

PS1-PL-2021 Report

**Pilot Study to develop recreational fishing monitoring methods
in Poland under the Data Collection Framework**

Authors : Adam M. Lejk, Łukasz Dziemian, Marta Szymańska, Katarzyna Krakówka, Rafał Bernaś
and Piotr Dębowski

Field work team: Łukasz Giedrojć, Adam Grochowski, Kamil Kisielewski, Piotr Pankowski,
Marcin Sułkowski, Michał Zimak



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Pilot study was carried out on the basis of „Polish Work Plan for data collection in the fisheries and aquaculture sectors (2017-2019)”, Version [1], Gdynia, 31.10.2016.

Cover photograph: Adam M. Lejk

MODULE 1 - COASTAL AND MARINE WATERS

1 INTRODUCTION

Year by year, angling in sea waters gathers more and more followers in Europe (Hyder et al. 2018). The variety of species and methods of fishing makes it possible to combine active recreation with the possibility of experiencing a sea adventure. Similar trend is observed in Poland. The attractiveness of fishing at sea is directly reflected in the number of licenses issued by the Sea Fisheries Inspectorates, which in recent years has reached 50,000 annually (Fig. 1). Recreational fishing is an important component of the Baltic Sea natural resource management model (ICES 2018), scientifically advised by the International Council for the Exploration of the Sea (ICES). Until now, the dataset only concerned organized cod fishing trips, during which data on the volume and structure of catches are recorded and biological material is collected for further research (Fertter et al., 2013). Additionally, scientists paid attention to other fish species included in the sea recreational catches, e.g. atlantic salmon, sea trout and eel, pointing to a data gap (Weltersbach, 2013). Nowadays there is no reporting system for salmon and sea trout trolling boats in the Baltic Sea. The situation is similar with eel recreational fishing. The specificity of fishing for these species requires the use of completely different research methods, taking into account regional conditions.

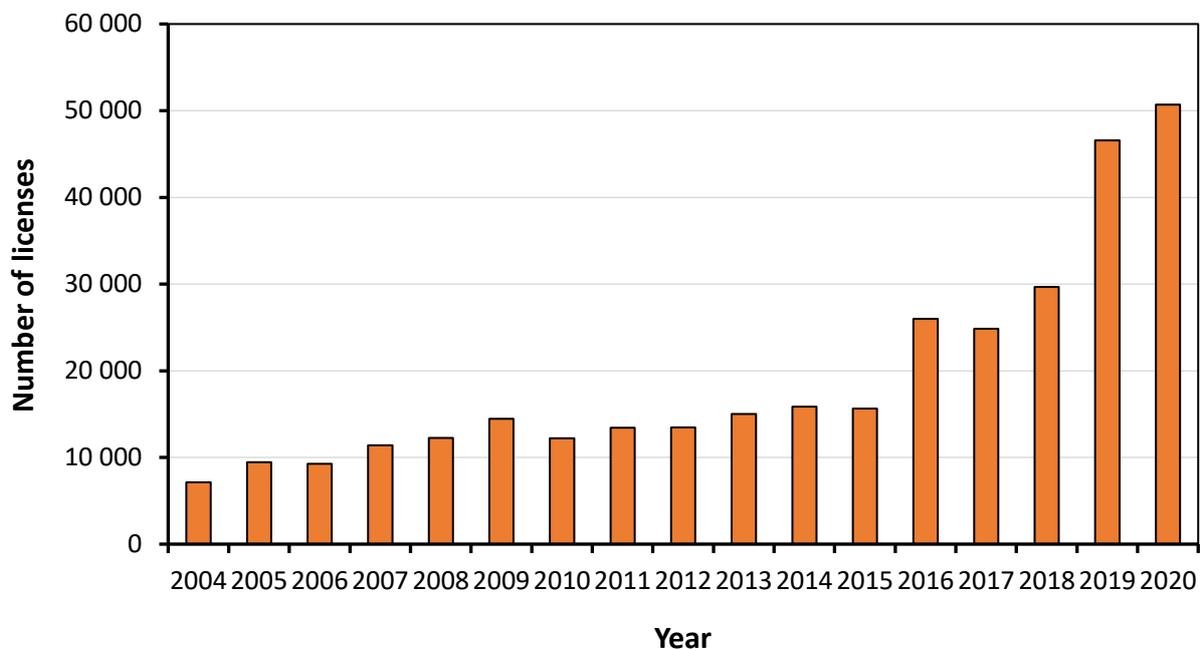


Figure 1. Number of individual fishing licenses issued by Maritime Fisheries Inspectorate, in consecutive years.

The beginning of recreational salmon trolling in Polish Maritime Waters dates back to 2004 (Ramutkowski 2013). Intensive development and growing interest in the marine recreational fishing have forced the extension of the observations carried out so far to include other forms of fishing activity. To this end, in 2017-2018, the National Marine Fisheries Research Institute (NMFRI) coordinated a pilot study aimed at developing methodological assumptions for conducting regular, scientific monitoring of recreational fishing in Polish Maritime Areas, taking into account the specificity of the Polish coast as well as technical and cultural conditions. The developed methods should provide information on the species structure of angling catches, the list of preferred species, seasonality as well as estimated catches and their potential impact on the marine ecosystem. The research was

carried out as part of the EU Multi-Annual Programme for Fisheries Data Collection under the Data Collection Framework, the implementation of which is a legal obligation of the EU Member States.

1.1 FISHING REGULATIONS

Fisheries management in Poland is currently under responsibility of the Department of Fisheries of the Ministry of Agriculture and Rural Development. The commercial and recreational fisheries is controlled by the General Maritime Fisheries Inspectorate (GMFI) in Słupsk, whose area of competence covers the entire Polish coast including internal Polish Maritime Waters (lagoons, mouths of rivers, harbor waters).

Recreational fishing in Polish Maritime Waters is regulated on the national level (Law on Fisheries of 19 December 2014 (Journal of Laws 2014, item 1592, with amendments). Currently, law sets the limits of daily catch of each species per one angler, individual size limits for particular species, protected spawning seasons/areas and number of fishing rods allowed to use in angling methods.

1.2 FISHING TECHNIQUES AT SEA

Sea recreational fisheries targeting salmon, sea trout and eel in Polish Maritime Waters is performed using rod fishing from the sea shore (Fig. 2) whereas fisheries targeting salmon (and to a lesser extent sea trout) is conducted with the use of trolling technique (trolling boats; Fig. 3). The target species strongly depends on the fishing season. The fishing for sea trout and salmon is conducted in late autumn, winter and early spring and take place both from the shore and offshore. The season for eel fishing starts at the beginning of July and ends early autumn.



Figure 2. Fishing for sea trout from the shore (author: Adam M. Lejk).



Figure 3. Trolling fishing for salmon (author: Adam M. Lejk).

2 METHODS

Due to the specificity of sea recreational fisheries targeting salmon, seatrout and eel, the applied methods have been adapted to particular fish species, taking into account spatial and temporal differences and fishing techniques, with aim to provide information on the following aspects:

- identification of categories of the Polish recreational fisheries,
- estimates of the catch volume and composition and catch per unit effort,
- spatial and temporal distribution of the salmon, seatrout and eel recreational fisheries,
- size and composition of the recreational fishery fleet (the share of the commercial trolling boats in the total number of trolling boats),
- number and structure of the recreational fishing permits issued annually,
- socio-economic information on recreational fishery,
- development of methods for effective monitoring of recreational fisheries, taking into account local conditions.

Field observations were conducted in 2017-2018. In 2019, the data analysis was carried out.

2.1. TROLLING BOAT COUNTING

Starting from April-May 2017, through November-December 2017 and January-May 2018 ending November-December 2018 a trolling boats were counted in Polish harbors (Fig. 4). NMFRI observers visited marinas and harbors along Polish coast. Boats have been counted in total of 12 harbors (six in western part and six in eastern part of Polish coast). Boats were classified as a trolling boats based on the characteristic equipment installed on boats used for trolling fishing, eg., downriggers, rod holders, planners. Boat counting took place once a month with equal time intervals. These information have been verified during on-site surveys and direct contact with a skippers.



Figure 4. Trolling boats in Hel harbor (author: Adam M. Lejk).

2.2 CCTV MONITORING

Preliminary results of the study on the use of remote CCTV cameras for monitoring of recreational salmon trolling fishery effort (presented at the 2016 ICES Annual Science Conference) revealed that remote cameras proved to be a cost-efficient method providing accurate fishing effort estimates helping to reduce bias in recreational catch estimates (Weltersbach et al., 2016). Digital cameras have been used in similar studies e.g., in New Zealand, Australia and Germany, to monitor recreational fishing effort (Hartil et al., 2020).

During the pilot study implemented by NMFRI, the remote CCTV cameras have been installed in two harbors i.e., Hel and Gdańsk Górkki Zachodnie (Fig. 5). These locations are known as the most important for salmon and seatrout recreational fishery and were also chosen because of availability of technical infrastructure. To install the cameras, the consent of the Maritime Office in Gdynia was required. In both locations, cameras are mounted on the towers of the radar stations (Fig. 6, Fig. 7).

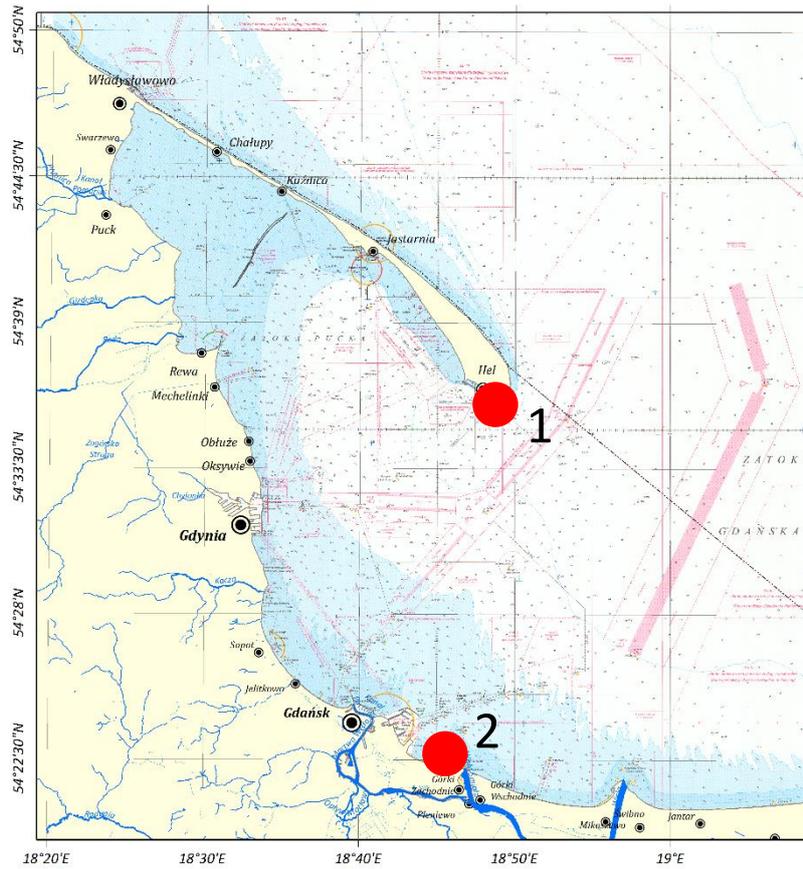


Figure 5. Locations of CCTV monitoring installed in 1) Hel and 2) Gdańsk Górki Zachodnie.

