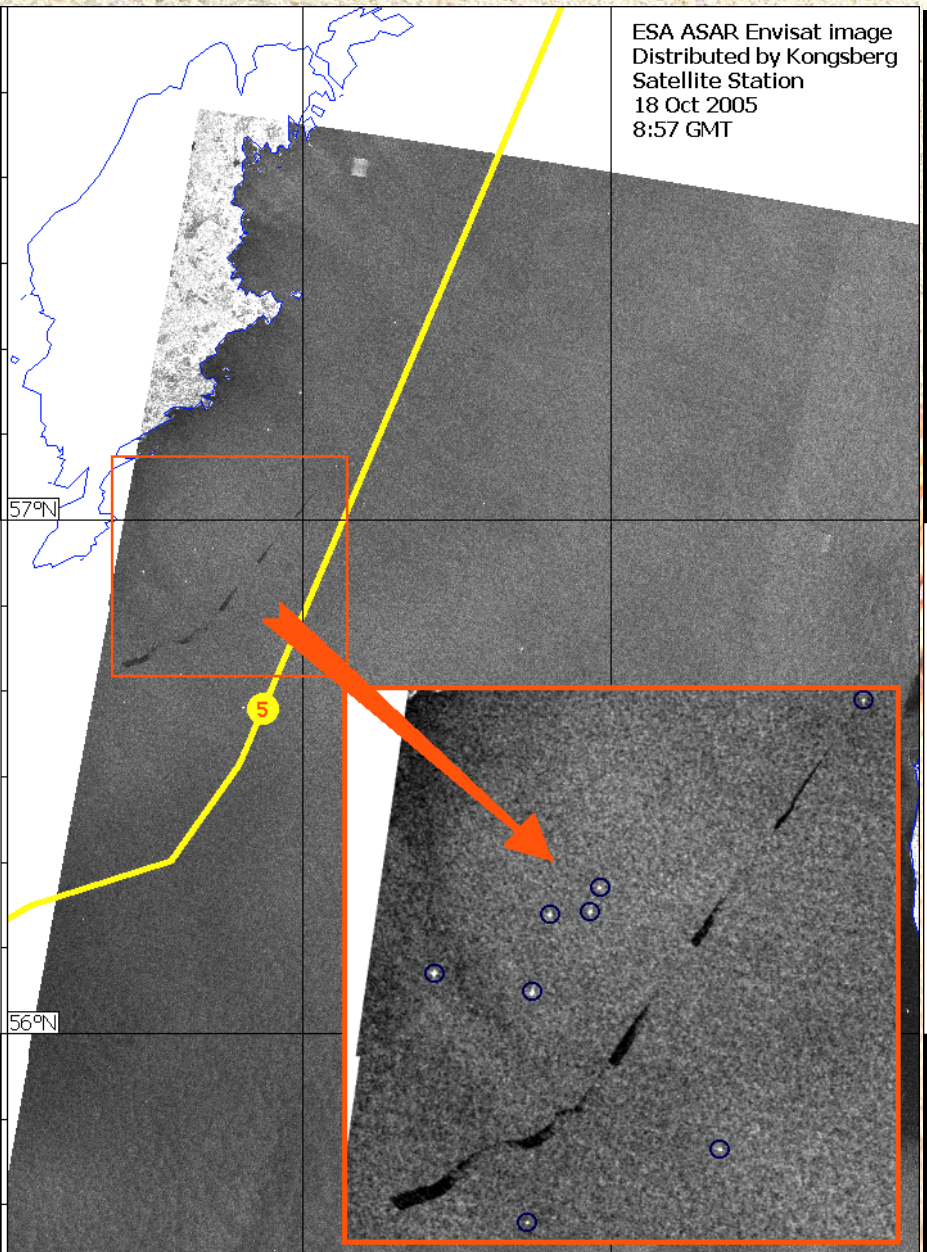


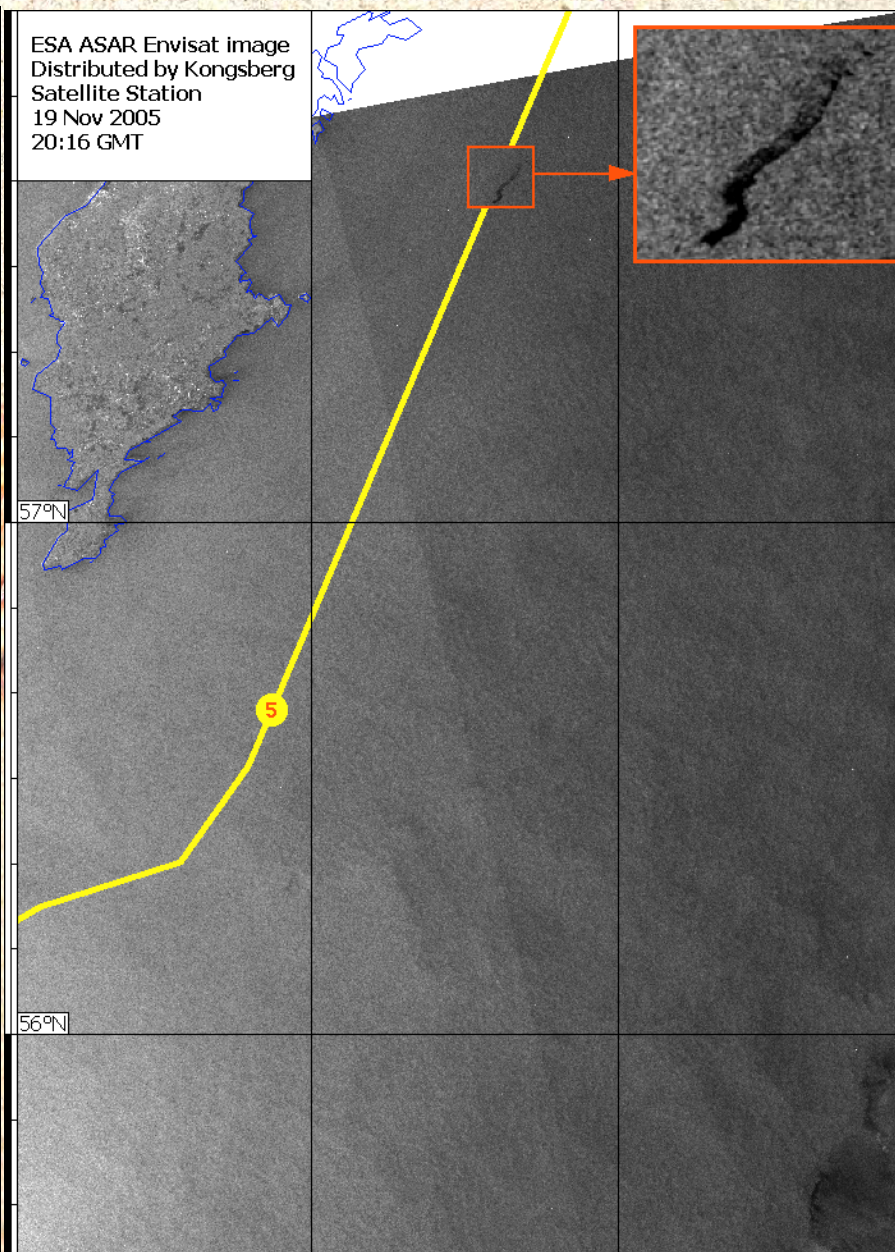
Oil spill gallery in the Baltic Sea

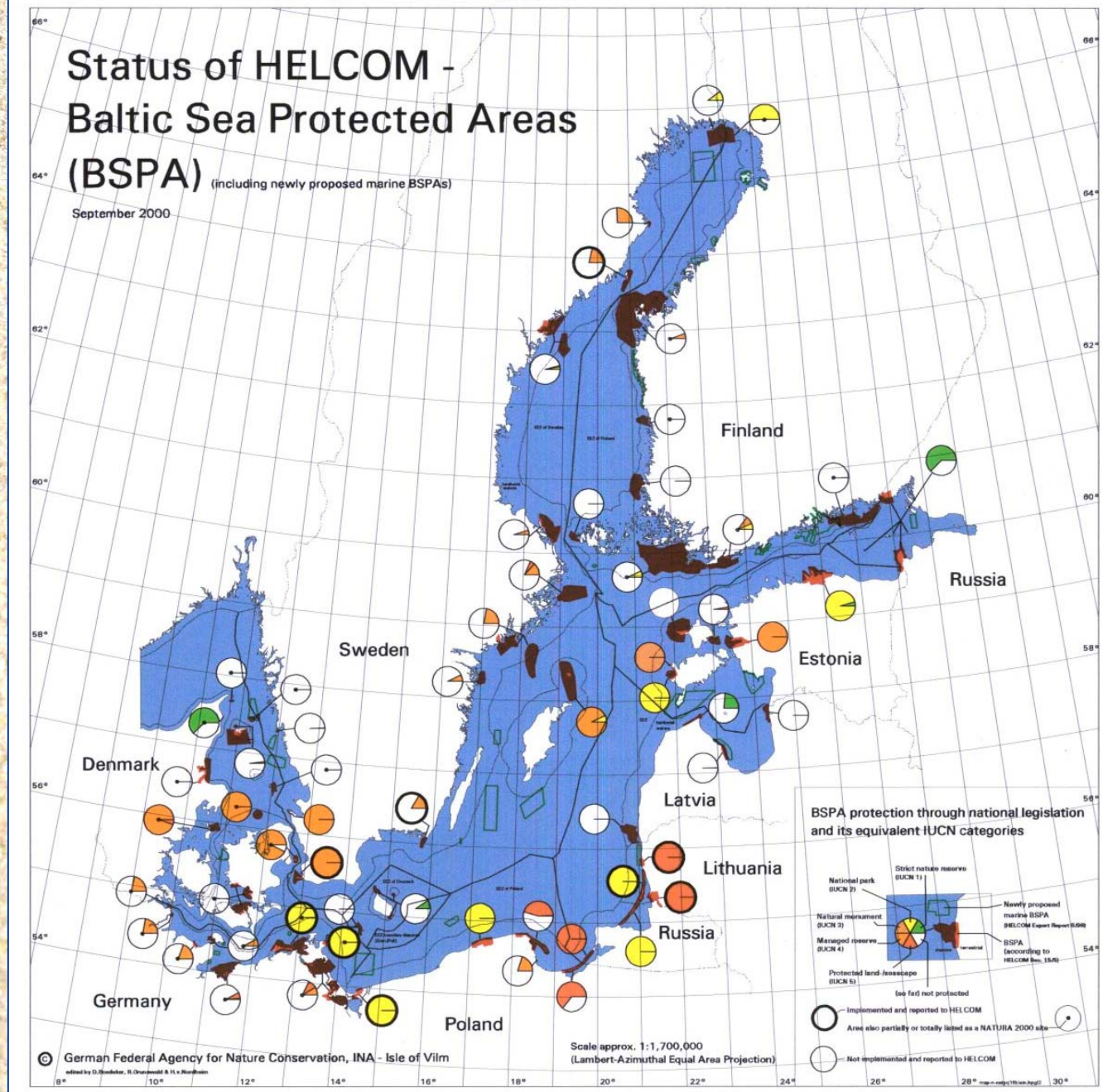




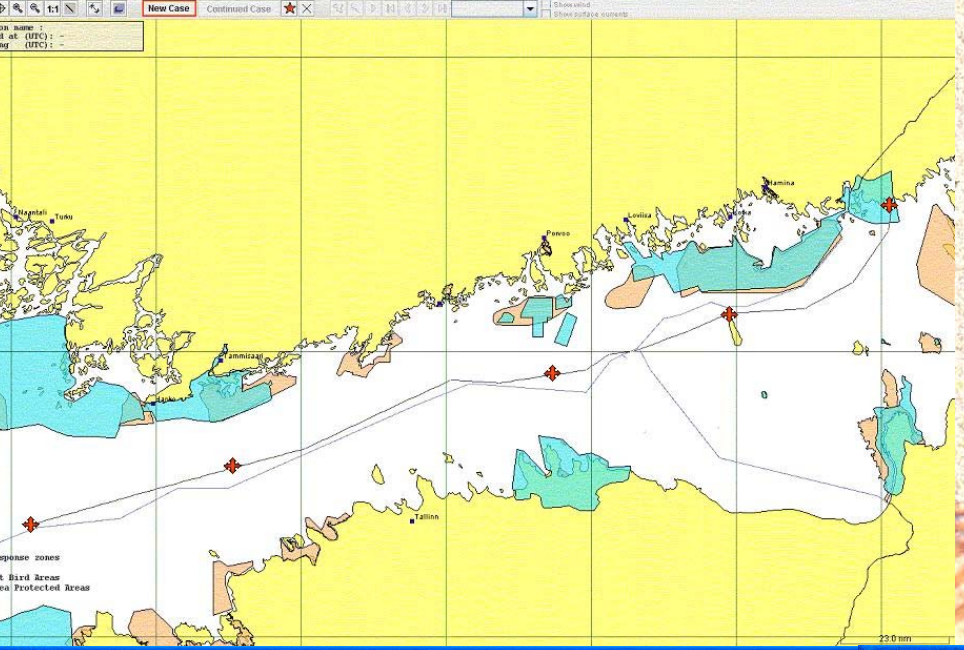
Oil spill gallery in the Baltic Sea

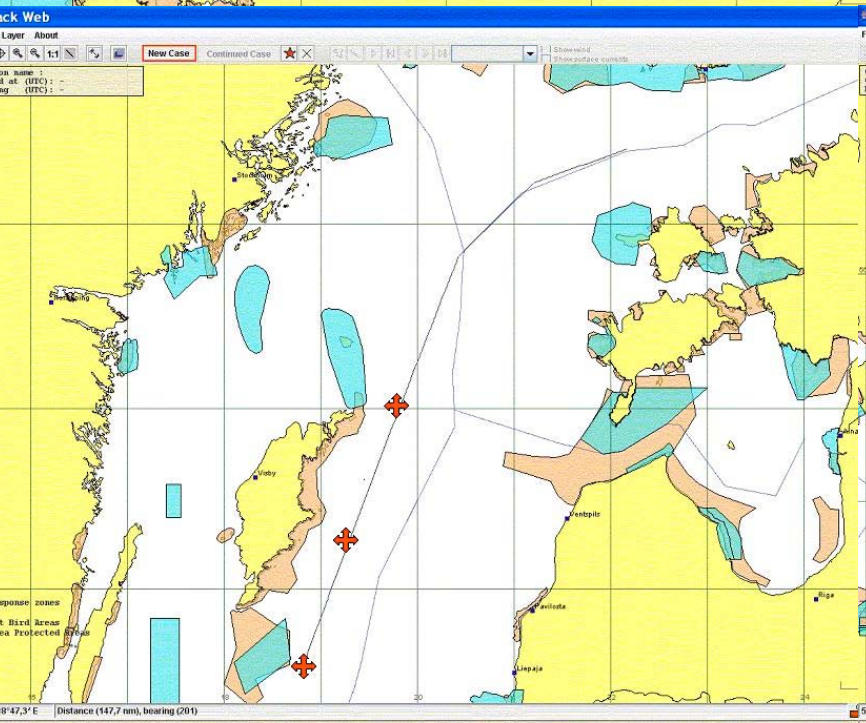


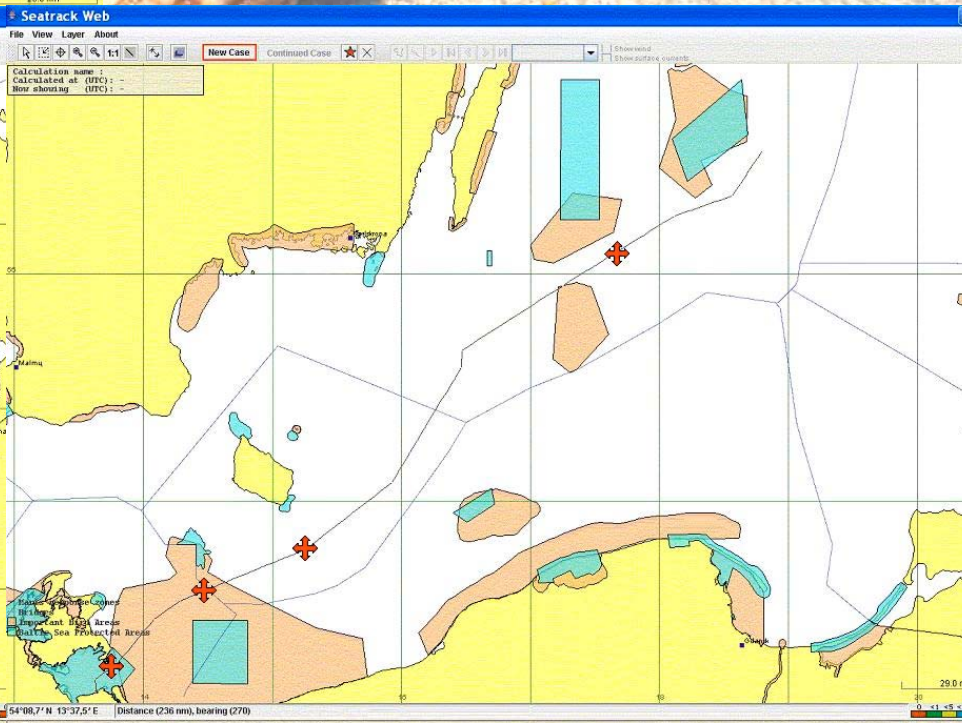


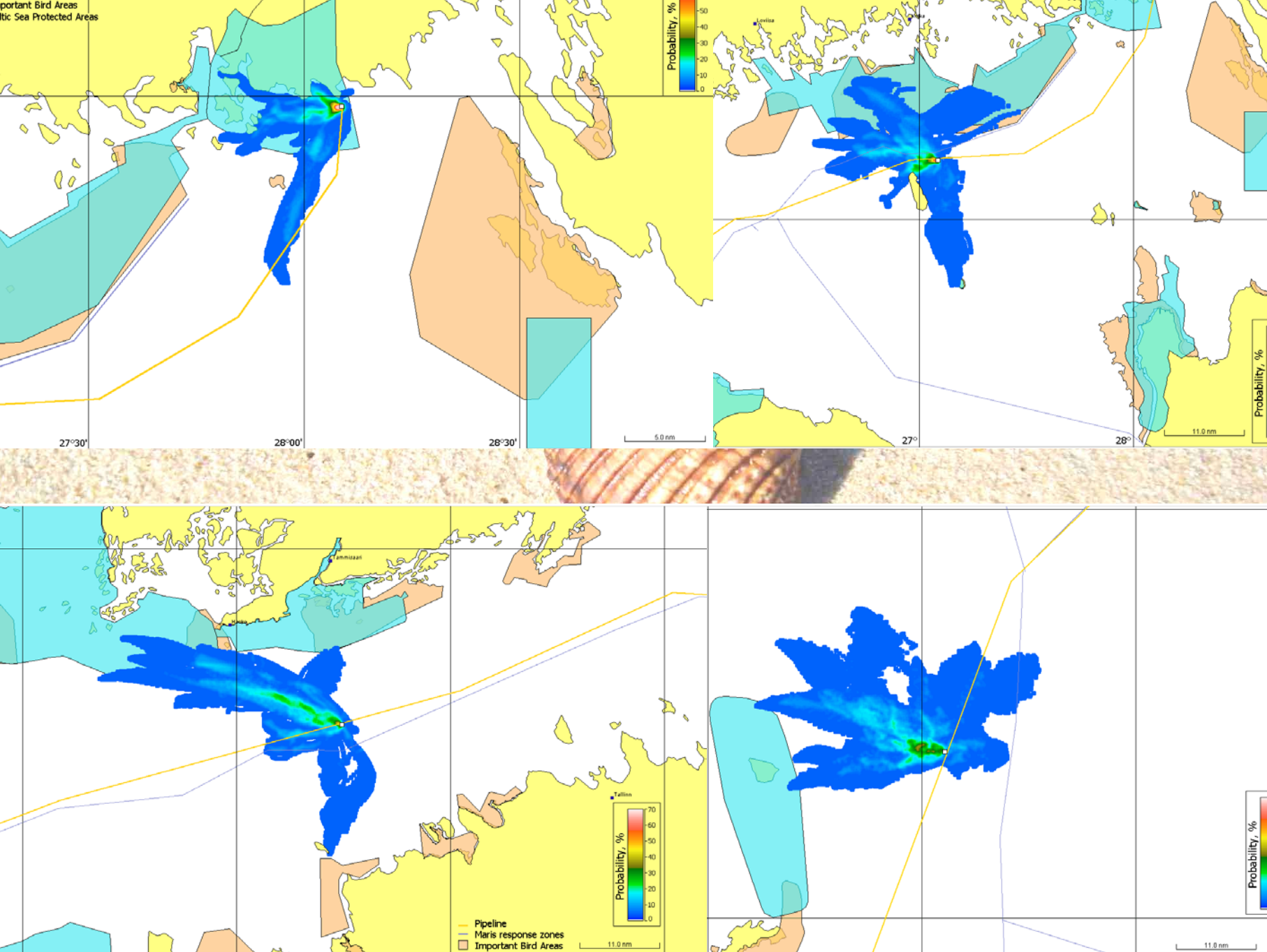

Status of HELCOM -
Baltic Sea Protected Areas
