

Quantitative analysis of the impact of fishing ship traffic streams on traffic streams of merchant vessels in Polish maritime areas

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Abstract

The Baltic Sea is crisscrossed by several dense vessel traffic routes. Growing shipping traffic increases the likelihood of collisions. A quantitative analysis of the impact of fishing vessel traffic streams on streams of merchant vessel traffic aims to identify areas of intense traffic of this type and to assess the potential risks. The identification of intersections of fishing vessel routes and merchant shipping traffic allows us to identify spots of potential collisions. The analysis made use of the IALA IWRAP Mk2 program and AIS data collected from April 1, 2013 to March 31, 2014.

Introduction

The intensity of commercial vessel traffic in the Baltic Sea has been increasing yearly. The observed growth comprises mainly bulk carriers, container ships, general cargo vessels and passenger ships. Since the LNG terminal in Świnoujście was put into operation, LNG tankers have also been present in the southern Baltic. Their number is not significant, but a large gas tanker manoeuvring in the approach channel is associated with an increased risk and vessel traffic restrictions (Maritime Office in Szczecin, 2017). One characteristic feature of the Baltic is the existence of many ferry routes linking the coastal states. Ro-ro vessels on some of these lines span Polish and Swedish ports. With an increase in vessel traffic, the size of individual vessels also increases. Measures to ensure the safety of vessels and to harmonise the traffic, including designated shipping routes, traffic separation schemes and reporting systems, aim to reduce the risk of collisions between vessels.

Shipping routes in the South Baltic – state of knowledge

The Helsinki Commission (HELCOM) conducts research on the vessel traffic density in the Baltic Sea. Traffic streams are recorded via the automatic identification system (AIS). There are 13 recording lines known as AIS lines across the Baltic Sea. Based on the collected information, HELCOM issues the Annual Report on Shipping Accidents in the Baltic Sea. The location of AIS passage lines and the number of crossing vessels are shown in Figure 1.

The HELCOM's Annual Report on Shipping Accidents in the Baltic Sea in 2013 shows that the greatest number of vessel crossings occurs in the region of the Danish Straits. In the Skagerrak Strait, separating the Jutland and Scandinavian Peninsulas, the AIS Skaw passage line was crossed by 57,567 ships. The largest group, cargo vessels, amounted to 24,188, or 42% of all vessels. In the same region the greatest number of tankers (10,523) was recorded.