The CCTV cameras started recording in January 2018 in both locations. The cameras recorded boat movements between 04:00 and 18:00 each day. A high image frame rate; Full HD format (25 images per sec-ond) is set to ensure full coverage of the activity at each monitored marina and correct identification of trolling boats.

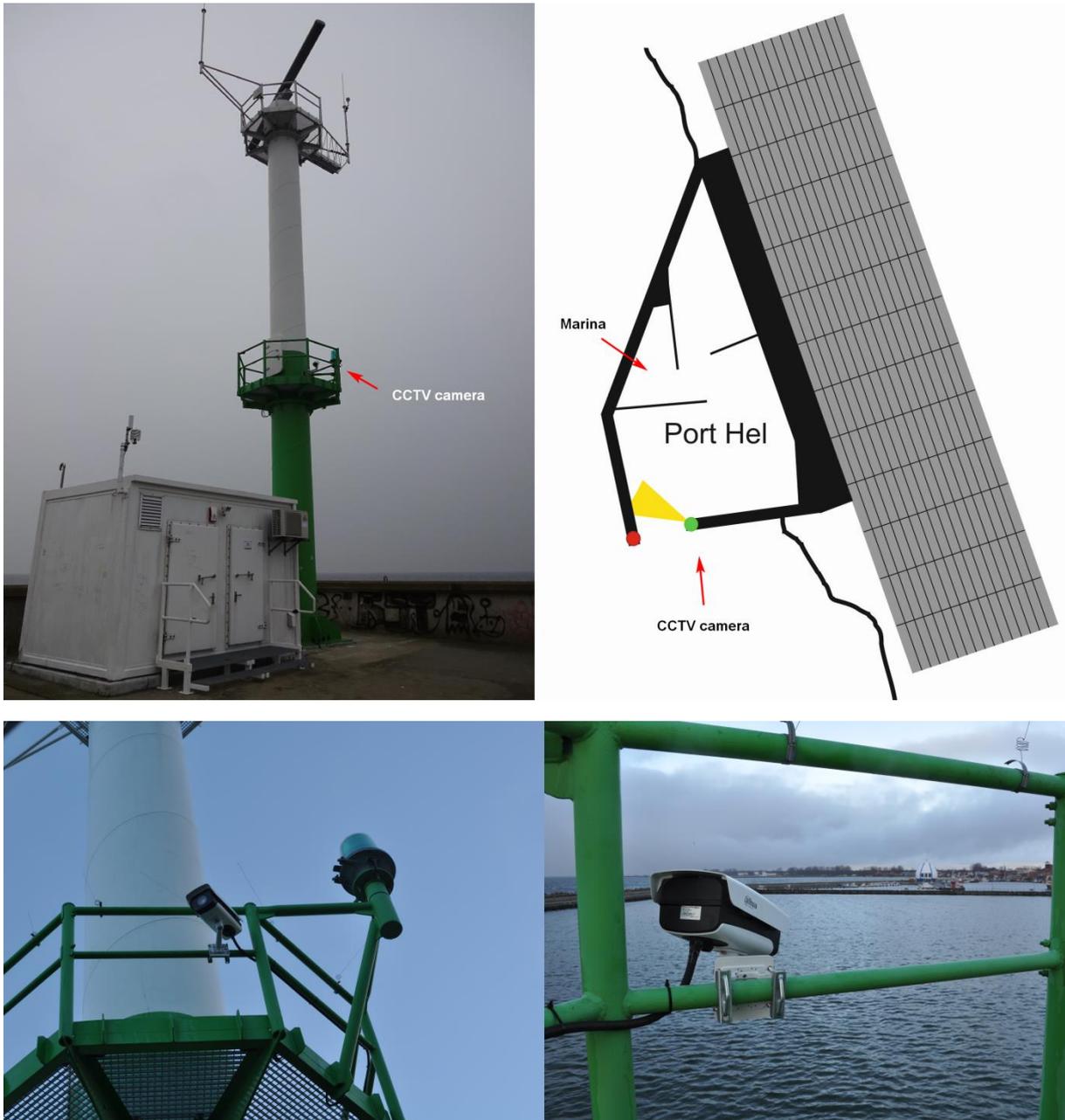


Figure 6. Technical scheme of location of CCTV camera in Hel (author: Adam M. Lejk).



Figure 7. Technical scheme of location of CCTV camera in Gdańsk Górki Zachodnie (author: Adam M. Lejk).

2.3 ON-BOARD OBSERVATIONS

In 2017-2018 NMFRI observers took part in six organised salmon trolling fishing trips from Hel and Gdańsk Górki Zachodnie harbors to test the possibility of direct, at sea collection of the catch composition and biological data. A special data collection form was implemented to collect information on particular cruise parameters and on biological samples during on-board observations (Fig. 8).

Karta rejsu trollingowego		gatunek <u>SAL</u>	
		data <u>06.01.2018</u>	
		nr <u>12017 / 760014</u>	
		80 cm	5200 g
		♀	gonady <u>3</u>
			zółdek <u>2</u>
			wiek <u>32+</u>
Numer wyprawy	<u>3</u>		
Data (dd-mm-rr)	<u>06.01.2018</u>		
Nazwa jednostki	<u>Fvodo III</u>		
Port wypłynięcia	<u>Hol</u>		
Godzina rozpoczęcia/zakończenia połowu	<u>8:00 / 15:50</u>		
Pozycja rozpoczęcia/głębokość	<u>54°33'N / 18°58'E / 80 m</u>		
Pozycja środkowa/głębokość	<u>54°37'N / 19°00'E / 83 m</u>		
Pozycja zakończenia/głębokość	<u>54°37'N / 19°02'E / 78 m</u>		
Liczba wędkujących	<u>4</u>		
Liczba zestawów w wodzie	<u>12</u>		
Sumaryczna liczba złowionych ryb	SAL: <u>1</u>	TRS:	inne: <u>2</u>
Liczba ryb zatrzymanych	SAL: <u>1</u>	TRS:	inne: <u>dorsz - 2</u>
Liczba ryb wypuszczonych	SAL:	TRS:	inne:
Zebrańie śladu GPS (tak/nie)	<u>nie</u>		
Uwagi: <u>SAL - 80 cm; 5,2 kg</u> <u>COD - 37 cm; 0,70 kg</u> <u>47 cm; 1,10 kg</u>			

Figure 8. Data collection form used for on-board observations and biological samples collected from trolling cruise (author: Adam M. Lejk).

2.4 SELF-SAMPLING OF TROLLING CATCHES

To monitor trolling cruises frequency, catch per unit effort as well as catch species composition a self-sampling method of trolling catches has been applied. This method consisted of three components:

- development of fishing logbook, containing cruise data as well as biological data of fish caught (Figure 9),
- entering into contracts with trolling boats' skippers/owners,
- fishing logbooks distribution among the trolling boats' skippers/owners to fill-in on a voluntary basis.

In the course of the Pilot Sudy 17 logbooks were distributed, covering four main harbours identified as the most important for salmon and sea trout recreational fishery and one other harbor with trolling boats activity identified:

- Gdańsk Górki Zachodnie – 4 logbooks,

- Gdynia – 4 logbooks,
- Hel – 6 logbooks,
- Kołobrzeg – 2 logbooks,
- Dziwnów – 1 logbook.



Gatunek	Długość [cm]	Masa [kg]	Płeć [samiec/samica]	Obecność płetwy tłuszczowej [tak/nie]	Zabrana / Wypuszczona [z/w]
			<input type="checkbox"/> SAMIEC <input type="checkbox"/> SAMICA	<input type="checkbox"/> TAK <input type="checkbox"/> NIE	<input type="checkbox"/> Z <input type="checkbox"/> W
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* Liczba uczestników łącznie z załogą jednostki. ** Od pierwszego wystawienia zestawów do ich wyciągnięcia.

Kontakt:
Adam Łęjk - email: adam.lejki@mir.gdynia.pl; tel: 660 475 745
Lukasz Dziemian - email: lukasz.dziemian@mir.gdynia.pl; tel: 604 106 196

Figure 9. The cover and report sheet from the trolling logbook.

2.5 ON-SITE SURVEY

On-site survey method has been applied to monitor sea trout, eel and salmon recreational fisheries activities. This method was based on a newly developed digital questionnaire installed on tablets enabling a direct interviews among anglers fishing from the shore for sea trout and eel and anglers attending trolling cruises for salmon returning to harbors/marinas from the sea.

Salmon

Salmon questionnaire interviews took place each year of pilot study duration in periods from November to early May. The interviews were carried out in three locations, i.e., Gdynia, Hel and Gdańsk Górkki Zachodnie.

Sea trout & eel

Sea trout questionnaire interviews took place each year of pilot study duration in periods from December to late April, identified as a sea trout fishing season from the shore. Based on expert

knowledge as well as informations collected from internet angling communities, main sea trout fishing hot spots were identified along the coast.

Eel questionnaire interviews took place from July to end of September – identified eel fishing season in Polish Maritime Areas. Similarly to the sea trout angling, fishing hot spots for eel were identified with the same basis - expert knowledge, internet data collection.

Questionnaire interview contains the following sections (Fig. 10):

- angler's consent to conduct an interview and questionnaire date, time and location,
- angler's personal data – sex, age, place of residence, fishing permit type,
- catch data – targeted species, number of rods being used, fishing duration,
- biological data of fish caught,
- socio – economical data – expenses for particular type of angling within last 12 months and approach type (catch and release, retaining the catch or mixed).