(BSPA) (including newly proposed marine BSPAs)
September 2000
Finland
Russia
Sweden
Estonia
Denmark
Latvia
Lithuania
Russia
Germany
Poland
BSPA protection through national legislation
and its equivalent IUCN categories
Strict nature reserve (IUCN 1)
National park (IUCN 2)
Natural monument (IUCN 3)
Managed reserve (IUCN 4)
Protected land-/seascape (IUCN 5)
Newly proposed marine BSPA
BSPA (according to HELCOM Rec. 15/5)
(so far) not protected
Implemented and reported to HELCOM
Area also partially or totally listed as a NATURA 2000 site
Not implemented and reported to HELCOM
Scale approx. 1:1,700,000
(Lambert-Azimuthal Equal Area Projection)
German Federal Agency for Nature Conservation, INA - Isle of Vilm

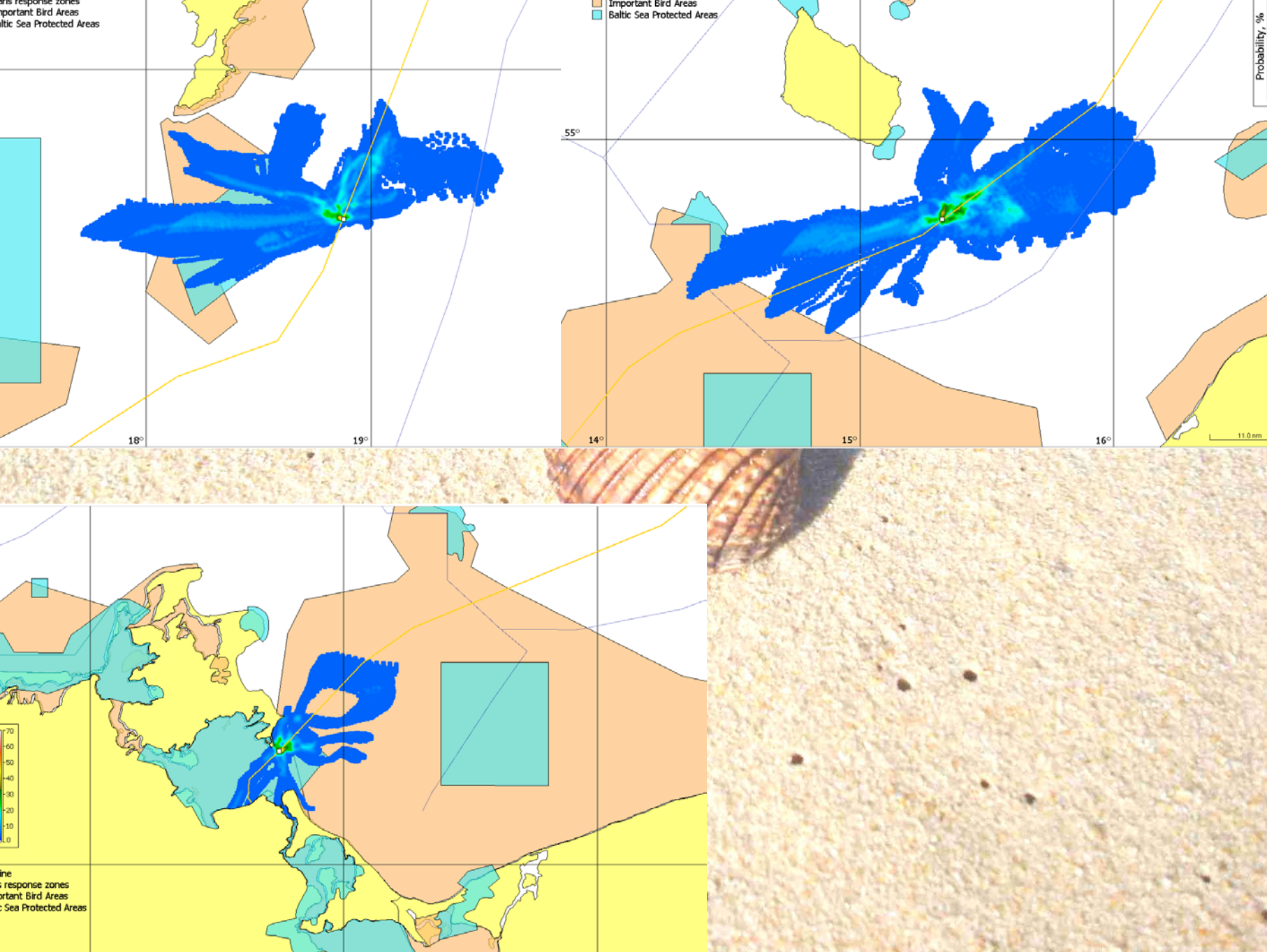
Modelling points in the Gulf of Finland, Baltic Proper and Southwestern Baltic Sea (July-August 2006)