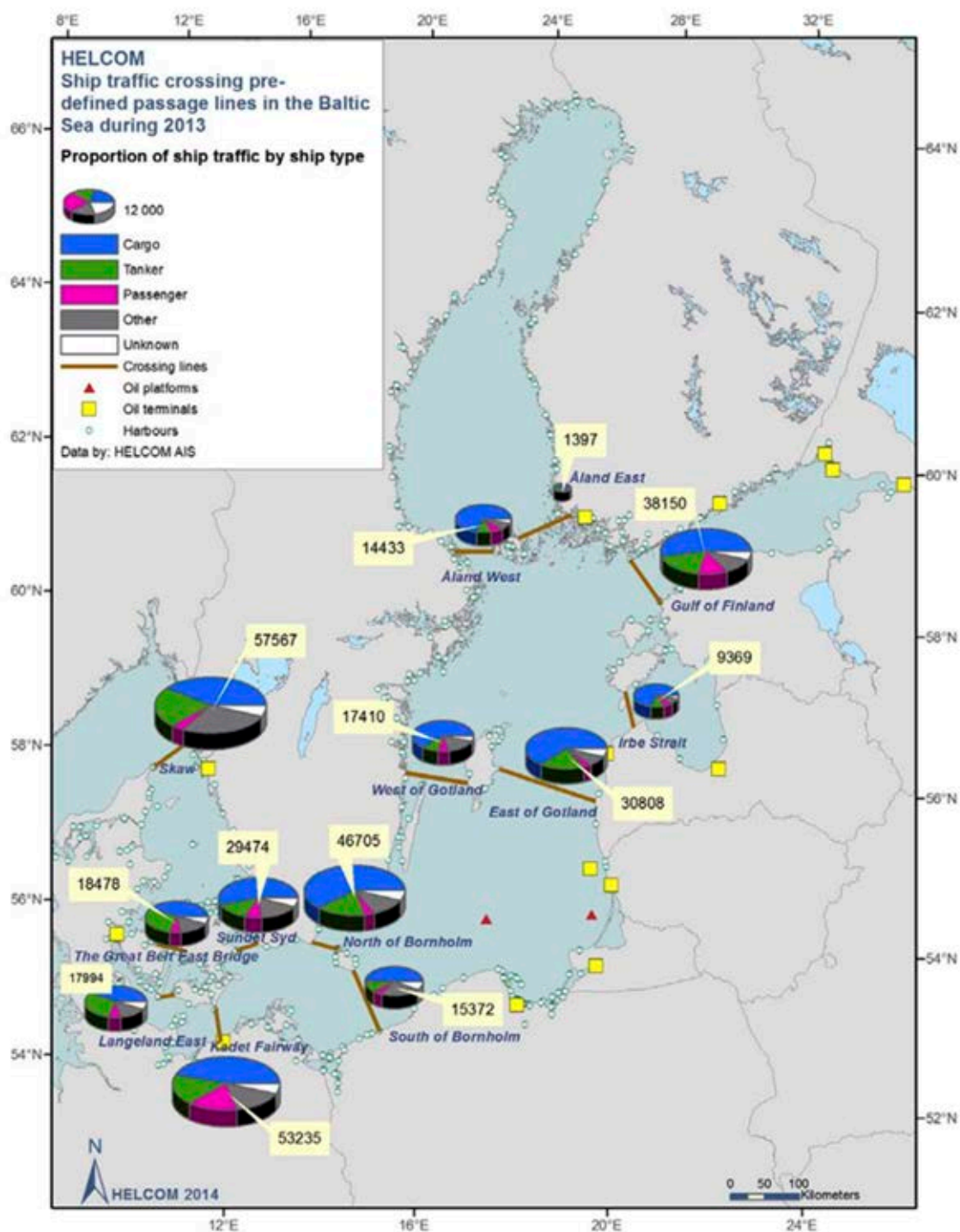


Figure 1. Location of AIS passage lines and numbers of ships crossing them in the Baltic Sea in 2013 (HELCOM, 2014)

The second most-frequently crossed AIS line was Kadet Fairway. According to HELCOM data, in 2013 the Kadet Fairway line was crossed by 53,235 ships, mostly cargo and passenger vessels. Another area of high traffic intensity, the Sound, runs between the Scandinavian Peninsula and Zealand, a Danish island. The AIS line in this area recorded 54,393 vessels in 2013, of which 29,179 were cargo vessels. Increased shipping traffic can also be observed in the Gulf of Finland. The AIS line in that region was

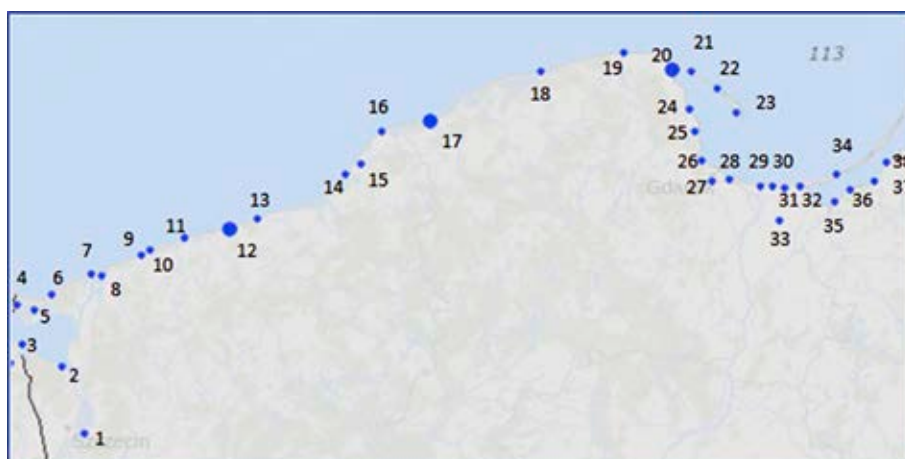
crossed by 29,474 vessels, of which 16,055 were cargo vessels (HELCOM, 2014). Table 1 shows the number of vessels recorded by AIS lines in 2013 according to the type of vessel.