Numbers of questionnaire interviews conducted in particular years of pilot study duration:

- 2017:
 - ✓ sea trout – 4
 - ✓ salmon – 7
 - ✓ eel – 36
- 2018
 - ✓ sea trout – 44
 - ✓ salmon – 60
 - ✓ eel – 36

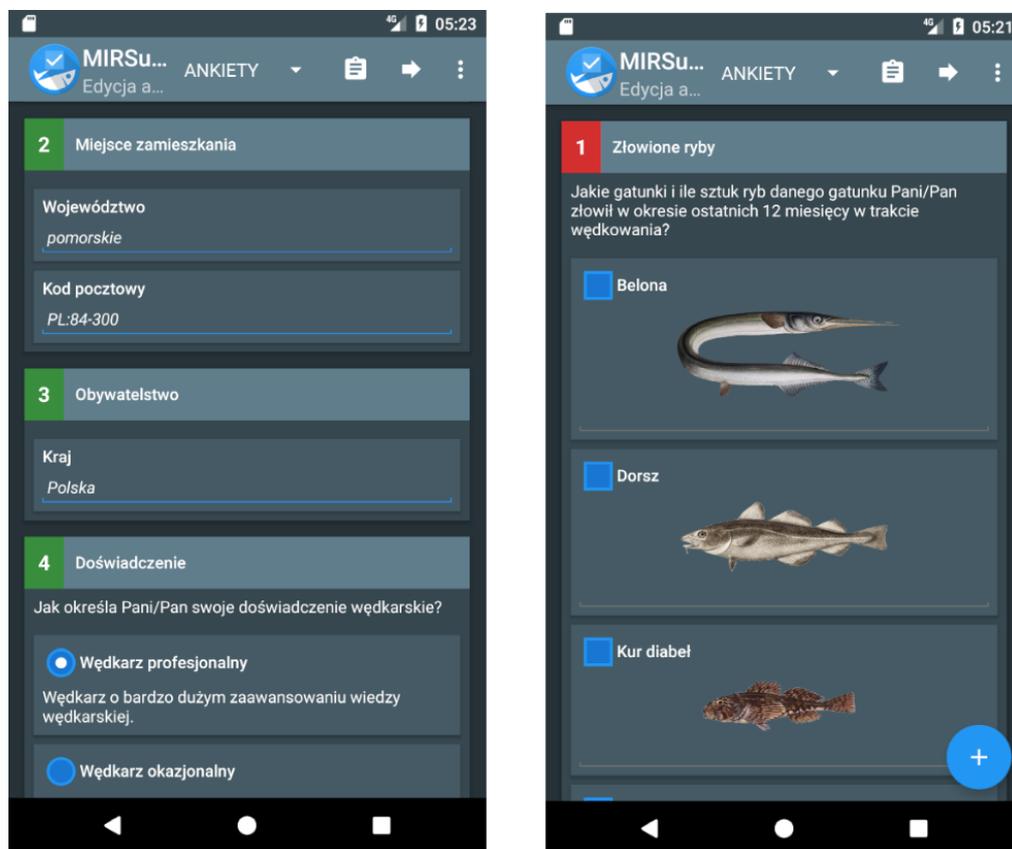


Figure 10. Screen of the some sections of on-site questionnaire.

2.6 OFF-SITE SURVEY

In March 2018 an off-site survey was initiated, targeting in general sea recreational fishing in Polish Maritime Waters. The core of this work consisted of a web-site (Fig. 11) including information about the survey and describing the aim of this work with a instruction how to fill a web-based questionnaire (Fig. 12). The survey concerned recreational sea catches performed in 2017 (12 months).

MORSKI INSTYTUT RYBACKI PAŃSTWOWY INSTYTUT BADAWCZY

Strona główna O Instytucje Oferta Działalność naukowa Infrastruktura Wynajem Kontakt

Ankieta wędkarska

W wiadomości > Ankieta wędkarska

Połowy wędkarskie w wodach morskich z roku na rok gromadzą coraz większą rzeszę zwolenników. Różnorodność gatunków ryb i metod połowu umożliwiają połączenie aktywnego wypoczynku z możliwością przeżycia morskiej przygody. Atrakcyjność połowów wędkarskich w morzu bezpośrednio odzwierciedla liczba licencji wydanych przez Okręgowe Inspektoraty Rybołówstwa Morskiego, sięgająca w ostatnich latach 40 tysięcy rocznie. Połowy rekreacyjne stanowią ważny komponent w modelu zarządzania zasobami naturalnymi Morza Bałtyckiego, którego naukowe doradztwo zapewnia Międzynarodowa Rada Badań Morza (ICES).

Morski Instytut Rybacki – Państwowy Instytut Badawczy (MIR-PIB) koordynuje badania pilotażowe mające na celu wypracowanie założeń metodycznych do prowadzenia regularnego, naukowego monitoringu połowów wędkarskich (tzw. rybołówstwa rekreacyjnego) w Polskich Obszarach Morskich, z uwzględnieniem specyfiki polskiego wybrzeża, warunków technicznych oraz zwyczajów kulturowych. Wypracowane metody umożliwią dostarczenie informacji na temat struktury gatunkowej połowów wędkarskich, listy preferowanych gatunków, sezonowości jak również szacowanych wielkości połowów oraz ich potencjalnego oddziaływania na ekosystem morski. Badania realizowane są w ramach unijnego Wieloletniego Programu Zbioru Danych Rybackich (WPZDR), którego realizacja jest prawnym zobowiązaniem krajów członkowskich Unii Europejskiej wynikającym z przepisów UE.

fot. Adam Ostrowski

MORSKI INSTYTUT RYBACKI PAŃSTWOWY INSTYTUT BADAWCZY

Przejdź do ankiety

Figure 11. Screen of the main web site of the Polish web-based survey.

Figure 12. Screen of the starting page of the Polish on-line questionnaire.

Information about the survey was made available on the Internet platforms, NMFRI web-site and social medias. In total, 304 filled questionnaires have been received and the collected data were analysed.

3 RESULTS & DISCUSION

Salmon trolling fishing was a very important component of the Pilot Study conducted. For this reason, this module has been divided into several sections to collect data on estimates of the catch volume and composition and catch per unit effort, spatial and temporal distribution of the salmon trolling fisheries.

Counting of trolling boats provided information about number of active trolling boats in inventoried 12 harbors located along Polish coast. In general, results obtained indicated two main salmon fishing grounds, i.e., the area on the west from Słupsk Bank and the Gdańsk Deep (Fig. 13). These two areas are visited by different groups of trolling anglers, see Figure 13. Observers visited harbors in Dziwnów, Mrzeżyno, Kołobrzeg, Darłowo, Ustka, Łeba, Władysławowo, Kuźnica, Jastarnia, Hel, Gdynia and Gdańsk Górki Zachodnie. The number of inventoried trolling boats differed between months and there is an observed increasing trend through the fishing season (Fig. 14). The 111 and 118 trolling boats were counted in 2017 and 2018, respectively. In total, the 133 different salmon trolling boats were inventoried in period 2017-2018. Among the 12 harbours covered by trolling boats counting, harbors located in Hel, Gdynia, Gdańsk Górki Zachodnie and Kołobrzeg seem to be the most important for salmon trolling fishing in Poland (Fig. 15). The trolling fleet consist mainly of private boats, taking occasionally on board recreational fishermen holding individual fishing permits. The share of commercial trolling boats was less than 10% of all active boats.

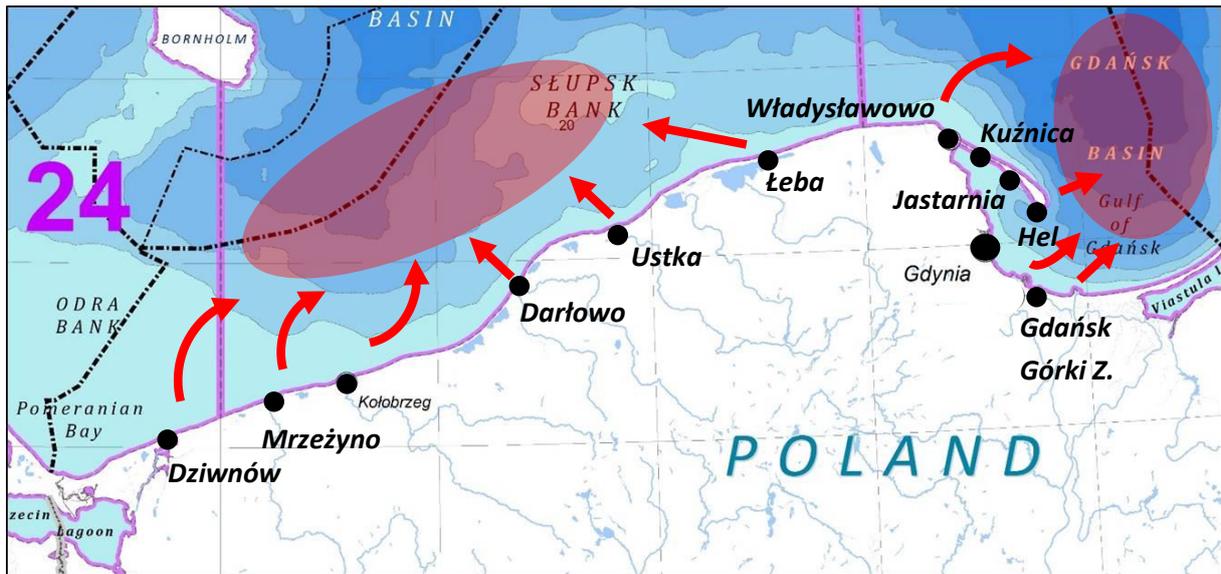


Figure 13. Map with locations of the main salmon trolling fishing areas in Polish Maritime Areas with the harbors having high importance for salmon trolling fishing.

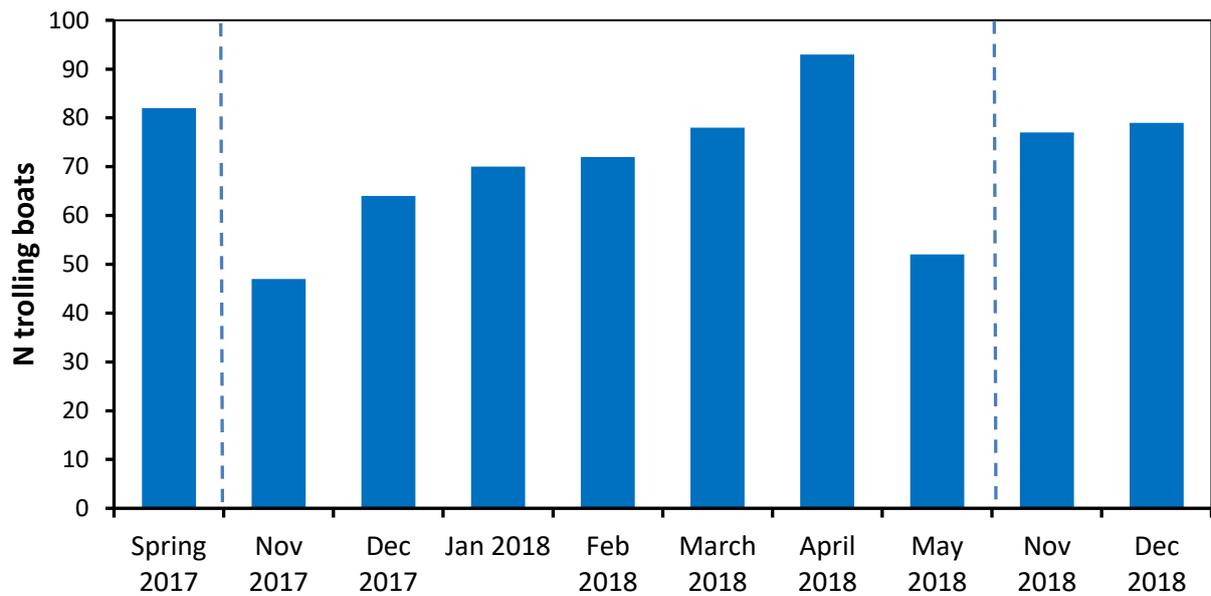


Figure 14. Number of trolling boats observed in main harbors along the Polish coast, since spring 2017 to December 2018. The vertical lines separate fishing seasons.