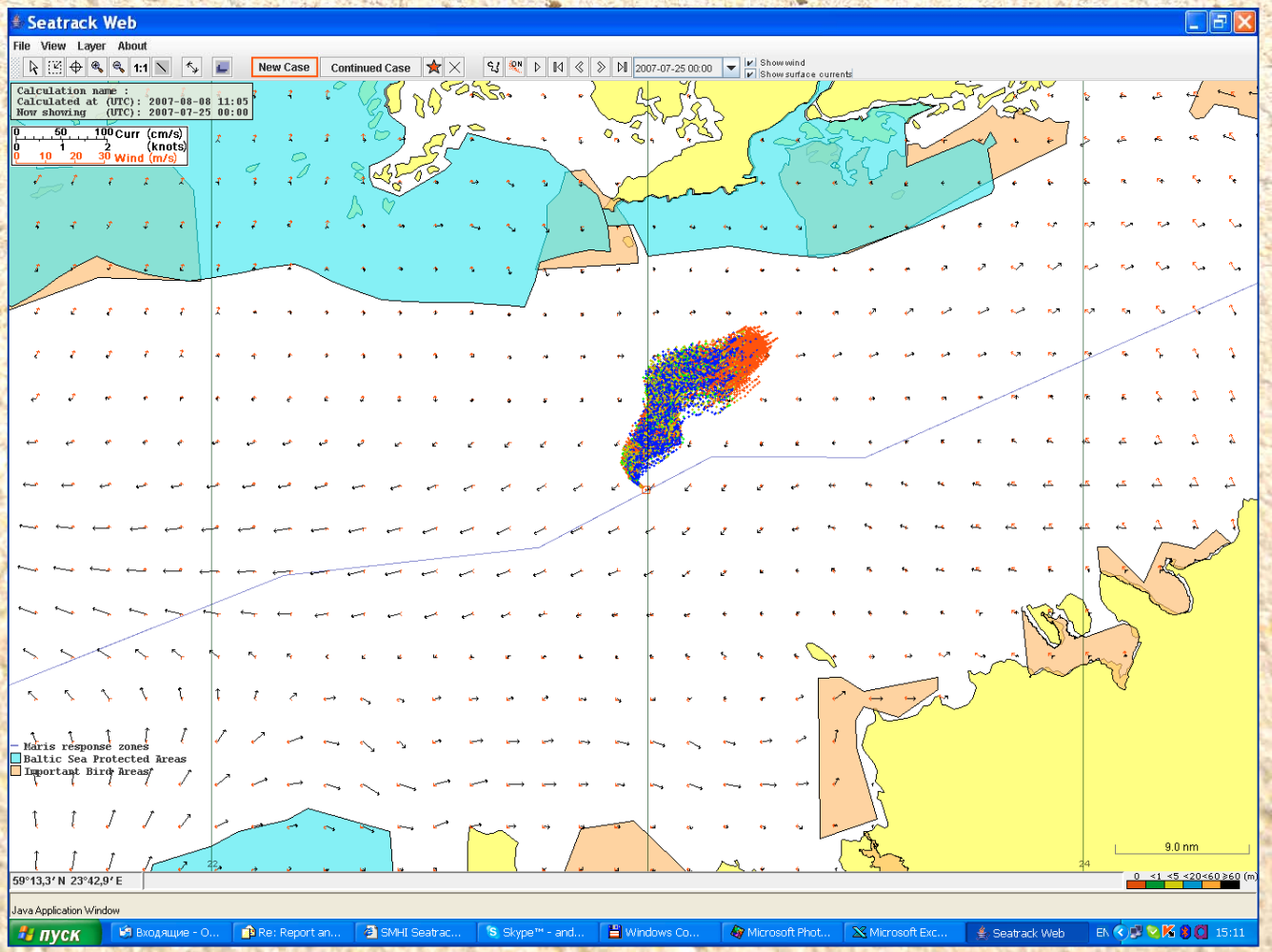

portant Bird Areas
tic Sea Protected Areas
Probability, %
70
60
50
40
30
20
10
0
27°30'
28°00'
28°30'
5.0 nm
Leviisa
Loviisa
27°
28°
11.0 nm
Tammisaari
Hanko
Tallinn
Pipeline
Maris response zones
Important Bird Areas
11.0 nm


Important Bird Areas
Baltic Sea Protected Areas
55°
18°
19°
14°
15°
16°
Probability, %
11.0 nm
response zones
Important Bird Areas
Sea Protected Areas

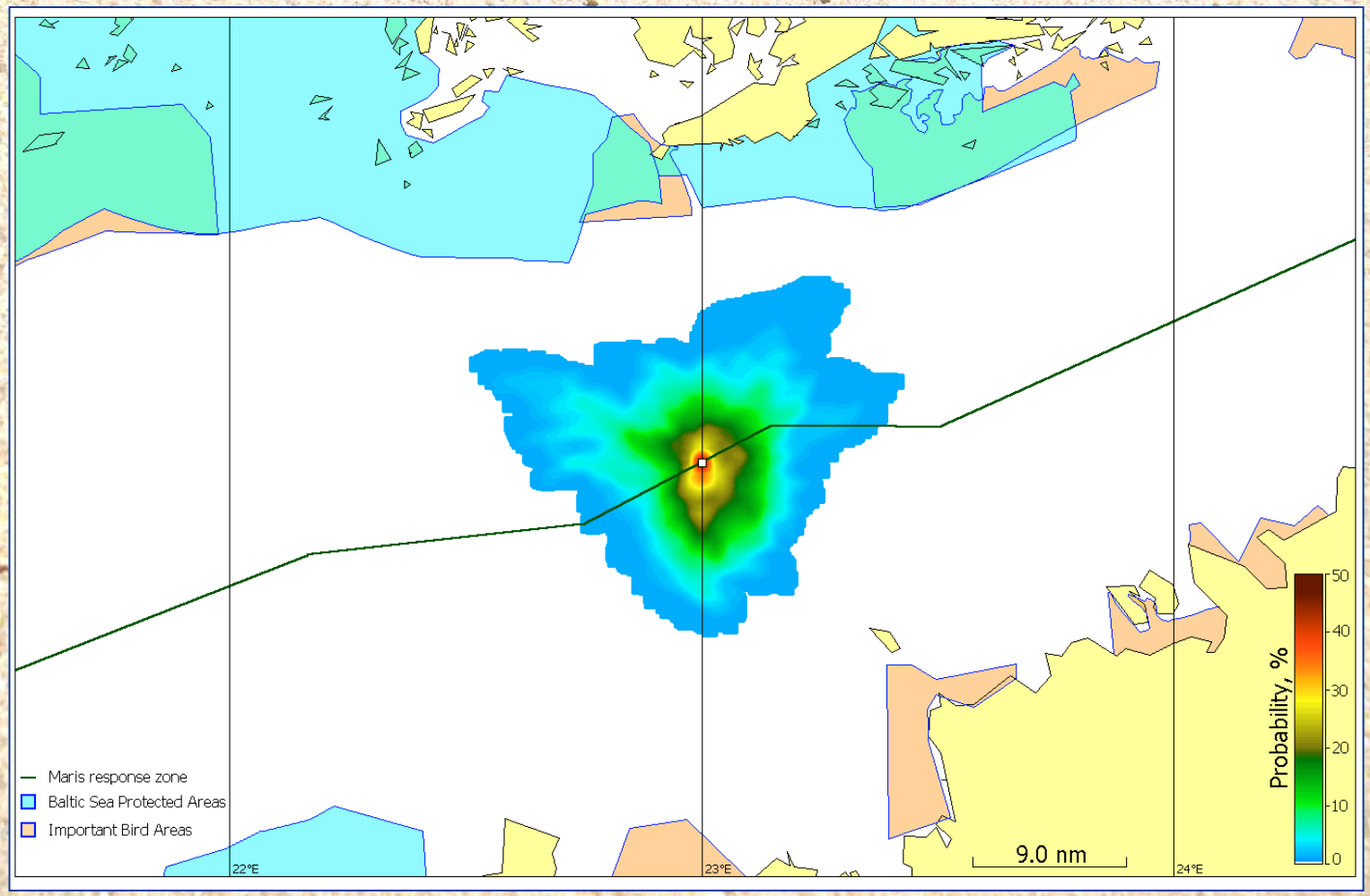
Modelling of oil spill drift in the Gulf of Finland