An analysis of Polish fishing ports and fishing boats and cutters landing locations

Polish ports important to Poland's fishing industry are located along the entire coast, from Świnoujście

Table 1. The number of vessels recorded by AIS passage lines in 2013 according to the type of vessel (HELCOM, 2014)

Location	Type of ship					Total
	Passenger	Cargo	Tanker	Other	Unknown	
Skaw	2 394	24 188	10 523	17 690	2 772	57 567
Great Belt East Bridge	1 544	7 961	4 925	3 079	969	18 478
Drogden	2 806	16 055	3 778	5 168	1 667	29 474
Langeland East	1 590	7 742	4 799	2 783	1 080	17 994
Kadet Fairway	10 171	24 556	7 590	8 600	2 318	53 235
North of Bornholm	1 903	27 875	9 232	5 434	2 261	46 705
South of Bornholm	920	7 701	1 468	4 143	1 140	15 372
West of Gotland	1498	10 502	1 850	2 835	725	17 410
East of Gotland	1 220	18 926	7 010	2 149	1 503	30 808
Aland West	1 231	10 039	1 608	980	575	14 433
Aland East	13	593	105	591	95	1 397
Gulf of Finland	5 261	20 113	7 118	3 975	1 683	38 150
Irbe Strait	778	6 519	1 187	532	353	9 369
Total	31 329	182 770	61 193	57 959	17 141	350 392
% of Total	9	52	17	17	5	100

**Figure 2. A map of Polish fishing ports and fishing boats and cutters landing locations (<http://ec.europa.eu>)**

in the west, through Dziwnów, Kołobrzeg, Darłowo, Ustka, Łeba, Władysławowo, Jastarnia, Hel and Gdynia in the east. These ports are the bases and catch landing locations for the most fishing vessels, shown in Figure 2.

In Figure 2, the numbers are assigned to the following harbours: 1 – Szczecin Dąbie; 2 – Trzebież; 3 – Altwarp (Germany), 4 – Świnoujście; 5 – Świnoujście–Karsibór; 6 – Międzyzdroje; 7 – Międzywodzie; 8 – Dziwnów; 9 – Rewal; 10 – Niechorze; 11 – Mrzeżyno; 12 – Kołobrzeg; 13 – Ustronie Morskie; 14 – Dąbki; 15 – Darłowo; 16 – Jarosławiec; 17 – Ustka; 18 – Łeba; 19 – Dębki; 20 – Władysławowo; 21 – Chałupy; 22 – Jastarnia; 23 – Hel; 24 – Rewa; 25 – Oksywie; 26 Maritime University of Szczecin – Gdynia; 27 – Gdańsk; 28 – Górkki Zachodnie.

On 1 September 2014 the Polish fishing fleet consisted of 867 ships registered in 65 locations. The

largest numbers of fishing craft were registered in Ustka (73), Władysławowo (61), Kołobrzeg (58) and Darłowo (57). Fishing vessels of overall length less than 15 meters numbered 726 ships, representing 83.7% of the total fleet. Fishing vessels with an overall length above 15 meters accounted for 16.3% (141 ships), and should be equipped with AIS B transponders (Anczykowska, Sobkowicz, Ślaczka, 2015). Within three years, the number of registered fishing vessels decreased to 841. The number of fishing vessels with an overall length above 15 meters fell to 130, which represents 15.5% of the total fleet. 711 fishing ships were had an overall length less than 15 meters (84.5%) (<http://ec.europa.eu>). Table 2 shows the number of ships registered in selected ports in 2014 and 2017.

In terms of capacity, the biggest vessels were noted in Gdansk, Gdynia and Sopot. They represent

Table 2. The number of Polish fishing vessels registered in ports on the southern Baltic coast on 1 September 2014 and 1 June 2017 (<http://ec.europa.eu>)