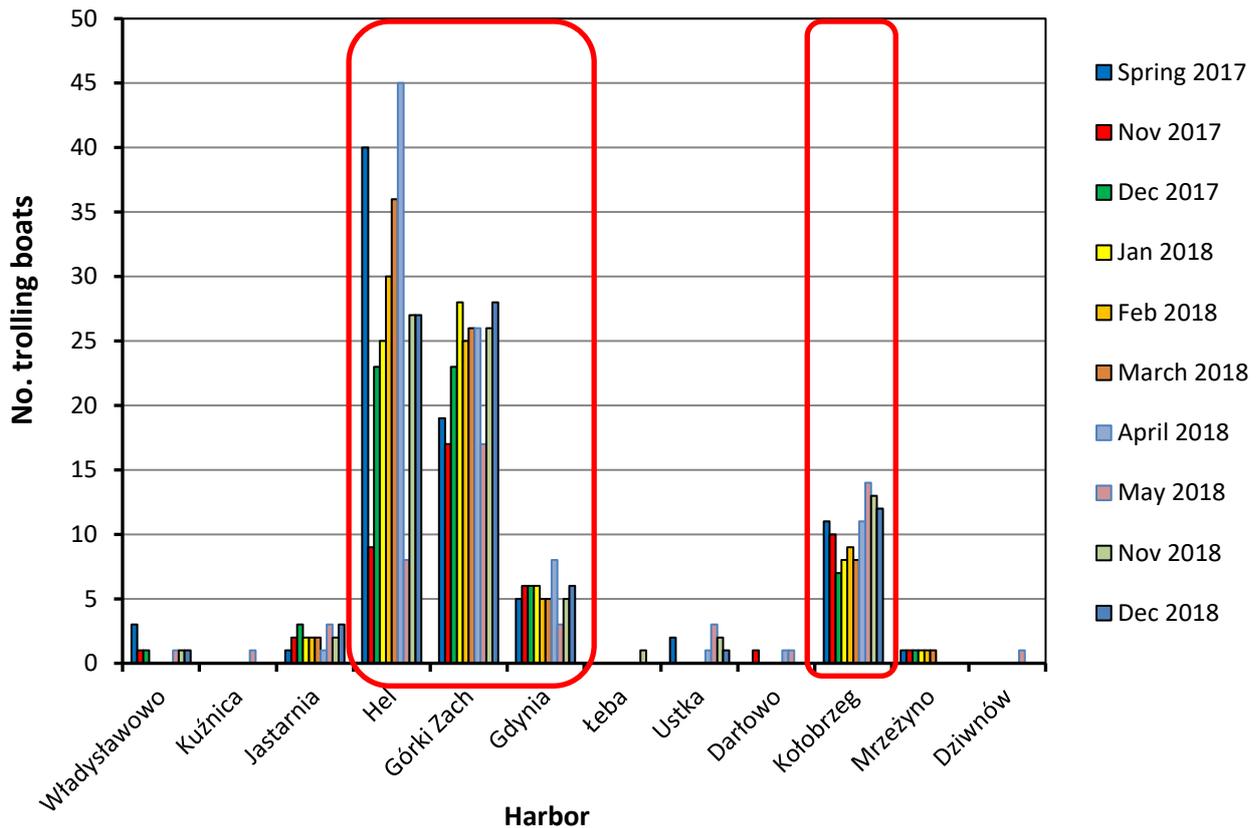


Figure. 15. Number of trolling boats observed in main harbors along the Polish coast, since spring 2017 to December 2018.

The CCTV monitoring installed in Hel and Gdańsk Górki Zachodnie provided accurate information about fishing effort expressed as a number of trolling trips (fishing days) each day per location. Moreover, visual analysis helps to explain the reasons of no fishing days. Knowing the total number of boats in the port and the percentage of active boats each day, this method makes possible to estimate fishing effort from harbors where no cameras were installed (on the condition that the number of trolling boats in that harbor is known).

The results from both locations present high variations between days through the fishing seasons (Fig. 16; Fig. 17; Fig. 18) and confirm the hypothesis that this fishing activity is strongly weather dependent. This provides potential problems with bias estimates, especially when observations concern wide spreaded areas, characterized by different weather conditions. Similar problems have been reported in other countries, e.g., Germany (Weltersbach et al. 2016).

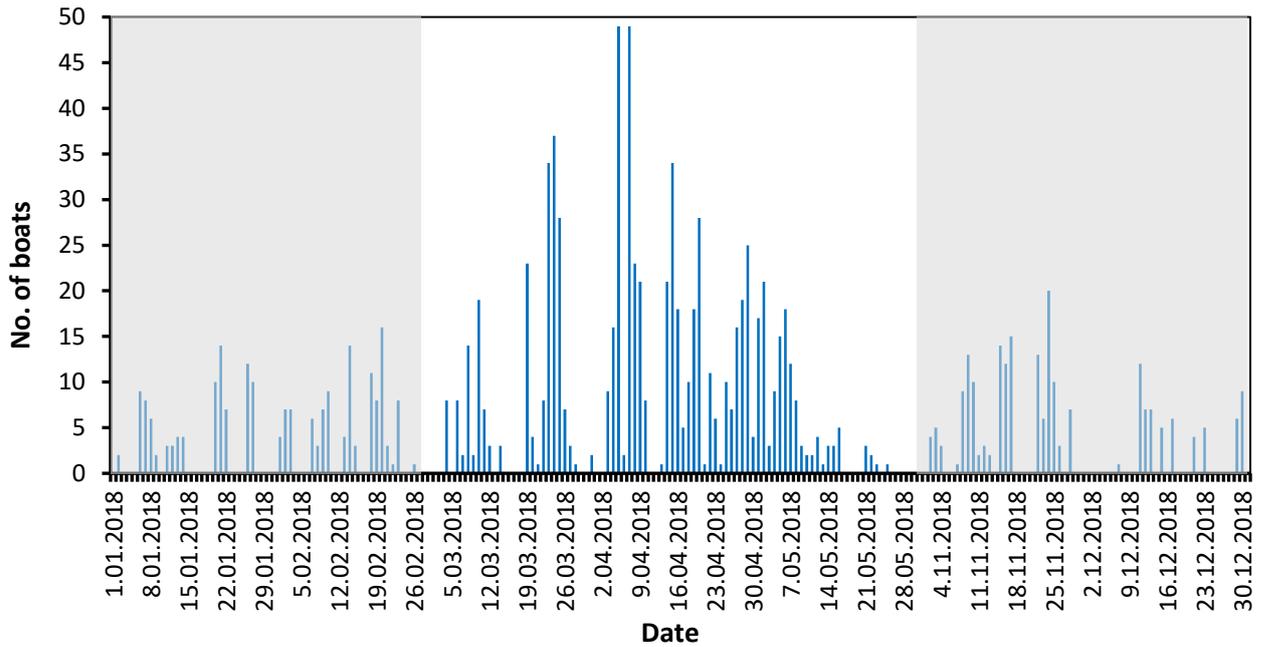


Figure 16. Number of trolling trips observed in Hel harbor, since 1st of January to 31st of December 2018 (N = 1179). Grey panel indicate winter part of fishing season.

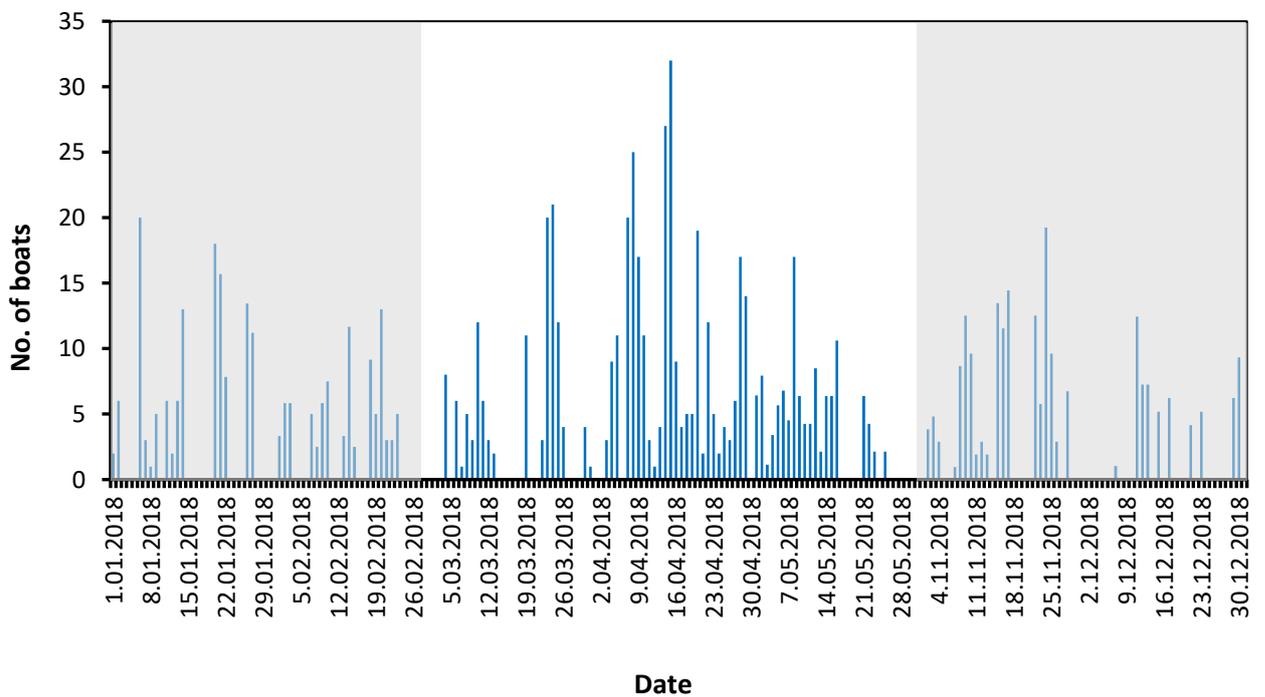


Figure 17. Number of trolling trips observed in Gdańsk Górkki Zachodnie, since 1st of January to 31st of December 2018 (N = 941). Grey panel indicate winter part of fishing season.



