

Plastic Free Ocean

Civic monitoring of macroplastics and microplastics in small rivers report from Pomeranian and Warmian-Masurian Voivodships in July - September 2019

1. Introduction

Monitoring of macroplastics and microplastics in small rivers were performed by students of chemistry from University of Gdańsk in Poland.

The six areas to river monitoring were indicated. In each of them, 2 km distance of five small rivers were watched and analyzed to the macroplastics and microplastics presence. Generally 50 km of small rivers in Pomeranian Voivodship and 10 km of small rivers in the Warmian-Masurian Voivodeship were watched.

Each participant of river watching was equipped with the set-up to collect and analyze micropollutants. In Fig. 1 the equipment for microplastics monitoring is presented.



Fig.1. The equipment for microplastics collection and monitoring

The set-up to microplastics collection was consisted of:

- two plastic pipes with the rubber flange,
- 15 pieces of filtration textiles with the pore diameter higher than 0,1 mm,
- 5 pieces of filtration textiles with the pore diameter higher than 1 mm,
- the mobilephone magnifier with 90 x magnification,
- graduated bucket with 10 L volume.

The coordinator prepared the instruction with detailed procedure of small river watching and sampling. The report template was prepared and sent to all watchers. The most important information was to be collected by participants in the appropriate table.

Each participant of river watching and sampling prepared the report and sent it to the coordinator with the description of river localization, surrounding area, number and type of pollution by macro -and micro- plastics etc.

The report is summarizing the data from all watched and sampled rivers in six regions presented in Fig 2.