Port of registry	2014	2017	Port of registry	2014	2017
Ustka	73	64	Krynica Morska I	7	7
Władysławowo	61	65	Puck	7	6
Kołobrzeg	58	52	Rewal	7	7
Darłowo	57	48	Ustronie Morskie	7	7
Jastarnia	49	44	Jantar	6	6
Kuźnica	44	40	Kamień Pomorski	6	6
Trzebież	35	35	Obłuże	6	6
Łeba	32	29	Rowy	6	6
Nowa Pasłęka	27	29	Sopot	6	6
Świnoujście	25	24	Szczecin – Stołczyn	6	7
Dziwnów	22	22	Dębki	5	5
Hel	20	21	Międzyzdroje	5	4
Jarosławiec	19	19	Niechorze	5	5
Frombork	16	16	Oksywie	5	5
Piaski II	14	14	Chłapowo	4	4
Unieście	14	13	Górki Zachodnie	4	3
Wolin	14	15	Międzywodzie	4	4
Chłopy	13	13	Orłowo	4	4
Piaski I	12	12	Świnoujście – Przytór	4	4
Kąty Rybackie I	11	13	Dźwirzyno	3	3
Stepnica	11	10	Gdynia	3	3
Kąty Rybackie II	10	9	Górki Wschodnie	3	3
Krynica Morska II	10	9	Mrzeżyno	3	4
Swarzewo	10	12	Rewa	3	4
Szczecin – Dąbie	10	10	Stegna	3	3
Chałupy	9	10	Gdańsk	2	2
Suchacz	9	9	Kamienica Elbląska	2	2
Świbno	9	9	Mikoszewo	2	2
Świnoujście – Karsibór	9	10	Nowe Warpno	2	2
Lubin	8	8	Jelitkowo	1	1
Mechelinki	8	8	Szczecin	1	0
Tolkmicko	8	9	Sztutowo	1	1
Dąbki	7	8			

60% of the total capacity of the Polish fishing fleet. The smallest craft were found in the region of Szczecin, where coastal fishing prevails (<http://ec.europa.eu>). Polish fishing vessels may use 59 landing stages, but 75% of the catch is discharged in Kołobrzeg, Władysławowo and Hel (European Parliament, 2011). Most of the landing stages are located on the beach and have no proper equipment to be capable of handling more vessels.

The Polish fishing fleet is engaged in coastal, Baltic and ocean fish catching operations. The main routes followed by fishing vessels run from their harbours to the fishing grounds. Major areas of operations of the Polish fishing vessels in the southwestern Baltic include the Kołobrzeg–Darłowo Fishery, Ławica *Odrzańska* and Bornholm S. Fishing grounds are defined as subdivisions by the International Council for the Exploration of the Sea (ICES) and fishing squares. Polish fisheries are contained in ICES subdivisions 24 and 25 (<http://www.marinarega.pl>). Table 3 describes Polish fisheries.

The main fisheries (Kołobrzeg–Darłowo, Ławica *Odrzańska* and Bornholm S) are divided into a number of smaller fisheries: identified by their square number. Figure 3 presents a map of the southern Baltic Sea with Polish fisheries divided into fishing squares.

Due to the irregular traffic of fishing vessels in the southern region of the Baltic, an analysis was conducted to identify major fishing vessel traffic directions of movement and the areas of the densest traffic. The access for Polish fishing vessels to fishing grounds is governed by international agreements between Poland and the Baltic countries (Ustawa, 1991).

Polish fishing vessels operate mainly within the exclusive economic zone (Przywarty, Jarząbek, Gucma, 2014). Based on several agreements, Polish vessels may catch fish outside Poland’s exclusive economic zone.

Table 3. Location of Polish fisheries in the southwestern Baltic Sea in ICES subdivisions (<http://www.marinarega.pl>)

Designation of fishery	ICES subdivision	Fishing squares	Description
Kołobrzeg – Darłowo	25	F-2, F-73, F-4, G-3, G-4, G-5, H-3, H-4, H-5, H-6, J-3, J-4, J-5, J-6, J-7, K-5, K-6, K-7, K-8	From Ławica Odrzańska to Ławica Słupska
Ławica Odrzańska	24	partly: C-1, C-2, D-3, D-4 whole: D-1, D-2, F-2, E-3, E-4	Southwest area of Polish fishing zone; fisheries of Pomorska Bay and Ławica <i>Odrzańska</i>
Bornholm S	25	E-5, E-6, F-5, F-6, G-6, G-7, G-8, H-7, H-8, J-8, J-9	Squares: E-5, E-6, G-6, G-8, J-9 lie beyond Polish exclusive economic zone