Figure 18. Example of screen shots from videos recorded in Hel (upper panel), and Gdańsk Górkі Zachodnie (lower panel).

During the monitoring in 2018, the $17.6 \pm 22.91\%$ (mean \pm SD) and $18.0 \pm 23.40\%$ (mean \pm SD) of trolling fleet stationing in Hel and Gdańsk Górkі Zachodnie were active daily. In total, 2120 salmon trolling trips have been recorded by cameras.

On basis of data recieved via self-sampling with the use of voluntary fishing logbooks as well as data gathered with on-site survey (questionnaires) catch per unit effort (with division on particular quarters of salmon trolling season; Table 1) and annual catch volume of salmon is being estimated. In

addition, biological data of caught salmon, sea trout and other fish species have been collected (Table 2).

Table 1. Catch-per-unit-effort (CPUE) data collected with use of self sampling (logbook) method during pilot study.

Year	2017		2018	
Quarter of the year	IV	I	II	IV
CPUE n fish/trip	1.17	2.18	3.51	2.51
CPUE n fish/trip	1.50		2.73	

Table 2. Biological data of salmon collected with the use of self sampling (logbook) method during pilot study. The discrepancies in the number of fish between analysed parameters are due to incompleteness of provided data.

	mean length (cm)	mean weight (kg)	% males	% females	% fish with adipose fin	% fish with no adipose fin	% fish retained	% fish released
	91.3	8.0	41.4	58.6	84.0	16.0	93.6	6.4
Number of fish with data available in logbooks	445	263	177	250	337	64	411	28
			427		401		439	

The roving creel survey is a popular and cost-effective method for collecting the data from the field. This method has been applied in monitoring of recreational fishing in many studies around the world and allows to collect social-economic and catch data (Nieman et al., 2021). During the roving creel survey in harbors and marinas concerning salmon trolling fishing 7 and 60 questionnaires were received in 2017 and 2018, respectively. The low number of filled questionnaires in 2017 is the result of a lack of trust in the institute's observers. This phenomenon was reflected in high refusal rate (Fig. 19). The refusal rate significantly decreased in 2018, what was the result of information campaign and remained at the average value of 18 percent. Much better situation was observed in case of sea trout fishing from the coast, where a refusal rate was not significant (mean 0.8%) in this group. A worse result was obtained for eel coastal fishing. The mean value of the refusal rate was 22.5%, but there was no differences between years of observation.

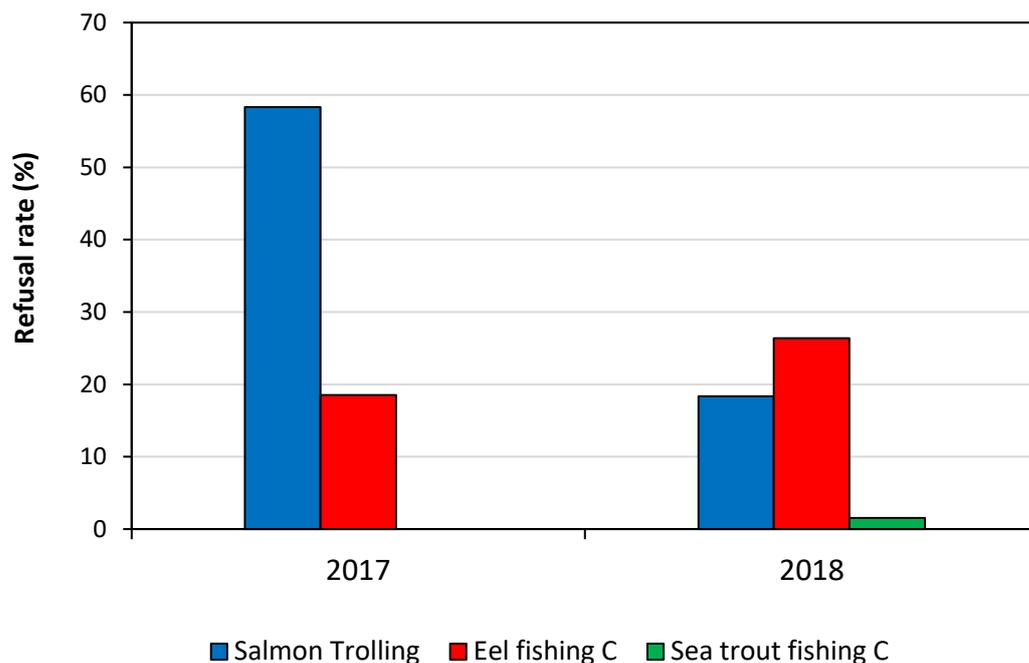


Figure 19. The refusal rate (%) of the on-site surveys observed in 2017-2018. The results concern salmon trolling, eel and sea trout fishing from the coast.

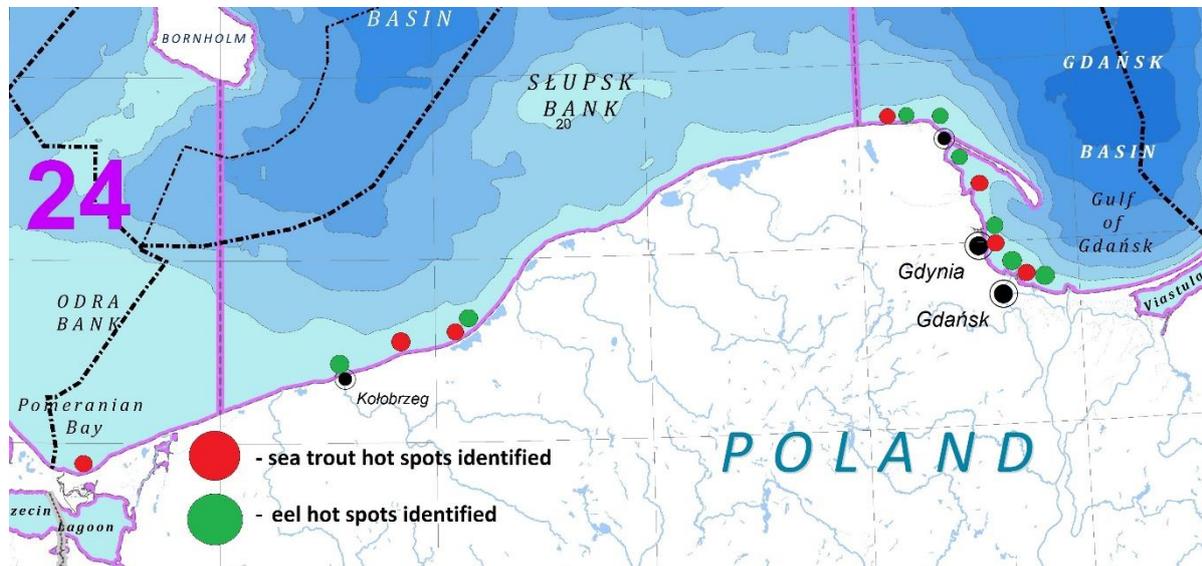


Figure 20. Identified hot spots for sea trout fishing from the shore (beaches). Identified hot spots for eel fishing from the shore (beaches, harbors/marinas).

The difference between these two mentioned targeted species can be visible on Figure 20. Identified sea trout hot spots cover only beaches, while eel is being caught from the beaches as well as in harbors/marinas from the piers, jetties and other harbor facilities.

The results of an off-site survey (304 filled on-line questionnaire) provided information about preferred fishing techniques and fish species, catch composition, the most popular fishing areas. Additionally, demographic and socio-economic data have been collected.

The vast majority of respondents were males (99%) and represented inhabitants from the northern and central Poland (Fig.21). The age group 25-44 was the most frequent (55% of respondents). On the second and third place was 45-54 age group and 55-64 age group, representing 23% and 12%, respectively. The respondents most often declared secondary and higher education level (47% and 41%, respectively; Fig. 21).

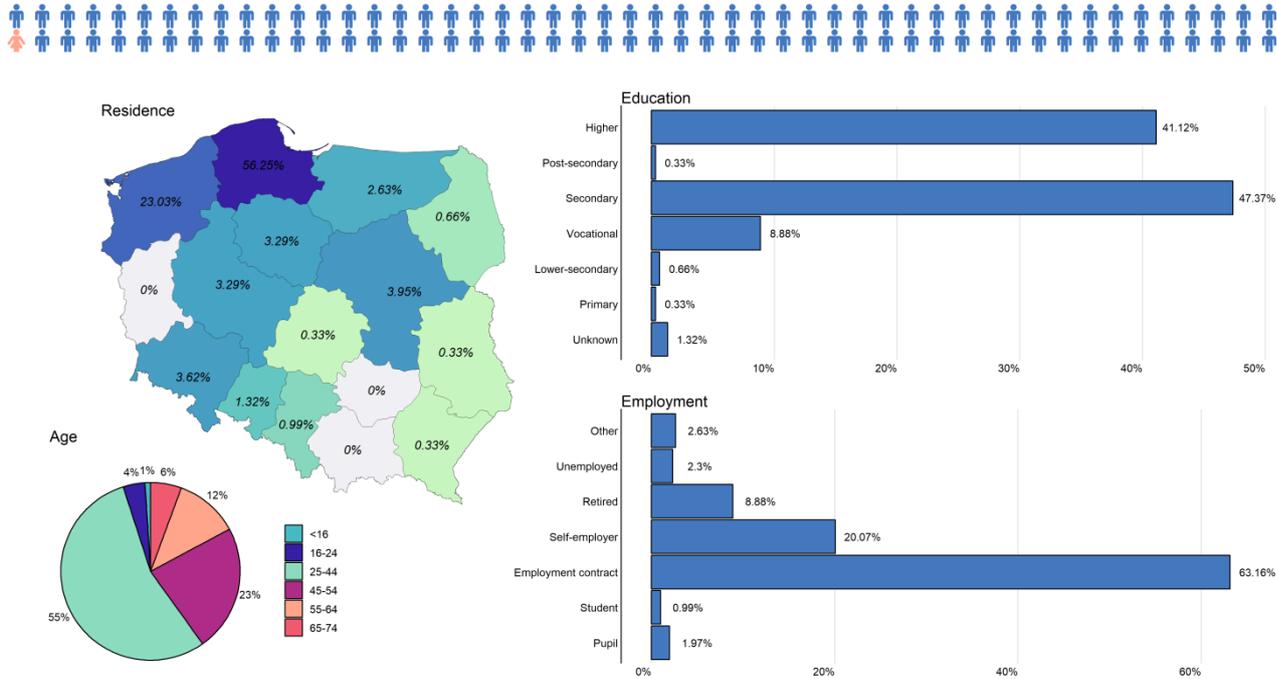


Figure 21. An overview of web-based survey respondents.