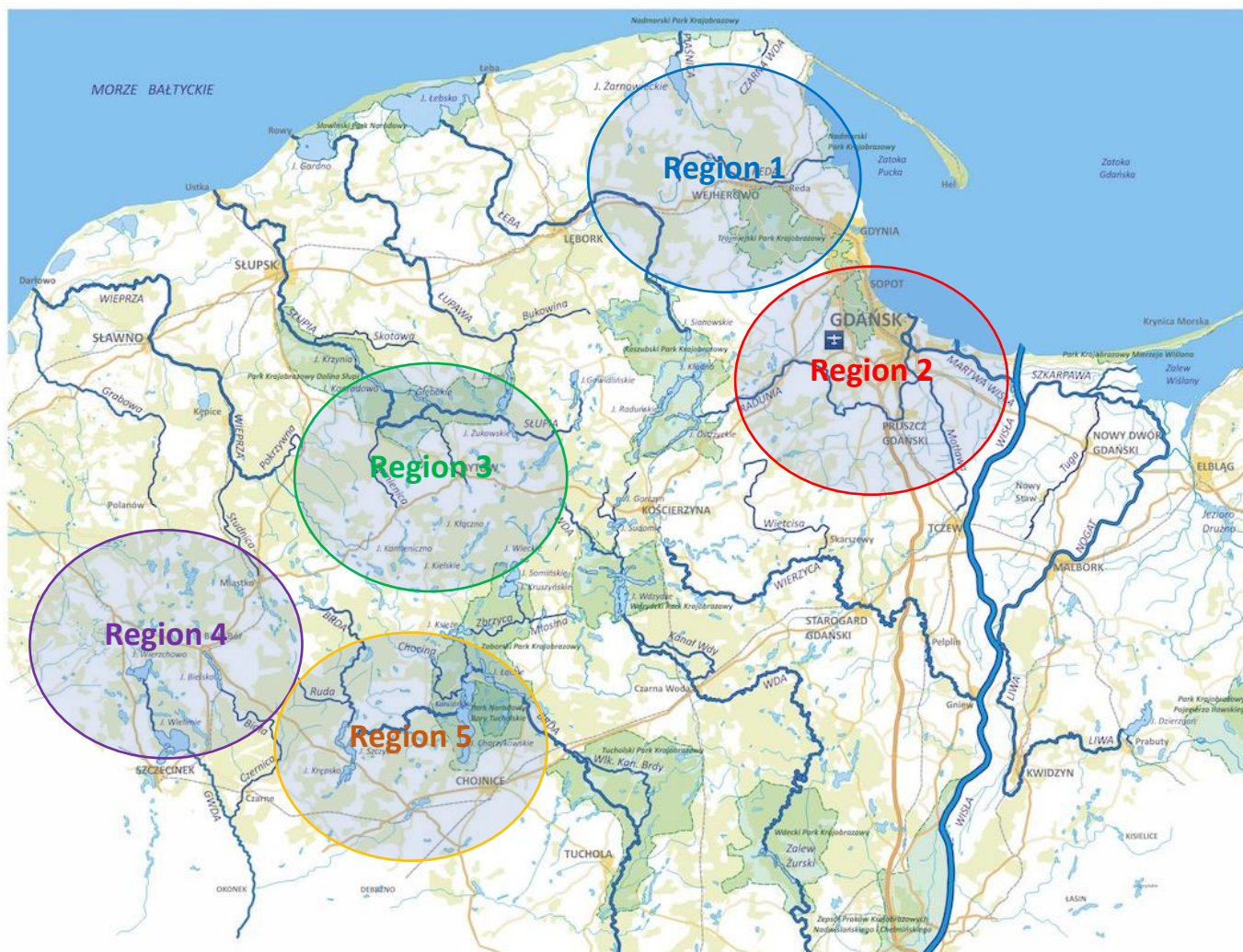


Fig.2. The localization of five sampling regions; region number 6 nearby Olsztyn including rivers from the Warmian-Masurian Voivodeship aren't presented in the map.

2. Results

2.1. The small rivers in Warmian-Masurian Voivodeship

In Table 1 the sampling points are characterized and the number of microplastics was estimated in two ranges:

- a) diameter higher than 1mm
- b) diameter from 0.1mm to 1 mm.

Additionally the presence of macroplastics along the sampling points of river was described.

Table 1 Characterisation of sampling points in Warmian-Masurian Voivodeship.

River	Sampling point	Micro-plastics number in 100 L (d >1mm)	Microplastics number in 100 L d <0,1mm-1mm> (in 100 L)	Presence of macroplastics	Remarks and comments
Lyna	53°46'12.7"N 20°28'53.9"E	0	0	PET bottle	Due to the tourist attractions of the place, it is an area intensively cleaned by the local government
	53°46'27.0"N 20°28'30.9"E	0	0	PET bottle, PE film	
	53°46'54.9"N 20°28'18.9"E	0	2	styrofoam, PET bottle	
Kortówka	53°45'16.9"N 20°27'07.8"E	0	10	PET bottles, PCV film, PE film	The area is intensively used by students of the nearby University for both leisure and outdoor events
	53°45'09.1"N 20°27'41.9"E	0	0	lack	Due to tourist attractions, the area is kept clean by the local government
	53°44'43.9"N 20°28'03.6"E	0	2	PET bottle	
Wadąg	53°49'13.3"N 20°30'05.1"E	0	6	PET bottles, PE films, PP films	The area has residential buildings and there is a place of rest
	53°49'02.9"N 20°30'38.2"E	0	8	lack	
	53°48'59.3"N 20°31'23.6"E	0	0	lack	The area is located near a place of the rest
Drwęca	53°42'14.7"N 19°57'36.1"E	0	8	PET bottle	The area has been revitalized and has tourist attractions
	53°42'07.7"N 19°58'23.8"E	0	10	A huge amount of plastic rubbish: bags, all kinds of packaging, bottles, films	Neglected and highly polluted area, there are poorly maintained and full garbage cans belonging to nearby residential buildings
	53°42'11.6"N 19°59'00.4"E	0	8		

Pisa Warmińska	53°49'43.5"N 20°41'36.2"E	0	20	Plastic bag, candy packaging	The urban area kept clean, revitalization of the banks and construction of walking paths are underway
	53°49'42.0"N 20°40'43.6"E	0	12	A huge amount of plastic rubbish: bags, all kinds of packaging, bottles, films.	An area that runs along the inhabitants rest places
	53°49'58.0"N 20°40'03.1"E	0	8	lack	Fields with hard-to-reach river bank

PET - polyethylene terephthalate

PE- poliethylene

PP- polipropylen

PCV – polychloride vinyl

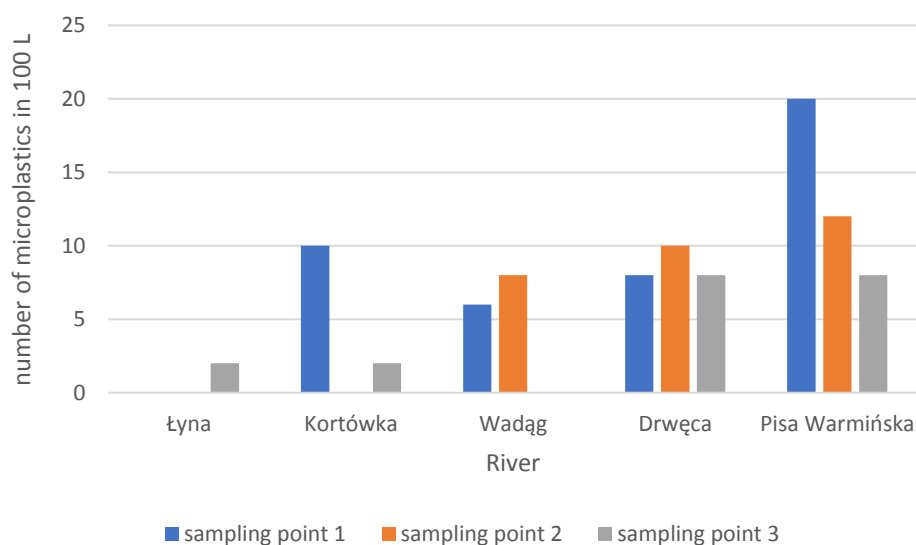


Fig. 3 The number of microplastics in three sampling points in studied small rivers in Warmian-Masurian Voivodeship

The highest number of microplastics (20 items) was found in Pisa Warmińska. It is a place of inhabitants rest. The lowest number of items was collected in Łyna.