Figure shows oil spill drift on 23 July 2007

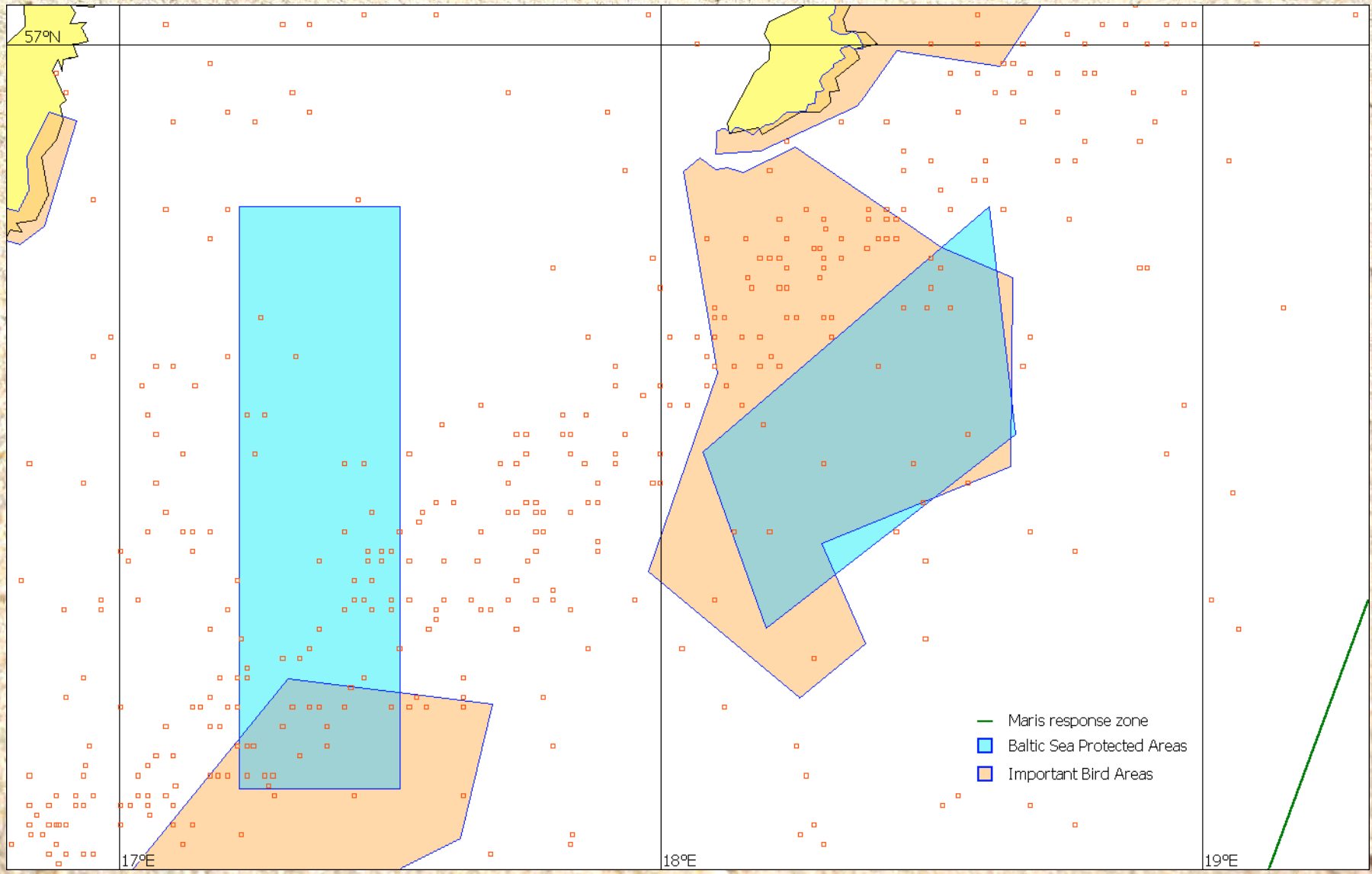
BSPAs are shown in blue, Important Bird Areas - in rose colors



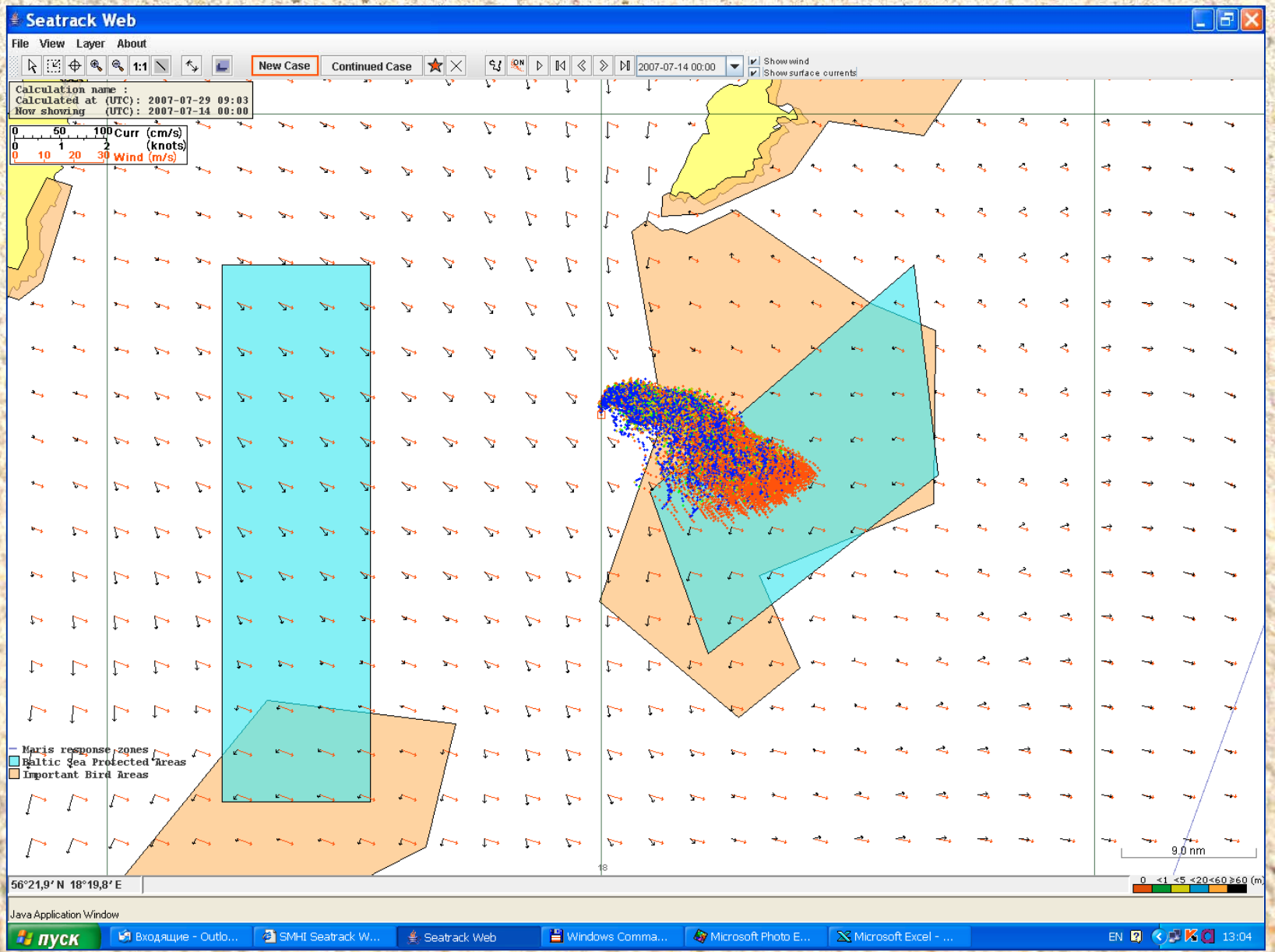
Probability (%) of oil spill drift calculated on the base of daily modelling at this point for real wind and currents conditions in July-August 2007