The expenditure for sea recreational fishing in 2017 declared by respondents ranged between 0-1 500 EUR (Fig. 22). The extreme declared values were 7 500, 8 000 and 12 000 EUR. The 81% of respondents were fishing with annual fishing licence. The vast majority of respondents declared own fishing experience between 1-25 years. In general, anglers were spreaded equal along Polish coast, with some higher agregation near Gdańsk Bay (Fig. 23). It is directly reflected in a observed fishing pressure in this area.

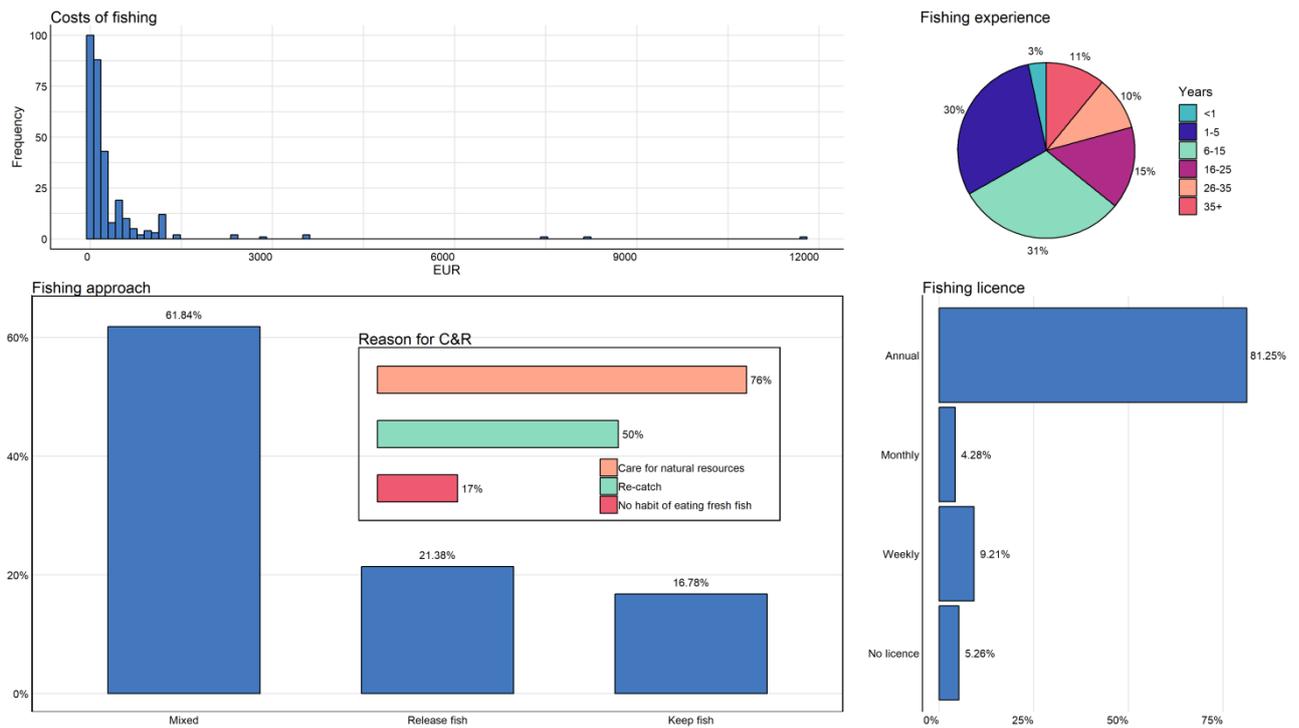


Figure 22. Expenditures, fishing approach and fishing preferences in 2017, of web-based survey respondents, regarding sea recreational fishing in Polish Maritime Waters.

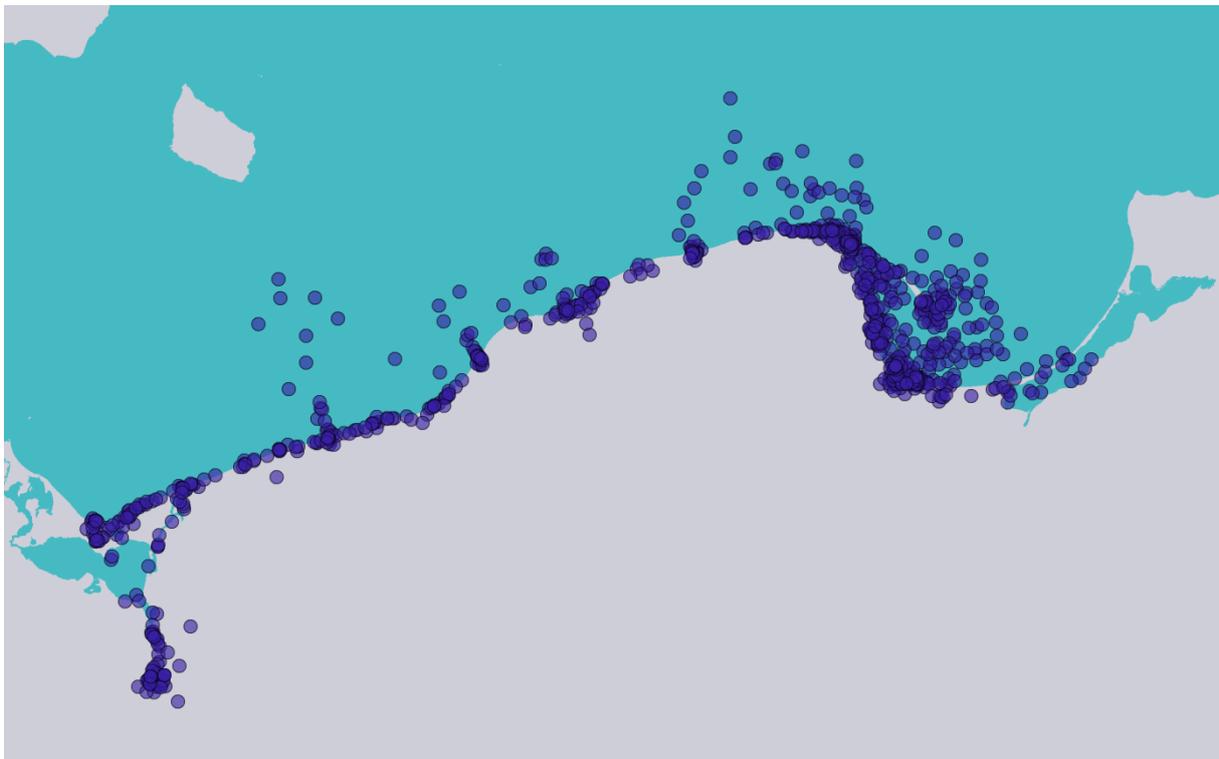


Figure 23. Map with the area of the Polish coast with the strongest fishing pressure in 2017, reported by web-based survey respondents, regarding sea recreational fishing.

The respondents declared catches of 18 fish species. The top 5 of the most important fish species were pikeperch, cod, perch, sea trout and Atlantic salmon (Fig. 24). In addition, anglers

reported catches of garfish, herring, flounder, bream and pike. Polish sea anglers prefer fishing in harbors and lure fishing from the shore.

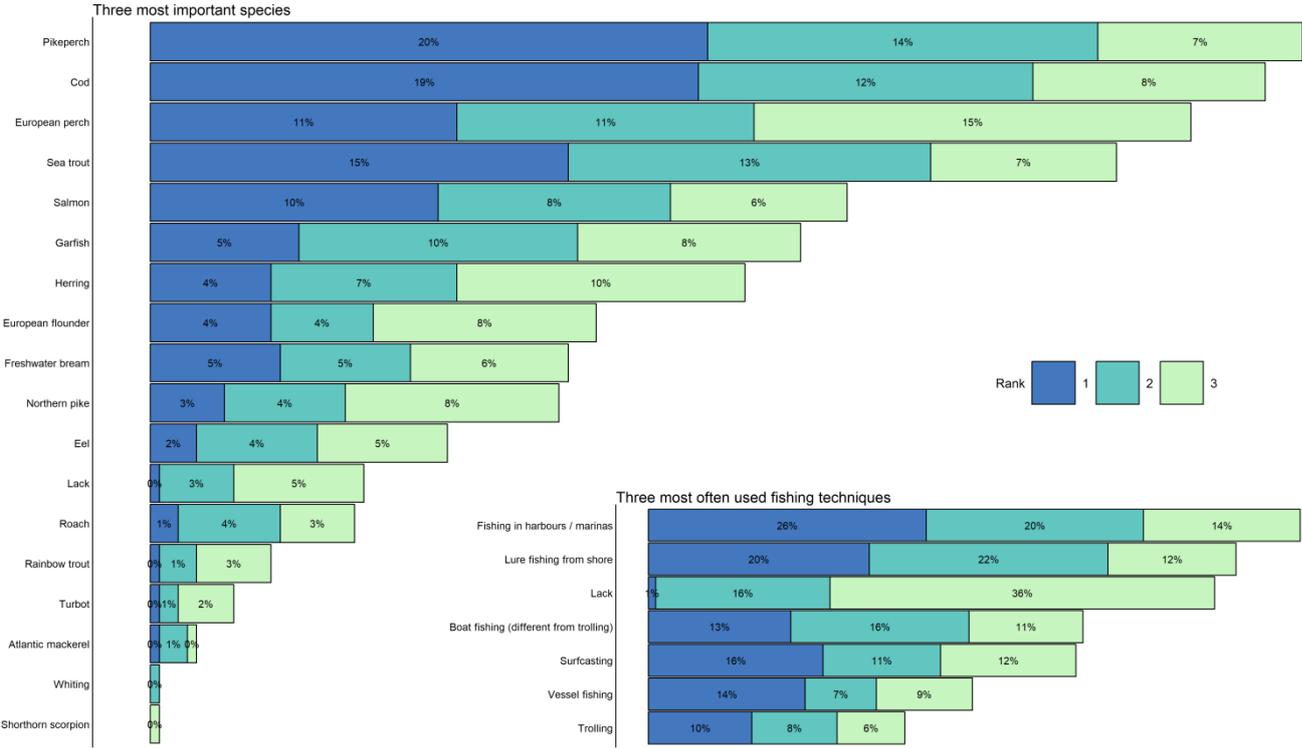


Figure 24. The preferred fish species and fishing techniques often chosen in 2017, reported by web-based survey respondents, regarding sea recreational fishing in Polish Maritime Waters.