Pisa and Wadąg are tributaries of the Łyna. The commune of Barczewo is implementing a project entitled "Development of the banks of the Pisa River" co-financed by the European Regional Development Fund under Measure 6.2 Natural heritage, Sub-measure 6.2.3 Effective use of the resources of the priority axis Culture and heritage of the Regional Operational Program of the Warmian-Masurian Voivodeship for 2014-2020. It is possible that construction works have caused the temporary increase the number of microplastics in waters of Pisa.

2.2.Pomeranian Voivodship

In Pomeranian Voivodship five regions were investigated, as it was shown in Fig. 1:

Region 1 – area around Gdynia, Reda, Wejherowo,

Region 2 – area around Gdańsk, Pruszcz Gdański, Kowale,

Region 3 – area around Bytów, Kołczygłowy,

Region 4 – area around Białogard, Wałcz,

Region 5 – area around Dobrzyń, Człuchów.

In Table 2-6 the sampling points of rivers were characterized and the number of microplastics was listed in two ranges:

- a) diameter higher than 1mm,
- b) diameter from 0.1mm to 1 mm.

Additionally the presence of macroplastics along the sampling points of river was described.

2.2.1. Region 1

Table 2. Characterisation of sampling points in Pomeranian Voivodeship in region 1

River	Sampling point	Microplastics number in 100 L >1mm	Microplastics number in 100 L 0.1mm - 1mm	Presence of macroplastics	Remarks and comments
Zagórska Struga	54°36'1.4"N 18°24'53.0"E	0	20	PE bag	Microplastics pollutions may be throughout with effluents from sewage treatment plants. The area is kept clean by the municipality of Puck.
	54°36'26.7"N 18°24'48.1"E	0	16	lack	
	54°36'48.2"N 18°25'23.3"E	0	10	lack	
Kanał Łyski	54°36'35.8"N 18°21'51.3"E	0	14	lack	Area around arable fields and farms, grazing area for animals.
	54°36'42.0"N 18°22'47.8"E	0	8	lack	
	54°36'42.2"N 18°23'38.7"E	0	18	lack	
Reda	54°38'23.1"N 18°27'8.4"E	0	16	lack	Agricultural land, bicycle path, place of recreation for residents
	54°38'13.6"N 18°26'23.5"E	0	10	lack	Urban area, kept clean by the municipality of Puck
	54°38'11.8"N 18°25'34.7"E	0	10	lack	Agricultural area.
Cedron I	54°33'47.7"N 18°14'36.8"E	0	24	lack	Forest area
	54°33'57.4"N 18°14'34.4"E	0	0	lack	Meadow near the forest
	54°34'41.7"N 18°15'14.4"E	0	14	lack	Forest area by a provincial road away from residential buildings
Cedr	54°35'56.6"N 18°15'23.2"E	0	10	lack	Forest area, near provincial road 218, away from

	54°35'21.6"N 18°14'58.4"E	0	6	lack	residential buildings, kept clean by the municipality of Wejherowo.
	54°35'41.1"N 18°14'23.0"E	0	0	Bar packaging	The area cleaned by the municipality of Wejherowo due to tourist attractions.

Zagórska Struga was watched in the vicinity of the town of Kazimierz. There was along a bicycle path, a place of recreation and leisure for both residents and tourists and the area of arable fields. The section of the Łyski Canal near the village of Reda was watched, along a dirt road near arable fields, acting as a watering hole for animals from nearby farms. The section 1 and 3 of the Cedron 1 River and section 2 of Reda River covered the area along provincial roads (number 100, 224 and 218) in the forest area.