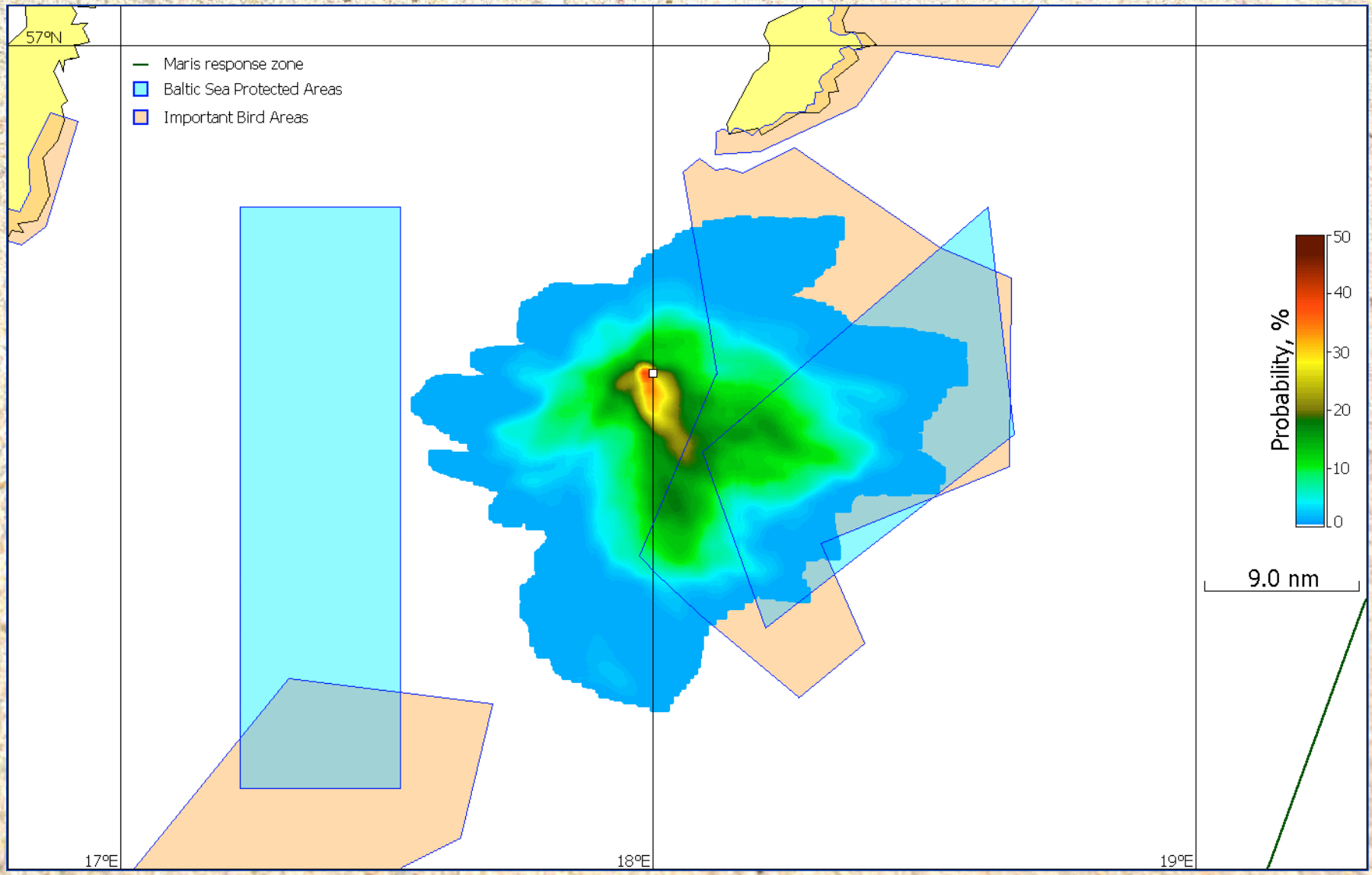
Oil spills at the ship route southward of Gotland (1989-2002)



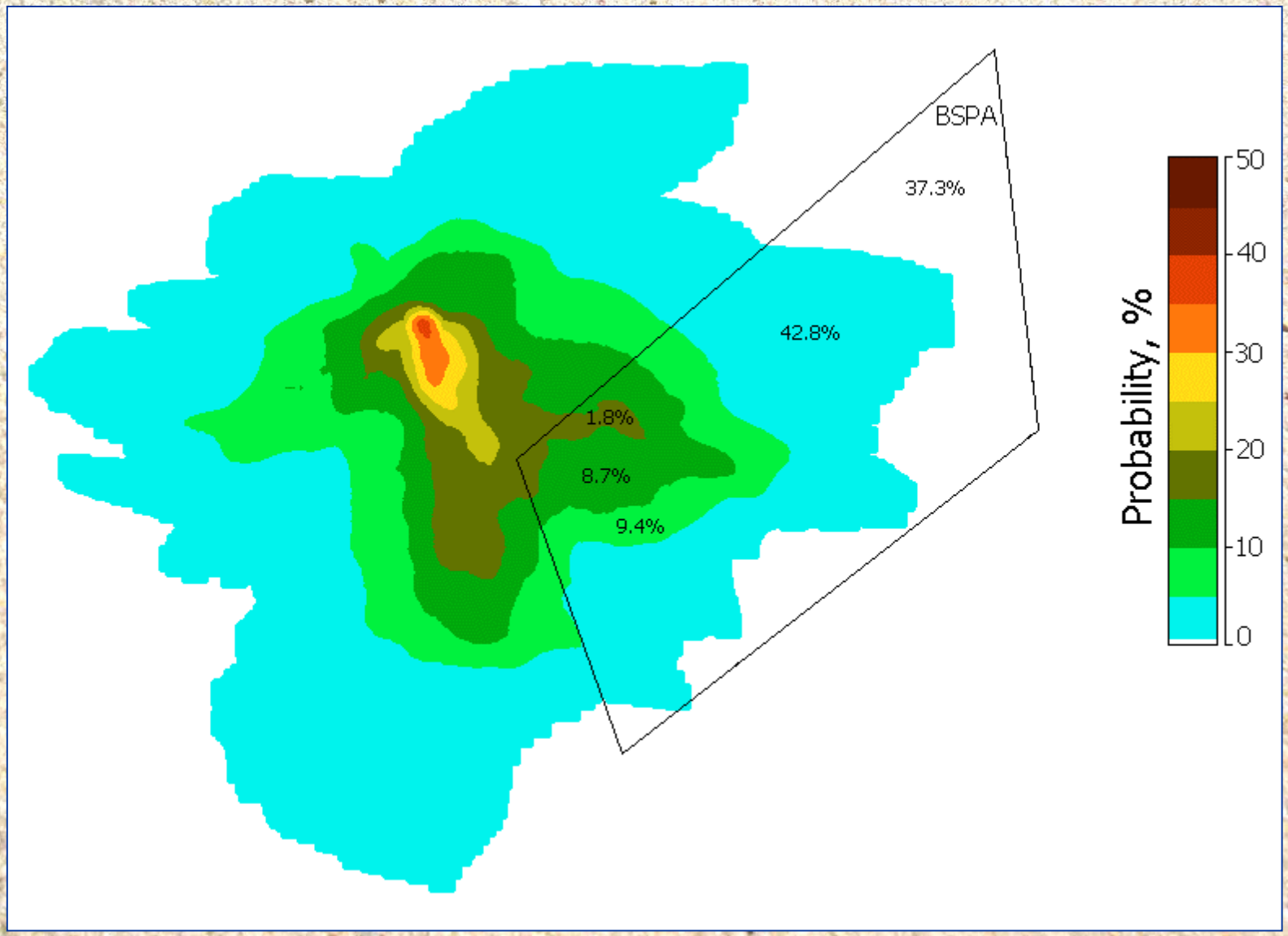
Modelling of oil spill drift southward of Gotland. Oil spill drift on 12 July 2007.