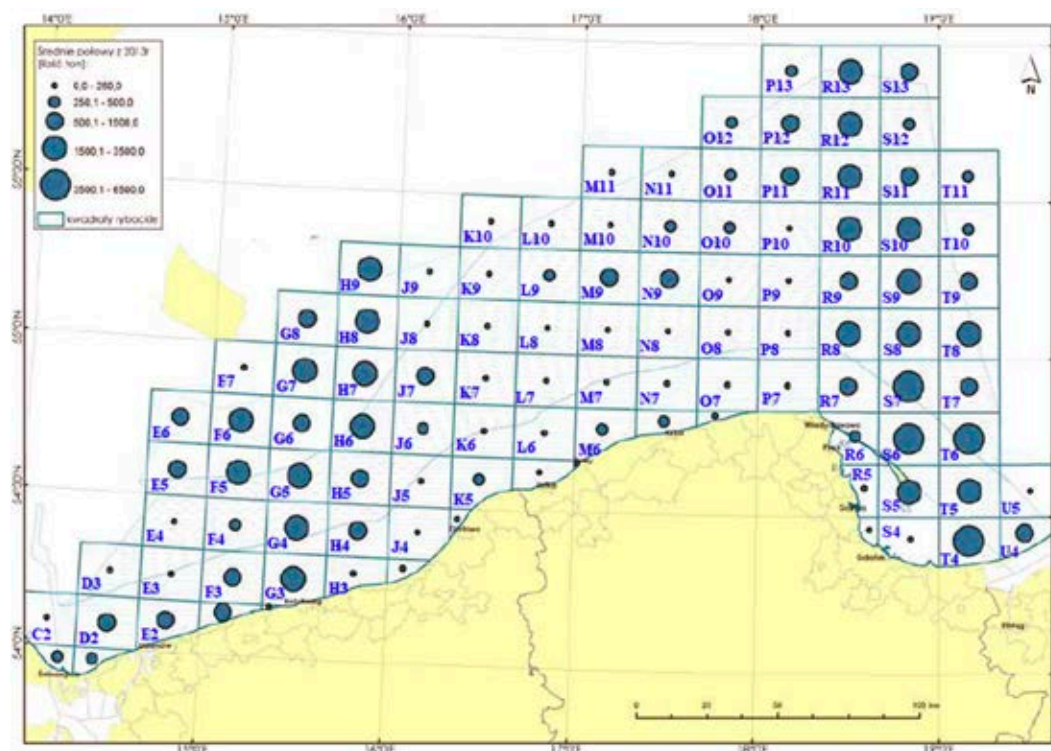


Figure 3. The main fishing grounds of the southern Baltic Sea divided into fishing squares (Maritime Institute in Gdańsk, 2015)

Methods and data analysis

For a detailed analysis of vessel traffic in the South Baltic Sea, research lines were established along the Polish coast. The study was conducted on the basis of AIS data using the IALA IWRAP Mk2 program.

The analysis covered three quarters of 2013 (April to December) and the first quarter of 2014. The results are shown in Table 4 and Figures 4 and 5.

The eight lines chosen for the analysis were as follows: Świnoujście 1, Świnoujście 2, Rewal, Kołobrzeg, Ustka, Hel, Gdynia and Gdańsk. The criterion

Table 4. The number of vessels in the 2nd, 3rd and 4th quarters of 2013 and 1st quarter of 2014 in selected research lines by vessel type

Research line	Direction	Type of ship						Total
		Passenger	General cargo ships	Oil products tanker	Support ships	Fishing ships	Other	
Świnoujście1	N bound	10 060	3 635	858	458	39	340	15 390
	S bound	9 568	3 783	714	402	44	410	14 921
Świnoujście2	W bound	8	1 528	544	37	11	39	2 167
	E bound	8	2 519	533	62	12	42	3 176
Rewal	W bound	175	4 941	1 429	118	23	137	6 823
	E bound	145	6 256	1 455	130	12	76	8 074
Kołobrzeg	W bound	463	5 712	1 584	182	24	202	8 167
	E bound	283	6 686	1 528	153	36	122	8 808
Ustka	W bound	596	8 669	2 043	366	40	235	11 949
	E bound	532	10 563	1 778	333	35	170	13 411
Hel	N bound	3 520	11 112	1 478	1 352	71	985	18 518
	S bound	3 509	11 097	1 533	1 374	63	940	18 516
Gdynia	W bound	2 829	6 349	413	186	39	533	10 349
	E bound	2 735	6 776	515	287	59	495	10 867
Gdańsk	N bound	0	1 320	1 084	36	15	40	2 495
	S bound	0	1 303	1 045	47	11	33	2 439