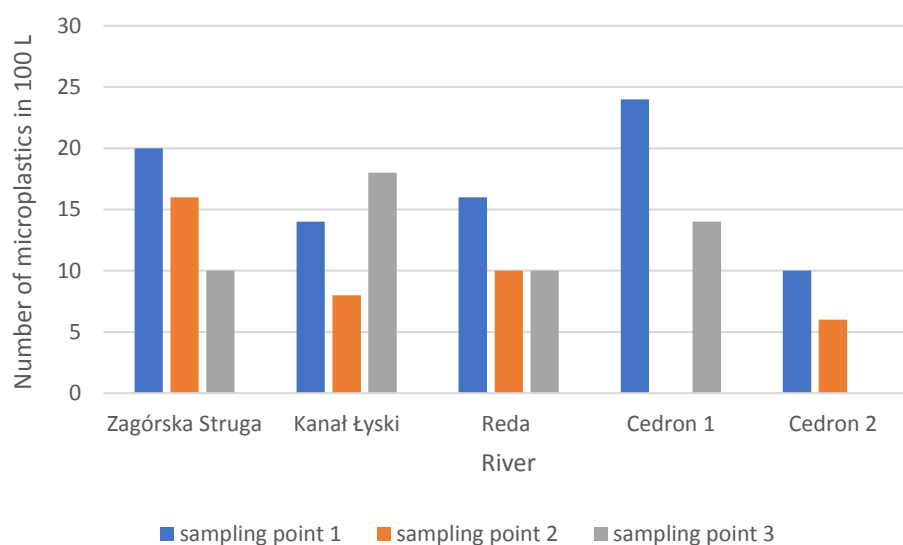


Fig. 4 The number of microplastics in three sampling points in studied small rivers in Pomeranian Voivodeship in region 1.

2.2.2. Region 2

Table 3. Characterisation of sampling points in Pomeranian Voivodeship in region 2

River	Sampling point	Microplastics >1mm	Microplastics 0,1mm - 1mm in 100 l	Macroplastics	Remarks and comments
Potok Oliwski	54°24'55.9"N 18°34'22.8"E	0	44	brak	the river passes through the park and playground, urban area, the area has been revitalized
	54°25'02.7"N 18°34'59.8"E	0	46	PCV pipes, PET bottles	
	54°25'24.8"N 18°35'37.6"E	0	48	PET bottles	
Strzyża	54°21'41.6"N 18°33'513.3"E	0	44	lack	Forest area
	54°21'41.1"N 18°33'39.1"E	0	16	PCV pipes, PET bottles	Urban area

	54°22'09.2"N 18°34'18.9"E	0	24	lack	Urban area, car wash and car workshop
Motława	54°20'32.3"N 18°38'56.5"E	0	40	lack	intensive shipping and sailing, tourist area, still revitalized
	54°20'51.3"N 18°39'20.6"E	0	52	lack	
	54°21'12.1"N 18°39'31.5"E	0	108	lack	
Radunia	54°15'40.2"N 18°38'44.9"E	0	54	lack	river by the road with very heavy traffic, construction works in the area
	54°16'12.0"N 18°38'20.9"E	0	54	PET bottle	
	54°16'47.1"N 18°38'23.1"E	brak	36	brak	
Odcieki z Szadółek	54°19'23.2"N 18°33'57.1"E	brak	38	brak	The river collects water from the landfill in Szadółki
	54°18'59.6"N 18°34'55.0"E	brak	14	brak	New urban area
	54°19'06.1"N 18°35'41.7"E	brak	116	brak	New urban area

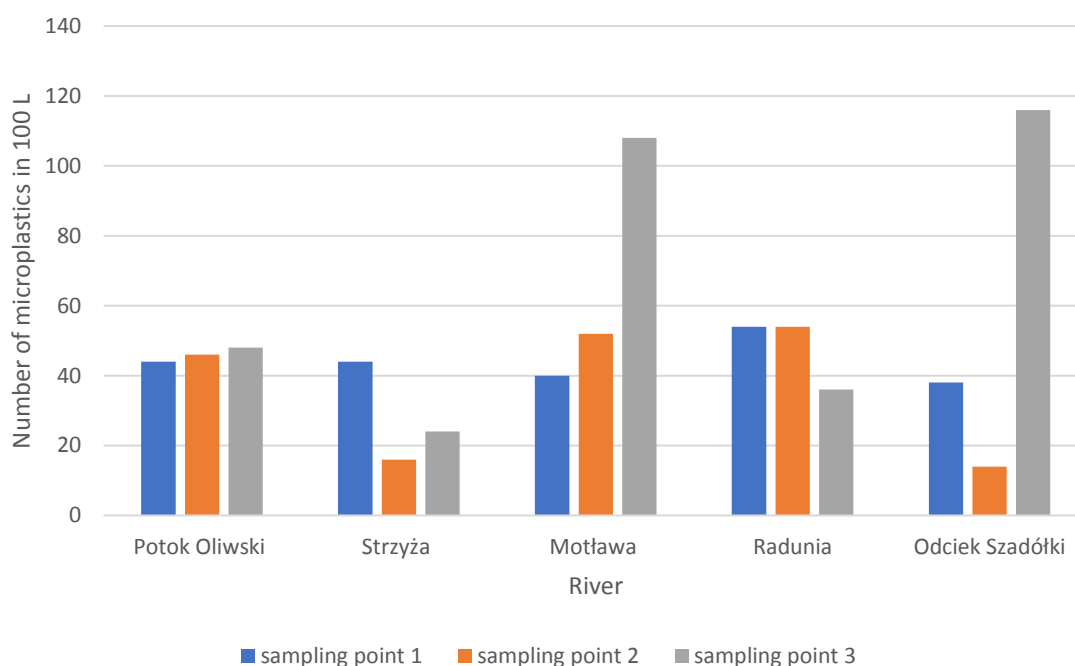


Fig. 5 The number of microplastics in three sampling points in studied small rivers in Pomeranian Voivodeship in region 2.