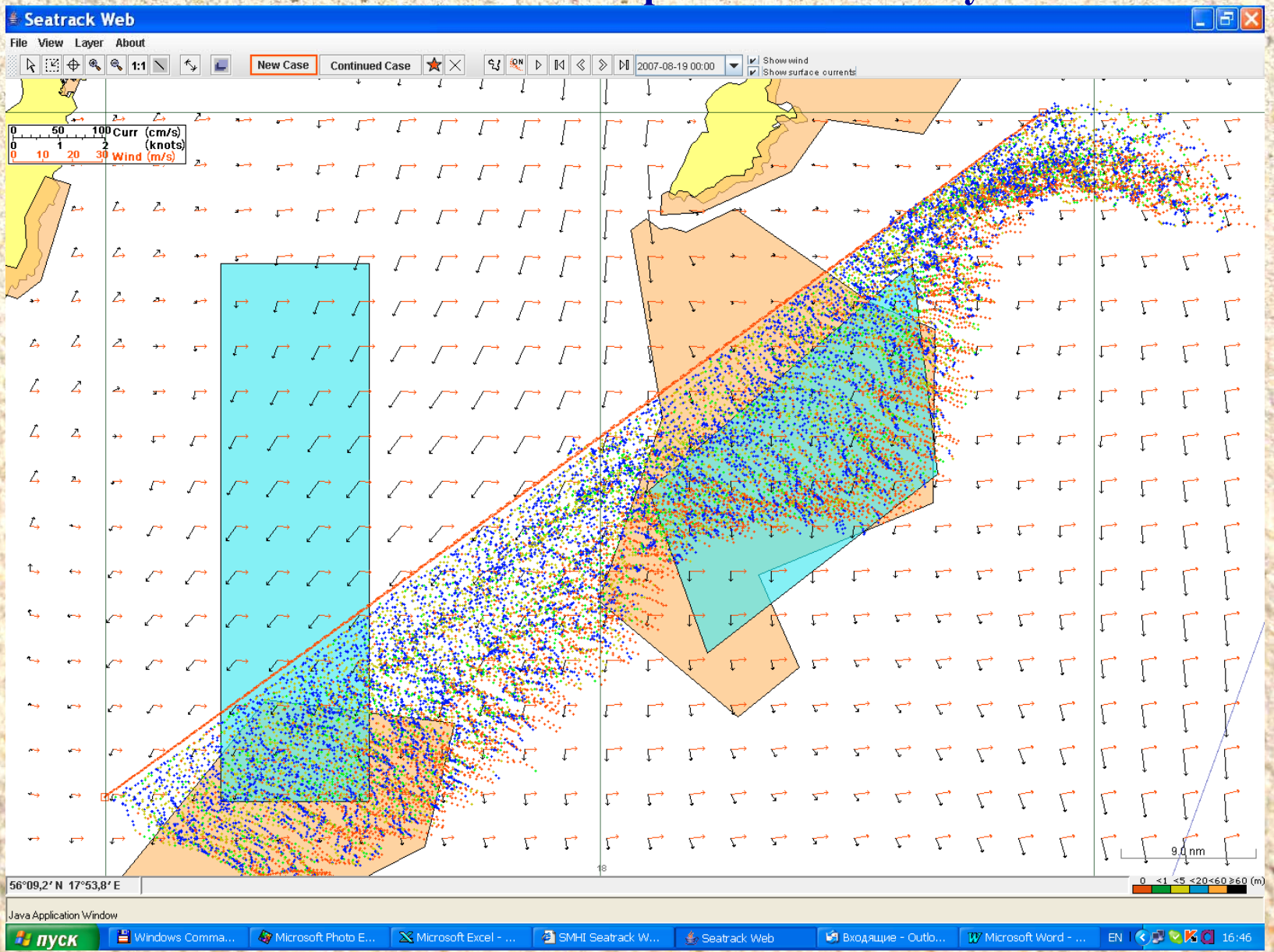
Probability (%) of oil spill drift calculated on the base of daily modelling at this point for real wind and currents conditions in July-August 2007.



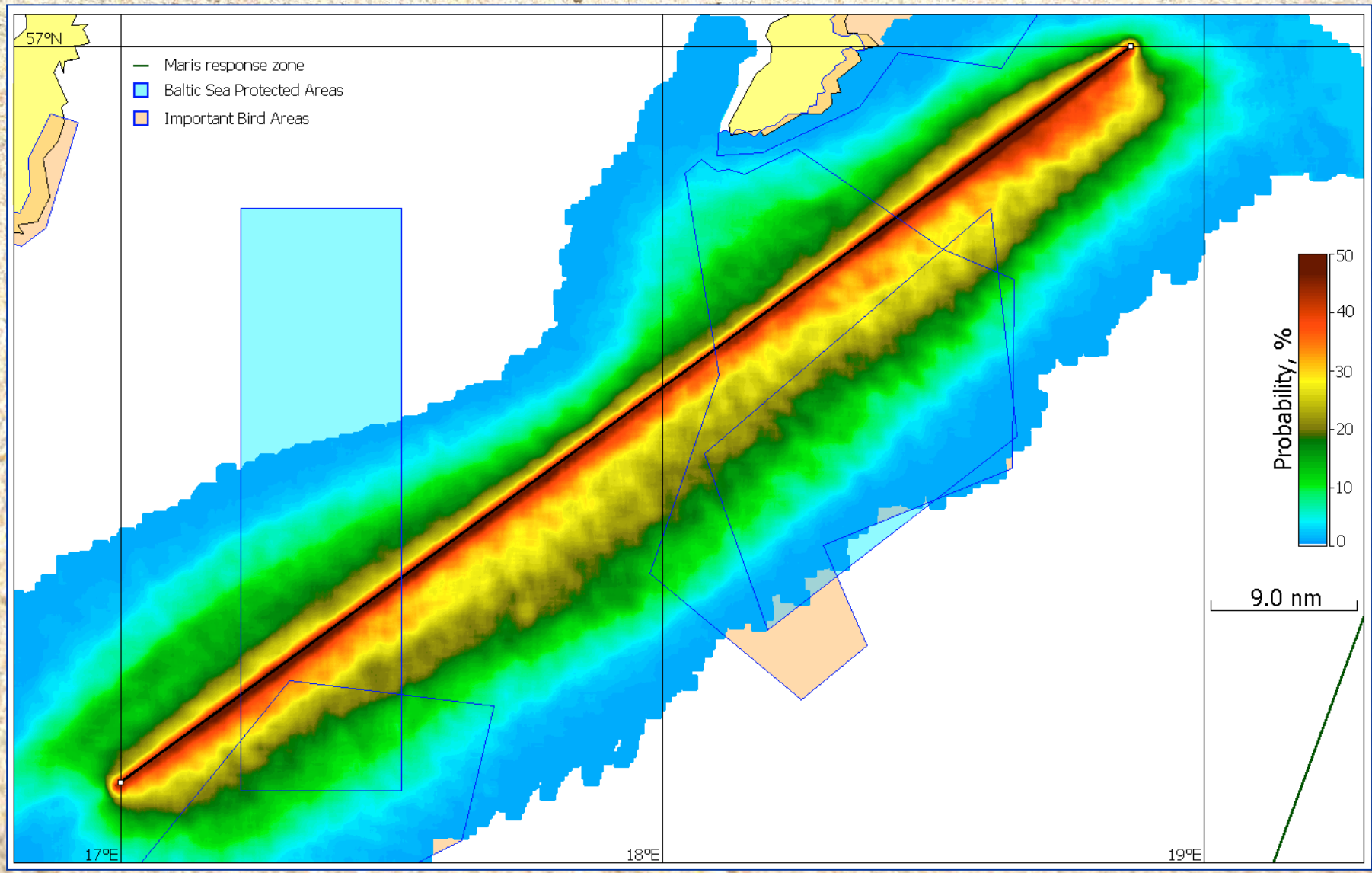
The impact of this point in the ship route on the BSPA