Figure 4. Location of the research lines in the southern part of the Baltic Sea and investigated directions of traffic flow

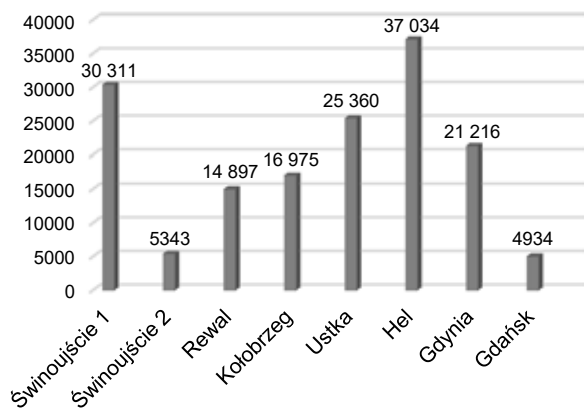


Figure 5. The total number of vessels in the measuring lines in the 2nd, 3rd and 4th quarter of 2013 and 1st quarter of 2014

for choosing the location of the lines was traffic intensity. Four lines were established on the western part and four on the eastern part of the Polish coast. AIS-registered vessel positions were marked on a chart of the southern Baltic Sea by the IALA IWRAP program. The analysis was made for two directions of shipping traffic.

The greatest vessel traffic is noted in the port approaches of Gdynia and Gdańsk (research line Hel) and Świnoujście. The research line Hel recorded the largest number of general cargo ships – 22,209. The approach to Świnoujście was passed by the largest number of passenger ships – 19,628, which results from ferry connections with Scandinavia.

Table 5. Percentage of fishing vessels by length in research lines Świnoujście 1 and 2, Rewal and Kołobrzeg in a specific period of research

L [m]	Świnoujście 1		Świnoujście 2		Rewal		Kołobrzeg	
	north bound	south bound	west bound	east bound	west bound	east bound	west bound	east bound
0–25	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	33.33%	11.11%
25–50	51.28%	54.55%	36.36%	33.33%	65.22%	66.67%	33.33%	77.78%
50–75	38.46%	36.36%	63.64%	66.67%	0.00%	33.33%	0.00%	11.11%
75–100	10.26%	9.09%	0.00%	0.00%	17.39%	0.00%	16.67%	0.00%
100–125	0.00%	0.00%	0.00%	0.00%	17.39%	0.00%	16.67%	0.00%
> 125	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 6. Percentage of fishing vessels by length in research lines Ustka, Hel, Gdynia and Gdańsk in a specific period of research

L [m]	Ustka		Hel		Gdynia		Gdańsk	
	west bound	east bound	north bound	south bound	west bound	east bound	north bound	south bound
0–25	20.00%	22.86%	0.00%	0.00%	0.00%	0.00%	0.00%	63.64%
25–50	60.00%	65.71%	60.56%	55.56%	89.74%	100.00%	100.00%	36.36%
50–75	0.00%	0.00%	16.90%	19.05%	10.26%	0.00%	0.00%	0.00%
75–100	10.00%	11.43%	5.63%	6.35%	0.00%	0.00%	0.00%	0.00%
100–125	10.00%	0.00%	16.90%	19.05%	0.00%	0.00%	0.00%	0.00%
> 125	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