There were all points located in urban areas, near roads with intensive traffic, in areas where new residential buildings are built or places intensively visited by tourists. Motława is a place intensively used by cruise ships, a water tram and private yachts. There are carried out the construction investments on the river banks.

2.2.3. Region 3

Table 4. Characterisation of sampling points in Pomeranian Voivodeship in region 3

River	Sampling point	Micro-plastic >1mm	Micro-plastics 0,1mm - 1mm	Macro-plastics	Remarks and Comments
Kamionka	54.217377, 17.299483	0	4	6 PET bottles, PE films	The bottles were in the environment for a long time, they were very old
	54.223662, 17.287151	0	2	5 PET bottle, 1 PE bottle, PCV films, PE film	
	54.227623, 17.281984	0	4	5 PET bottles 6 PE bags, 2 PE films	Pollutants found around the road and bridge, hunters leave garbage - shooting pulpit, garbage left by people parked for a break
Kamienica	54.232199, 17.274906	0	2	4 PET bottles, 3 PE films 1 PE box	Area around the road and the new kayak harbor, a stopping place for people traveling to the sea. The trash bins were full
	54.237258, 17.283249	0	8	4 PET bottles, PE bag, plastic film	Forest section, among fields
	54.245265, 17.285494	0	6	3 PET bottles 1 plastic bag after fertilizers, 1 plastic label, 1 candy wrapper	
Słupia	54.282344, 17.314804	0	6	3 PET bottles, PE bag, PE bottle plastic film after icecreams	Forest area, hiking trail
	54.287617, 17.307669	0	14	2 PET bottles, 2 PE bags, candy wrapper, plastic films	The area is located near the camping site for kayaks, there are bins available
	54.288488, 17.299650	0	8	3 PE bags, 1 PET bottle, plastic box, candy wrappers	The area is located near the bonfire site
Zbrzyca	53.933267, 17.544268	0	6	Plastic bottle and folies, plastic from ciggarettes	rural area, around the camping site, there are litter bins nearby
	53.929976, 17.529081	0	2	lack	Forest area
	53.929976, 17.529081	0	2		
Pokrzywna	54.159238, 17.224928	0	0	3 PET bottles, 5 plastic foils	Forest area, pollution could flow from upstream of river, significant amounts of plastic films – bags of fertilizers or wood cover
	54.165711, 17.218188	0	0	9 plastic films, 4 PET bottles, 2 tire, 1 plastic bottle, 1 PE bottle	

54.170615, 17.209352	0	0	13 pieces of plastic film, 4 PET bottles, 2 tires, 1 bucket, 2 PE bottle, 1 piece of polyurethane foam, 1 piece of roof (plastic or asbestos)	
54.143526, 17.218824	0	2	3 pieces of plastic	Lake area - a place visited by tourists

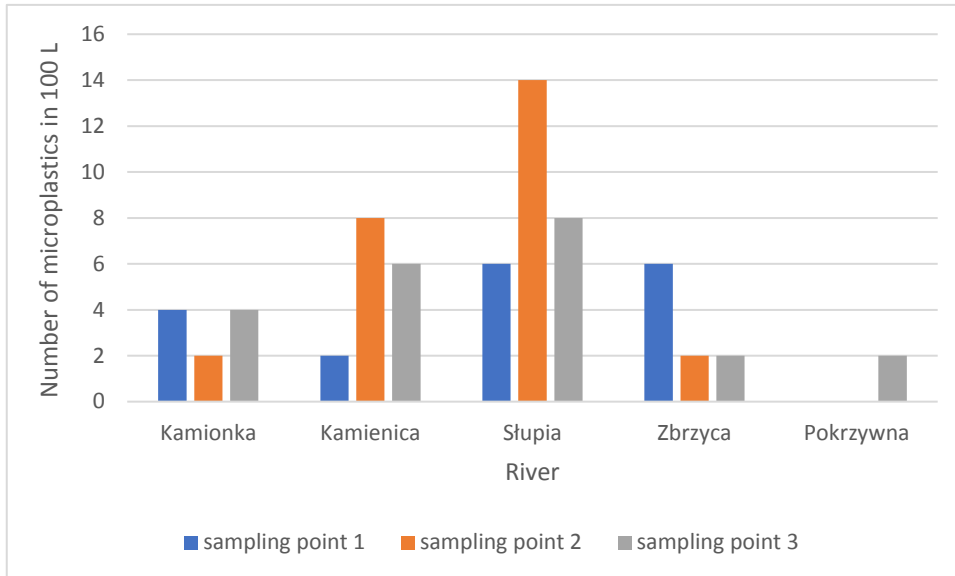


Fig. 6 The number of microplastics in three sampling points in studied small rivers in Pomeranian Voivodeship in region 3.