The most frequently fish species caught (in numbers) in 2017 in Polish Maritime Waters were herring, perch and cod. They accounted for 72% of the catch declared by respondents (Fig. 25). On the next places were roach, flounder, bream, garfish and pikeperch. The salmonid species accounted for 2% of the declared catch.

Consequently, declared catch information corresponded with a CPUE data (Fig. 26), with herring, atlantic mackerel and cod on the first three places, respectively.

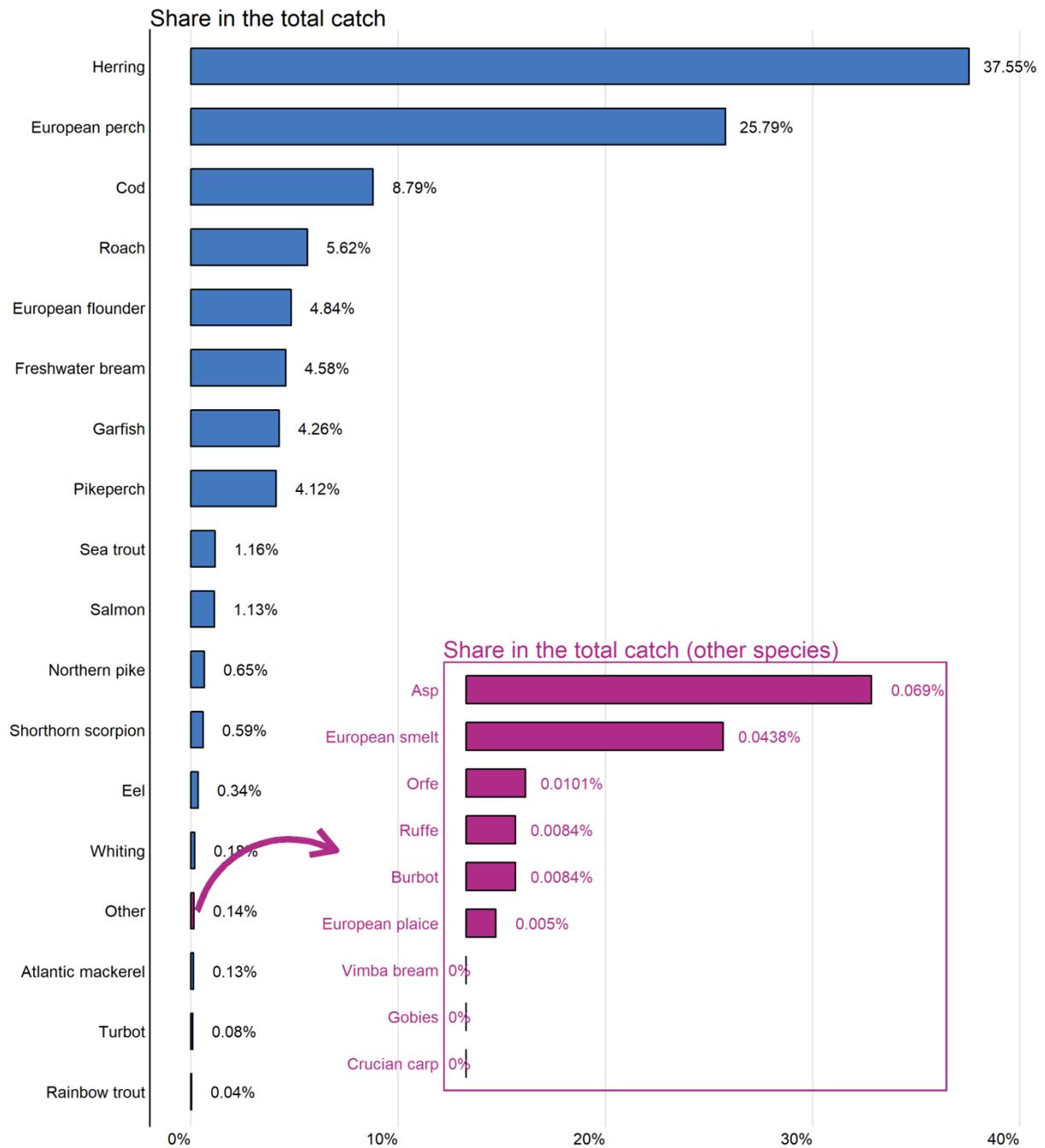


Figure 25. The share (%) in total catch of particular fish species in 2017, reported by web-based survey respondents, regarding sea recreational fishing in Polish Maritime Waters.

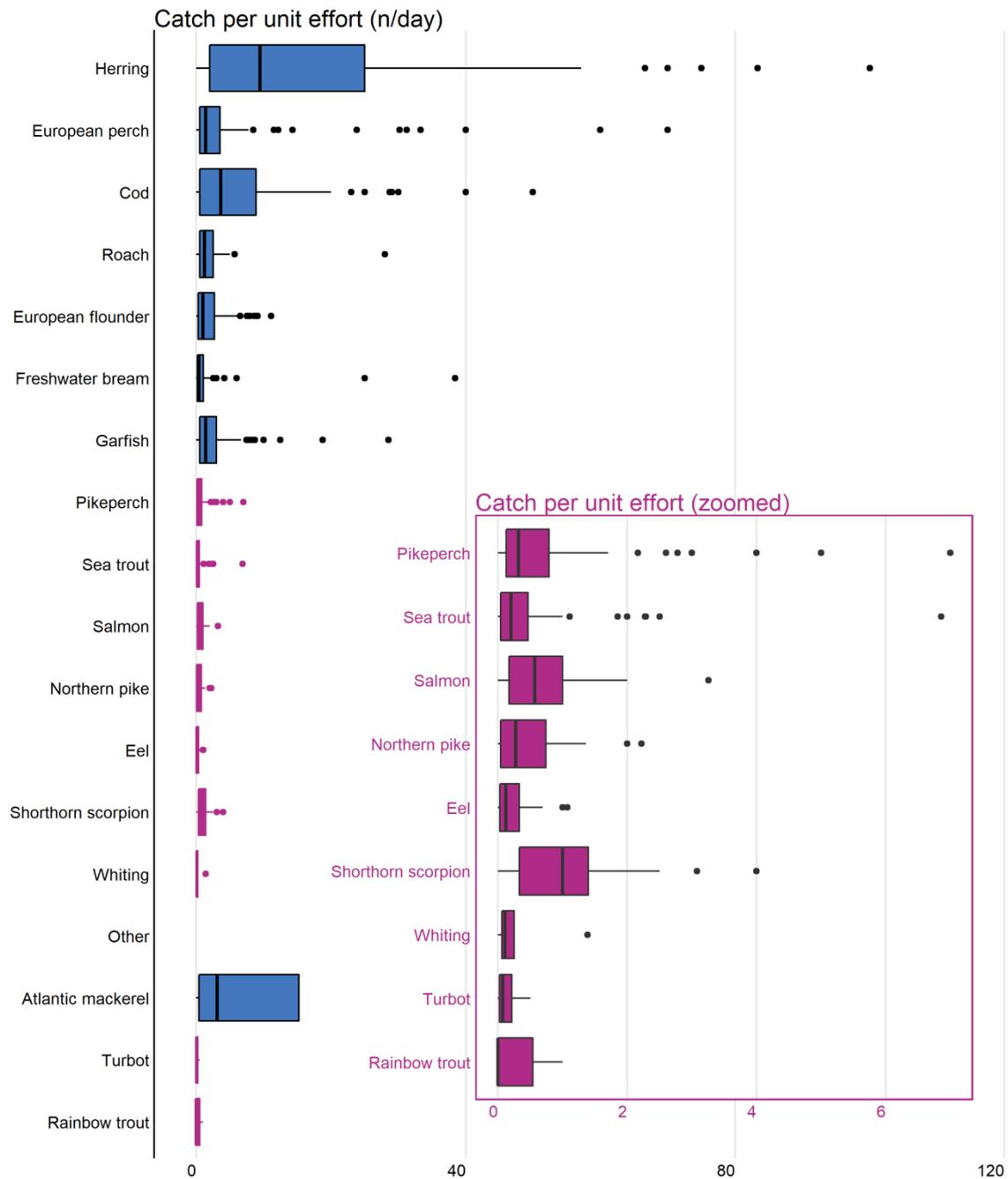


Figure 26. Catch-per-unit-effort (CPUE) of particular fish species in 2017 (mean, 25-75%, min-max, outliers), reported by web-based survey respondents, regarding sea recreational fishing in Polish Maritime Waters.

MODULE 2 - INLAND WATERS

4 INTRODUCTION

Sea trout fishing is the most important fishing destination in Pomeranian rivers and it is caught occasionally in other rivers of northern Poland. Currently, there are 26 rivers for sea trout, i.e. those where this species naturally spawn (ICES, 2020), with the majority of the population having the status

of mixed, i.e. those where, apart from natural spawning, there is regular restocking of varying intensity. So far, there has been no method of estimating the amount of fishing for these species in inland waters and the calculations used were indicative and based only on expert knowledge or residual data.

5 METHODS

As part of the task, the following activities were performed in 2017-2019:

- Direct on-site survey,
- Analysis of fishing records from fishing users,
- Analysis of online angling forums devoted to angling,
- Development of data on migration from fish counters on Słupia and Parsęta and comparing them with catch registers and survey results as well as river catches of spawners obtained by river users. These two rivers spatially represented western and middle part of the Polish coastline. Furthermore, the longest catch data series was available for these two rivers.

The survey was conducted with the use of an anonymous questionnaire containing 14 questions. The questions were structured to provide information on the origin of the angler, the method of fishing, the time spent on fishing, the fishing season, the amount of sea trout and salmon caught in the current and previous season, fishing places, handling of caught fish and other species caught.

6 RESULTS

In total, in 2017-2019, 719 direct surveys were collected, of which 70 in Słupia 282, Rega 274, Ina 171 and Parsęta rivers (Fig. 27). Anglers reported that in 2016-2019 they caught 1623 sea trout, of which 593 in Słupia, 371 in Rega, 243 in Ina and 416 in Parsęta rivers. The surveys show that the average catch per one surveyed angler ranged from 0.9 sea trout (2016-2017) to 2.7 sea trout in (2018-2019). It was also observed that these values were higher for the Parsęta River compared to Słupia, Rega and Ina (Fig. 28).