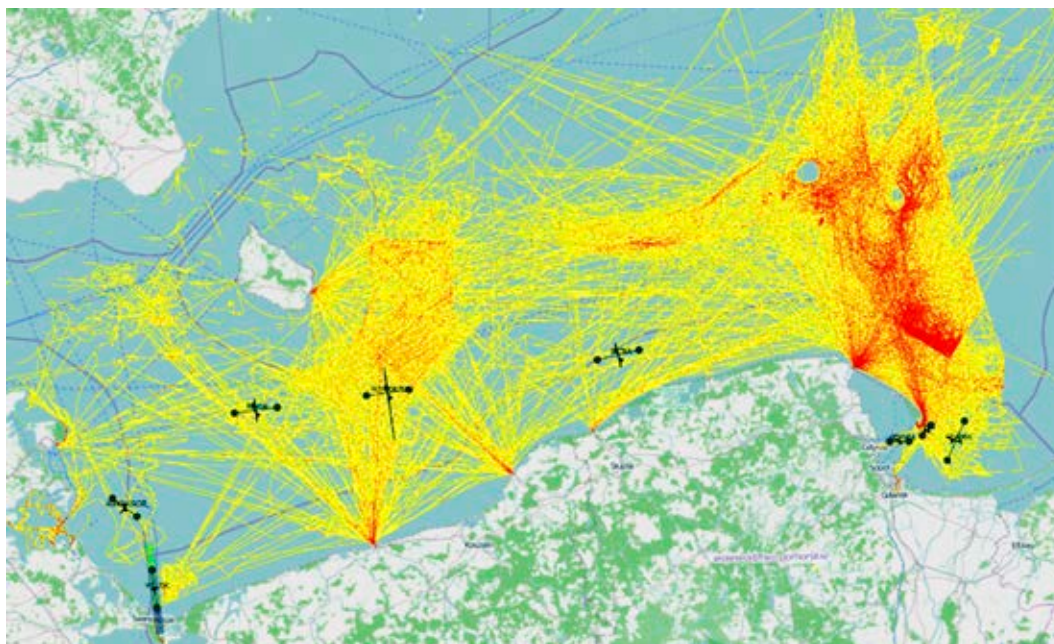


Figure 6. The main traffic streams of fishing crafts in the South Baltic Sea registered by AIS in 2nd quarter of 2013

Fishing vessel routes

The analysis, performed with the IALA IWRAP Mk2 program, aimed at examining vessel traffic in two directions. Ships were grouped by length. Tables 5 and 6 indicate the percentage of fishing vessels in each research line.

The presented statistics reflect vessels fitted with AIS transponders. Despite the requirement for fishing vessels to carry AIS transponders, some vessels do not have them (Anczykowska, Sobkowicz, Ślęczka, 2015). Figure 6 shows the main traffic streams of fishing craft in the South Baltic Sea registered by AIS in the 2nd quarter of 2013.

The impact of fishing vessel traffic on merchant vessel traffic streams along shipping routes in the South Baltic Sea

Quite naturally, the main shipping routes cross routes of fishing vessels proceeding to and from fishing grounds. For this reason, there is an increased risk of collision with fishing vessels. Based on the research carried out, the authors have indicated two areas of increased risk of collisions involving fishing vessels. Streams of vessel traffic on the main shipping routes in the South Baltic Sea are shown in Figure 7.

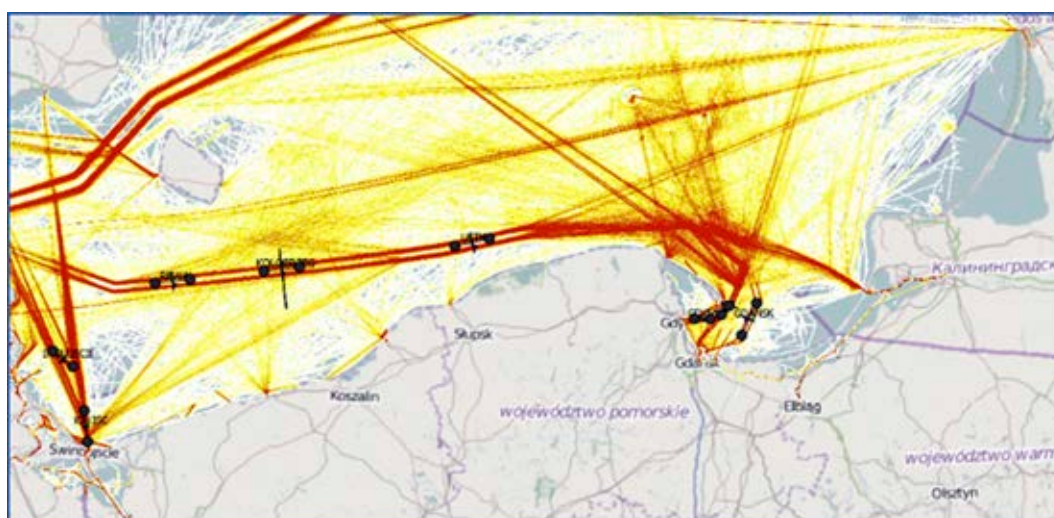


Figure 7. Streams of vessel traffic on the main shipping routes in the South Baltic Sea recorded by AIS in 2nd quarter of 2013