All sampling points of rivers were in the forest area. The largest river among the monitored rivers was the Słupia River. The largest number of microplastics was also found there. Any microplastics larger than 1 mm were not found. Due to the fact that the majority of sampled places were attractive for tourists, numerous macroplastics contamination was observed.

2.2.4. Region 4

Table 5. Characterisation of sampling points in Pomeranian Voivodeship in region 4

River	Sampling point	Micro-plastic >1mm	Micro-plastics 0,1mm - 1mm	Macro-plastics	Remarks and Comments
Dębica	53°46'54.1"N 16°08'25.8"E	0	0	present	
	53°46'13.2"N 16°08'40.8"E	0	4	lack	
	53°45'51.3"N 16°09'59.4"E	0	0	lack	
Dobrzyca	53°35'05.9"N 16°19'50.0"E	0	0	lack	Polluted water
	53°34'38.8"N 16°19'48.6"E	0	0	lack	
	53°34'19.8"N 16°19'20.0"E	0	0	lack	

Piława	53°35'53.2"N 16°26'58.1"E	0	0	lack	
	53°35'15.2"N 16°27'06.7"E	0	0	present	
	53°34'52.5"N 16°27'43.4"E	0	0	lack	
Parsęta	53°47'14.4"N 16°25'44.6"E	0	0	lack	
	53°47'04.9"N 16°26'23.2"E	0	0	present	
	53°46'59.4"N 16°27'03.6"E	0	0	lack	
Gęsia	53°44'09.6"N 16°20'16.7"E	0	0	lack	
	53°44'29.8"N 16°20'54.2"E	0	0	present	
	53°44'51.0"N 16°21'37.1"E	0	0	present	

The sampling points of rivers were located near small towns in the forest areas and meadows.

2.2.5. Region 5

Table 6. Characterisation of sampling points in Pomeranian Voivodeship in region 5

River	Sampling point	Micro-plastic >1mm	Micro-plastics 0,1mm - 1mm	Macro-plastics	Remarks and Comments
Dobrzynka	53.548013, 17.285622	0	0	lack	
	53.556835, 17.282532	0	0	lack	
	53.560352, 17.295492	0	0	lack	
Chrzastowa	53.595382, 17.165992	0	0	lack	
	53.599661, 17.181699	0	0	presence	
	53.604652, 17.194231	0	0	presence	
Silnica	53.709729, 17.208384	0	8	1	
	53.703239, 17.216281	0	6	2	
	53.694512, 17.221559	0	4	lack	
Brda	53.778781, 17.235442	0	2	6	
	53.778712, 17.251707	0	6	lack	
	53.777830, 17.261835	0	10	1	
Ruda	53.823959, 17.173880	0	2	lack	
	53.826897, 17.162036	0	4	lack	
	53.827429, 17.146844	0	0	lack	

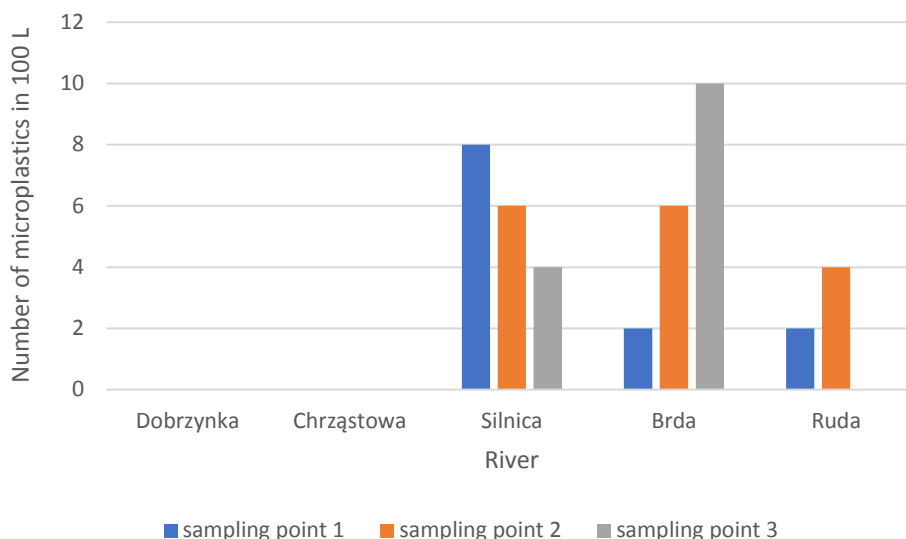


Fig. 7 The number of microplastics in three sampling points in studied small rivers in Pomeranian Voivodeship in region 5.