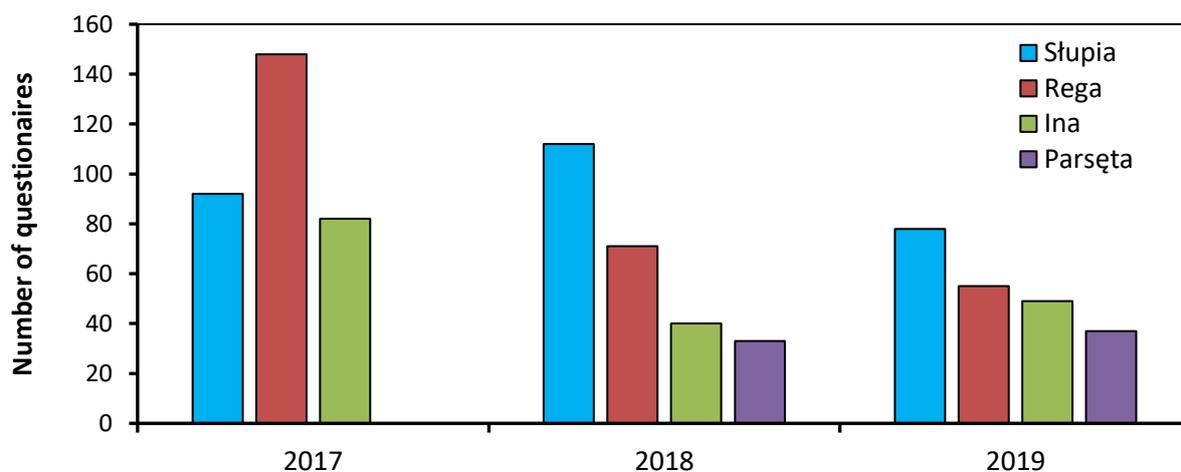


Figure 27. Number of filled questionnaires for selected rivers, in 2017-2019.

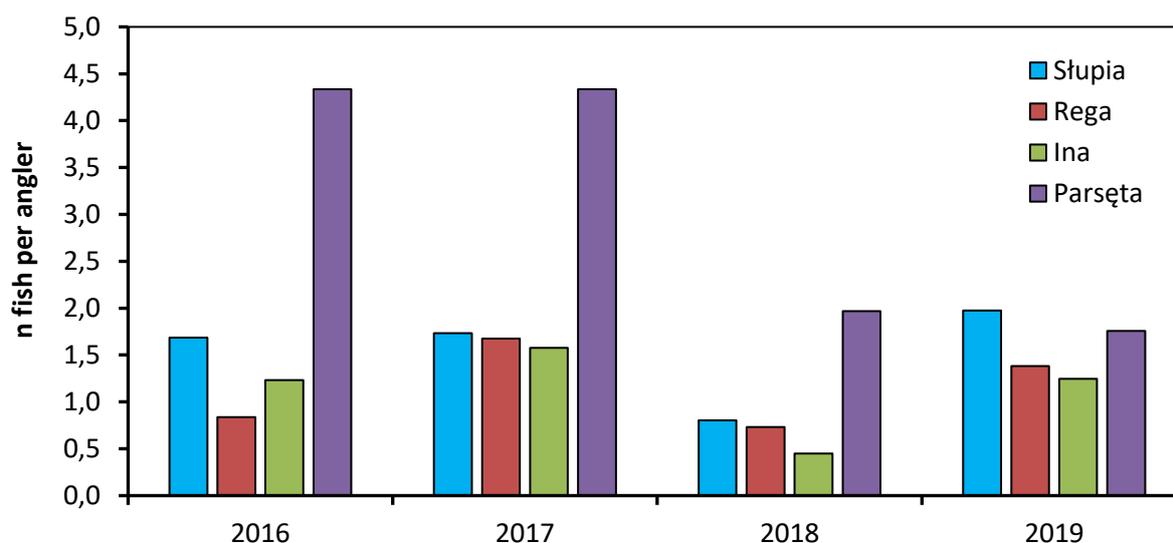


Figure 28. Number of sea trout caught by individual angler in selected rivers, reported by respondents in 2017-2019.

The analysis of fishing registers consisted in the elaboration of available data obtained from river users, mainly from the districts of the Polish Angling Association (Wołos, 2008), and in the case of the Parsęta River from the Association of Towns and Communes of the Parsęta River Basin. The longest series of data was compiled for the Słupia river from 2003 to 2017, on the Ina and Rega rivers from 2013 to 2017 and on the Parsęta for 2017-2018 (Table 3). Registers returned ranged from 14% to 55% depending on the river. The average amounts of sea trout reported in the registers amounted to 237 heads in Słupia, 274 in Rega, 295 heads per year in Ina and 460 in Parsęta, respectively. The salmon catches were very low and averaged 5 fish per year for Słupia, 1.5 for Rega, 0.5 for Ina and 4 fish in Parsęta.

Table 3. Salmon and sea trout angling catches in Słupia, Rega, Ina and Parsęta rivers, reported in 2003-2018)

Year	Słupia		Rega		Ina		Parsęta	
	Sea trout	Salmon						
2018	-	-	-	-	-	-	318	0
2017	173	3	236	0	166	0	599	4
2016	94	5	155	1	353	0	-	-
2015	131	11	263	0	400	0	-	-
2014	115	5	269	2	245	2	-	-
2013	187	11	447	3	312	0	-	-
2012	283	6	-	-	-	-	-	-
2011	285	5	-	-	-	-	-	-
2010	173	5	-	-	-	-	-	-
2009	183	20	-	-	-	-	-	-
2008	276	0	-	-	-	-	-	-
2007	197	0	-	-	-	-	-	-
2006	232	0	-	-	-	-	-	-
2005	266	0	-	-	-	-	-	-
2004	535	0	-	-	-	-	-	-
2003	425	0	-	-	-	-	-	-

Records on two Internet forums devoted to trout fishing were also researched. The list of trout and salmon caught in the Słupia, Ina, Rega and Parsęta rivers was prepared annually on the basis of anglers' entries and photos of the caught fish. In total, in 2017-2019, reports were collected about the catch of 115 sea trout in Słupia, 109 in Ina, 112 in Rega and 159 in Parsęta rivers. Additionally, in the analyzed period, there were 9 records concerning salmon individuals caught in Słupia and 7 salmon in Parsęta.

The data collected as part of the pilot program was used to calculate several dependencies that can be used in estimating the level of fishing catches and to verify the credibility of the collected data and their relevance. The calculations showed the presence of a significant correlation between the data from the fish counters.

7 CONCLUSIONS & RECOMMENDATIONS

- Survey must be preceded by a promotional campaign due to the limited trust of the respondents, concerning both marine and freshwater recreational fishing,
- On-site surveys regarding sea trout and eel fishing in the sea proved to be time and cost consuming vs. obtained results,
- Harbors located in Hel, Gdynia, Gdańsk Górkki Zachodnie and Kołobrzeg are the most important for salmon trolling fishing in Poland,

- CCTV monitoring provide accurate fishing effort estimates helping to reduce bias in recreational salmon trolling catch estimates,
- Self-sampling method is a good tool for verification of data collected using other methods,
- Web-based survey – low response rate,
- Web-based survey should be repeated annually concerning previous calendar year,
- The analysis of log-books from following rivers: Ina, Rega, Parsęta, Słupia, Łeba, Reda and Drwęca should be repeated annually concerning previous calendar year,
- On-site survey concerning sea trout fishing in following rivers: Ina, Rega, Parsęta, Słupia, Łeba, Reda and Drwęca should be conducted each year.
- On-site and off-site surveys related to freshwater angling, must be supported by the analysis of records from fish counters and commercial fishing.

Based on the results of the Pilot Study conducted in 2017-2019, sampling programme was included into regular sampling.

8 REFERENCES

- Hartill B.W., Taylor S.M., Keller K., Weltersbach M.S. (2020). Digital camera monitoring of recreational fishing effort: Applications and challenges. *Fish and Fisheries*, 21: 204–215.
- Hyder K., Weltersbach M.S., Armstrong M., Ferter K., Townhill B., Ahvonen A., Arlinghaus R., Baikov A., Bellanger M., Birzaks J., Borch T., Cambie G., de Graaf M., Diogo H.M.C., Dziemian Ł., Gordo A., Grzebielec R., Hartill B., Kagervall A., Kapiris K., Karlsson M., Kleiven A.R., Lejk A.M., Levrel H., Lovell S., Lyle J., Moilanen P., Monkman G., Morales-Nin B., Mugerza E., Martinez R., O'Reilly P., Olesen H.J., Papadopoulos A., Pita P., Radford Z., Radtke K., Roche W., Rocklin D., Ruiz J., Scougal C., Silvestri R., Skov C., Steinback S., Sundelöf A., Svagzdys A., Turnbull D., van der Hammen T., van Voorhees D., van Winsen F., Verleye T., Veiga P., Vølstad J.H., Zarauz L., Zolubas T., Strehlow H.V. (2018). Recreational sea fishing in Europe in a global context – participation rates, fishing effort, expenditure, and implications for monitoring and assessment. *Fish and Fisheries*, 19: 225–243.
- ICES (2018). Report of the Working Group on Recreational Fisheries Surveys (WGRFS), 11–15 June 2015, Faro, Portugal. ICES CM 2018/EOSG:19. 111 pp.
- ICES (2020). Baltic Salmon and Trout Assessment Working Group (WGBAST). *ICES Scientific Reports*, 2, 22, 261 pp.
- Ferter K., Weltersbach M.S., Strehlow H.V., Vølstad J.H., Alós J., Arlinghaus R., Armstrong M., Dorow M., de Graaf M., van der Hammen T., Hyder K., Levrel H., Paulrud A., Radtke K., Rocklin D., Sparrevohn C.R., Veiga P. (2013). Unexpectedly high catch-and-release rates in European marine recreational fisheries: implications for science and management. *ICES Journal of Marine Sciences*, 70: 1319–1329.
- Nieman C.L., Iwicki C., Lynch A.J., Sass G.G., Solomon C.T., Trudeau A., van Poorten B. (2021). Creel surveys for social-ecological-systems focused fisheries management. *Reviews in Fisheries Science and Aquaculture*, (in press)
- Ramutkowski M. (2013). Polskie połowy rekreacyjne łososi metodą trollingową w Bałtyku [Polish salmon recreational fisheries using trolling method in the Baltic Sea]. *Wiadomości Rybackie*, 7-8 (194): 21–24.

- Weltersbach M.S. (2013). Recreational fishery on salmon and sea trout. Planned research activities in Germany. WGBAST. Tallinn, 06.04.2013.
- Weltersbach M.S., Kaiser F., Strehlow H.V. (2016). Surveying 2.0 - Using remote cameras to monitor a highly specialized recreational fishery in the Baltic Sea. Oral presentation. ICES Annual Science Conference, organized in Riga (Latvia), 19-23 September 2016.
- Wołos A. (2008). Register of angling catches with the need for rational fisheries management on the example of selected districts of Polish Angling Association (PAA). Fisheries User – A new reality. PAA: 102–119.