The greatest risk of collisions involving fishing vessels exists in the Gulf of Gdańsk and northeast of the Hel Peninsula. The collision risk is due to the intersections of frequented shipping routes (ferry lines between Poland and Sweden, or offshore vessel service to Baltic Beta drilling rig) and fishing vessel routes to/from fisheries in squares P11 to P13, R7 to R13 and S5 to S13 which cross these areas.

The other region posing an increased risk of collisions with fishing vessels is the area southeast of the island of Bornholm, the largest fishing ground in the South Baltic Sea, called Bornholm S. The intensity of fishing vessel traffic in that area is due to the proximity of a few fishing harbours on the Polish coast: the Kołobrzeg, Darłowo and Ustka, bases and landing stages for a major portion of the Polish fleet. Fishing vessel traffic is greatest in spring and summer. During these seasons, hydrometeorological conditions in the region are favourable and fish protection periods, which are related to the fishing quotas granted for each calendar year to the EU states concerned, are rare (<http://ec.europa.eu>).

Potentially, the lowest risk of collisions involving fishing vessels exists in the Świnoujście approach channel. There are not any large fishing grounds in that area, while the harbours in Świnoujście and on the shore of Zalew Szczeciński are home to only a small part of the Polish fleet.

Conclusions

The analysis of the traffic streams performed using the IALA IWRAP program, for the period including the 2nd, 3rd and 4th quarters of 2013 and three months of 2014, and available AIS data have revealed that the greatest intensity of vessel traffic occurs during the 2nd and 3rd quarters of the year. This is due to favourable hydrometeorological conditions prevailing in the southern Baltic Sea and permitted fishing periods.

The vessel traffic density is greatest on the main shipping routes and Baltic port approach waters. Their location results from good sea practices and marine traffic separation schemes established under the Collision Regulations. Publications on voyage planning in the southern Baltic Sea (Mariners Routing Guide Baltic Sea – HELCOM) suggest that these shipping routes should be chosen. These routes are well established and are the most frequented shipping routes in the Baltic.

The analysis of fishing vessel traffic streams has also found that, despite a large number of ports of registry, the fishing craft generally land at only a few

ports. These include ports in Gdańsk Bay and the Hel Peninsula (Władysławowo, Hel), Świnoujście, Kołobrzeg, Darłowo, Ustka and Łeba. The traffic is reduced in winter, as poor weather conditions and ice affect fishing operations. In the winter months, fishing vessel traffic is reduced in the area in the southwestern Baltic Sea (from Ustka towards Świnoujście), while an increase in fishing vessel traffic is observed in the southeastern part of the Baltic Sea in the area of Gdańsk Bay. The observations also indicate a significant reduction in vessel traffic in the area of oil rigs located north of Cape Rozewie, where safety zones around the platforms have been established.

The analysis has shown that the fishing vessel traffic streams in the southern Baltic Sea have an impact on commercial vessel traffic. Fishing vessels sailing irregularly increase the risk of collisions with other vessels, particularly when en-route to the fishing ground or back to the port base. Shipping safety in this context depends largely on the fishing crews because the observed common practice by fishermen is not to give way, even if their vessel is not engaged in fishing.

Passenger/car ferries plying between Poland and Sweden face an increased risk of collisions with fishing vessels. Their routes cross the main fishing grounds of the Polish fleet. In cases of a collision situation developing between a fishing vessel and a ferry, the personnel of both vessels should be required to take precautions and keep a sharp lookout in order to avoid dangerous situations.

To sum up, fishing vessel personnel should, by all means, comply with the Collision Regulations, in particular those concerning day shapes and lights.

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