The sampling points of rivers were located near small towns in the forest areas including canoe routes.

3. Summarizing the results

The designed sampling set-up was light and simply to use. It served its purpose well. Both used filter fabrics were a drawback. The first had too large pores, and the second was not uniform enough.

50 L were enough volume to estimation of number of microplastics in rivers located in urban area, while in places away from buildings 100 L would be more suitable.

The most sampling points were located in places away from buildings in the forest or filed. The urban area with heavy touristic and car traffic was located in region 2 in Pomeranian Voivodship.

Nowhere microplastics larger than 1 mm were found.

In all studied rivers, except the rivers in region 4, the microplastics with the diameter in range 0.1-1 mm were found (Fig 8).. The highest amount of microplastics were collected form rivers located in urban area, where the construction works have been done. The shipping and sailing were one of the major source of microplastics in Motlawa river (Fig. 8). The rivers located in forest areas were less exposed to microplastics contamination. In urban areas the main microplastics contamination was fibers, while flacks and fibers were recognized in other places (Fig. 9). The microplastics characterized the different colors: blue, black, pink, and red fibers and black, pink, green and transparent flacks.

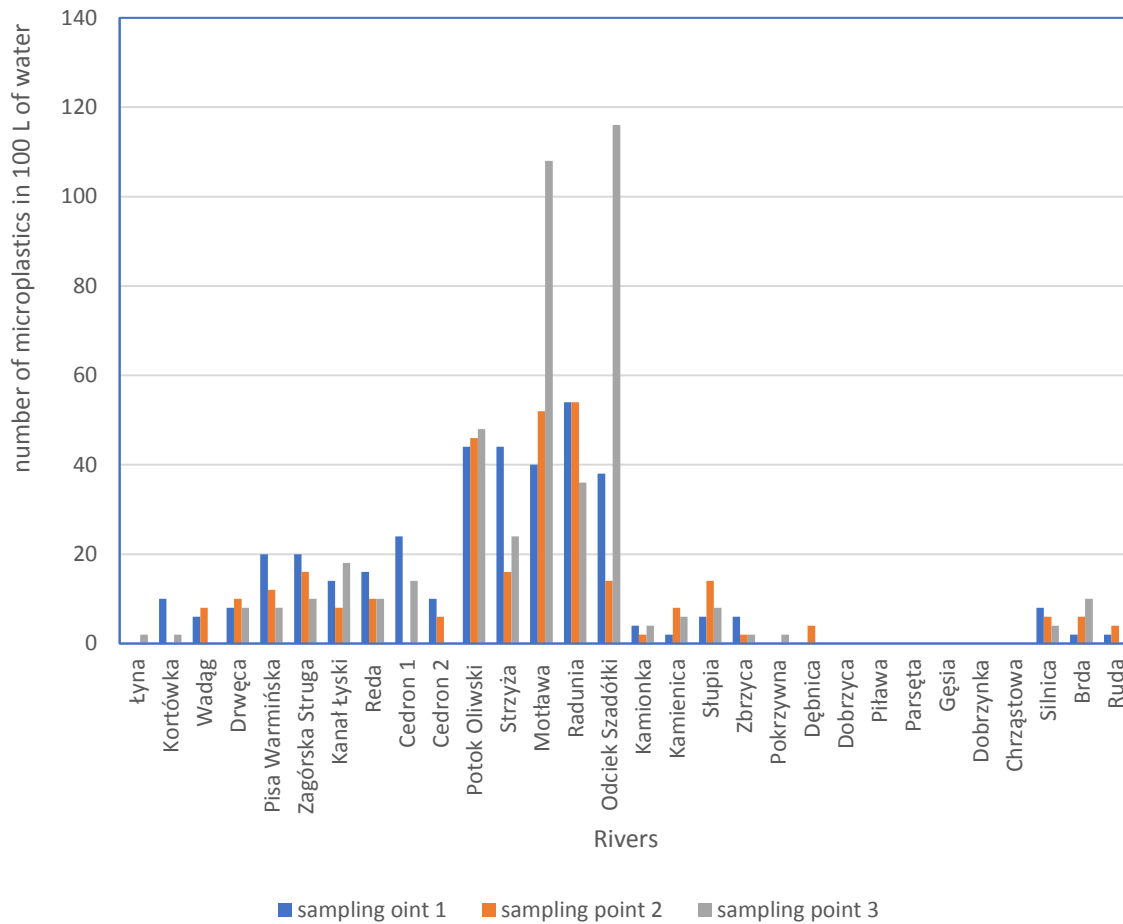


Fig. 8. The number of microplastics in rivers in one region of Warmian-Masurian Voivodeship and five regions of Pomeranian Voivodship