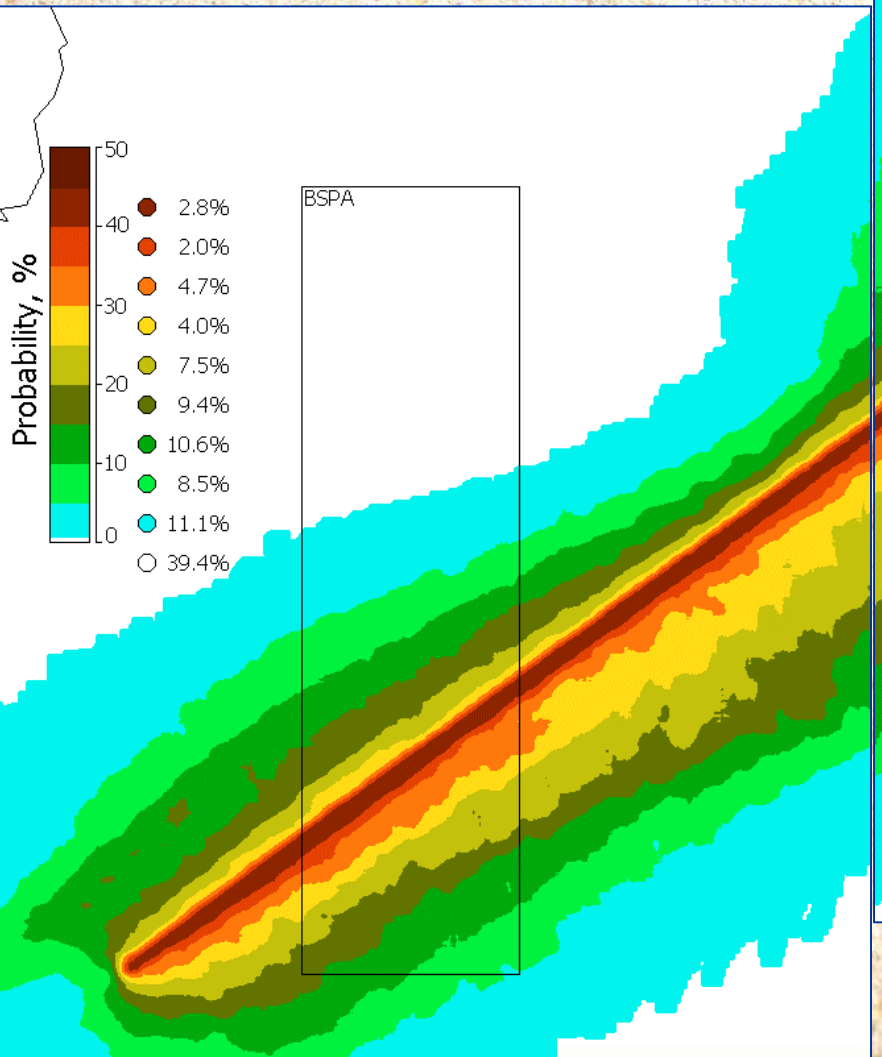
Modelling of oil spill drift released from a long part of the ship route located southward of Gotland. Oil spill drift on 12 July 2007.

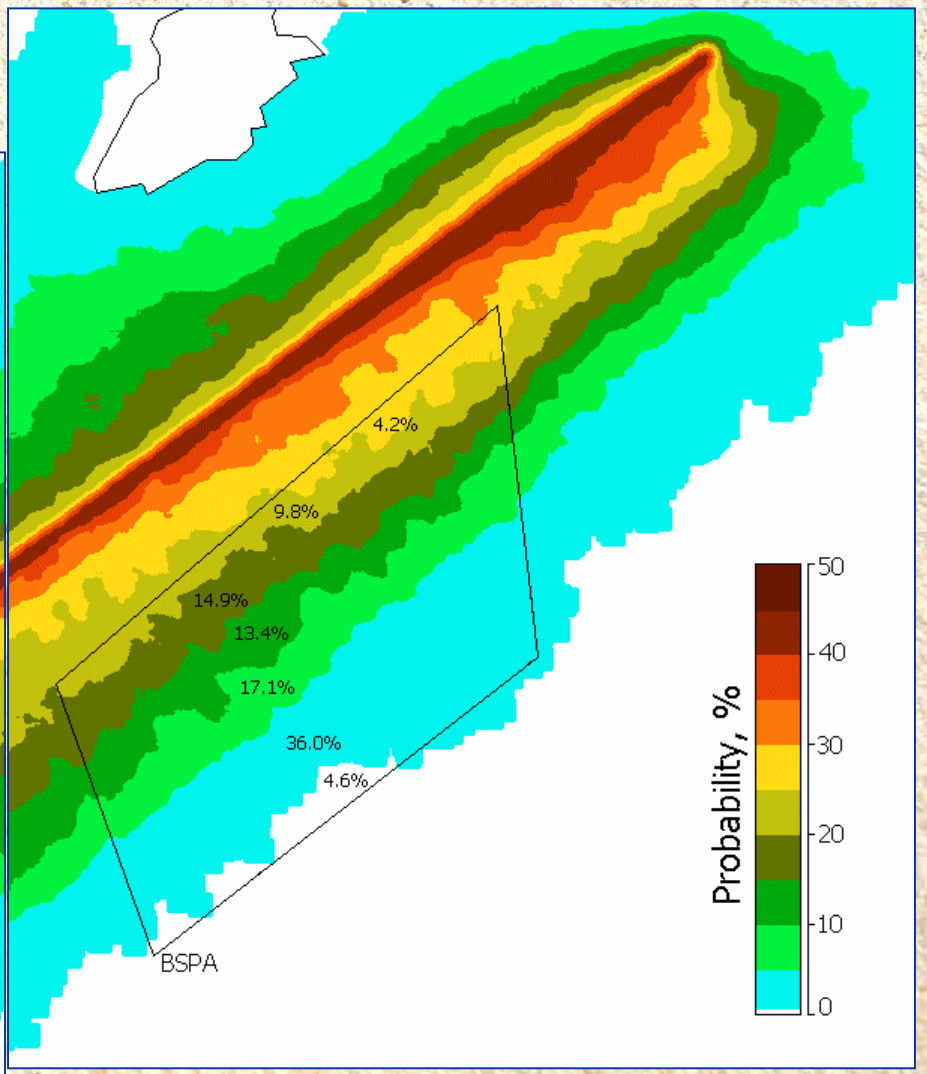


Probability (%) of oil spill drift calculated on the base of daily modelling at this line for real wind and currents conditions in July-August 2007



The impact of this part of the ship route on both BSPAs.





CONCLUSIONS:

For July-August 2007 we obtained that there is no impact of possible oil spills drift on the surrounding Baltic Sea protected areas (BSPAs) located along the coasts of Finland and Estonia. But it was the case in July-August 2006. Results of modelling show a significant impact of oil pollution produced by illegal oil spillages along the ship route located southward of Gotland. Both BSPAs located there were subjected to oil pollution but at different degree that it was possible to estimate quantitatively with the help of the Seatrack Web model. In this case even the coastal zone of Gotland was potentially threatened by oil pollution with clearly calculated probability.

This new technology based on the Seatrack Web model allows also to assess quantitatively the ecological risks related to potential oil pollution of every MPAs in the Baltic Sea resulted from main ship routes, oil terminals and ports, and "Nord Stream" gas pipeline construction.