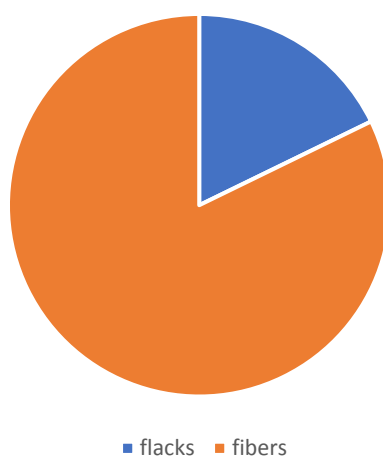


Fig. 9. The flacks and fibers participation in microplastics sampling in all watching regions.

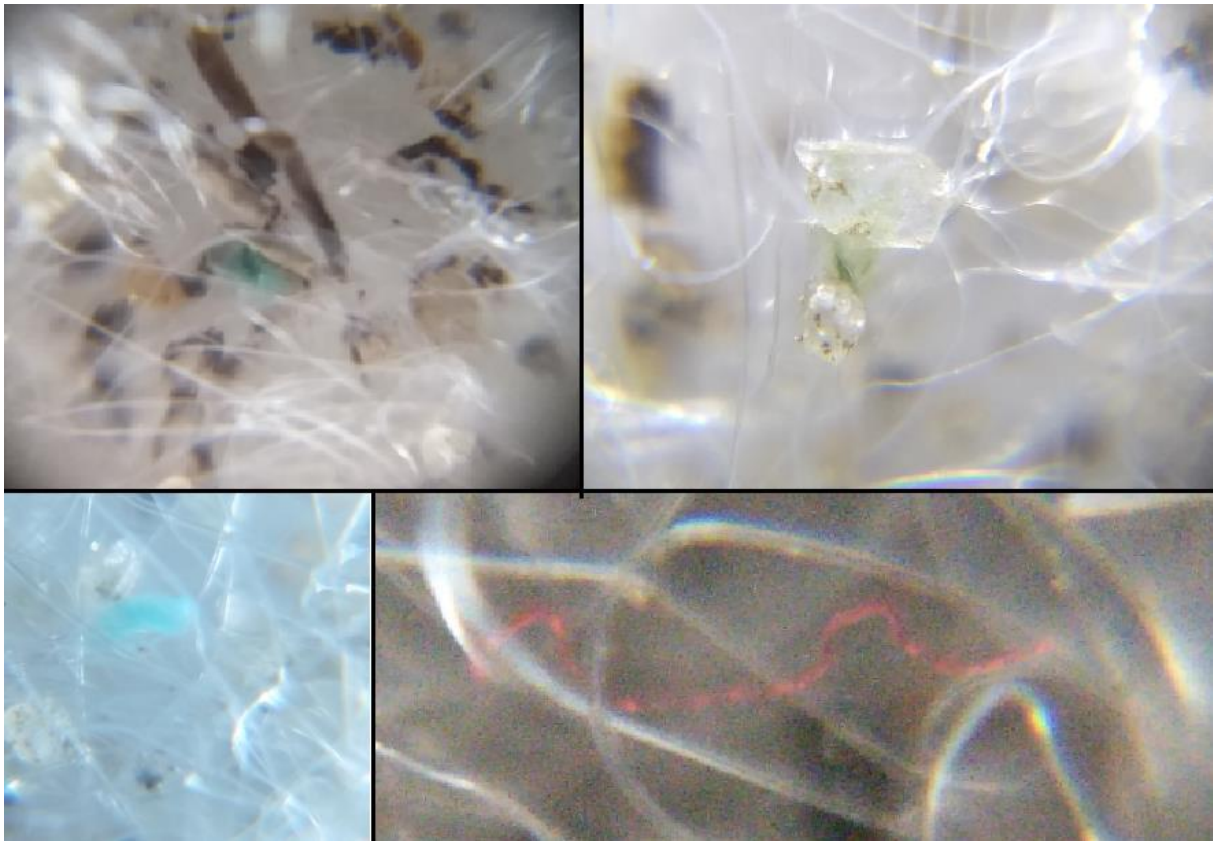


Fig.10. The images of microplastics in flacks and fiber forms collected from rivers.

Macroplastics were found in most places of sampling. There are mainly PET (polyethylene terephthalate) bottles, LDPE/HDPE (low density polyethylene/ high density polyethylene) films and PP (polypropylene) containers. Polistyren and PCV (polychloride vinyl) pieces were also found in some places.

In order to full estimate the microplastics pollution of small rivers, their monitoring should be carried out at least twice a year in early summer and late autumn.

The examples of sampling points are presented in Fig 14

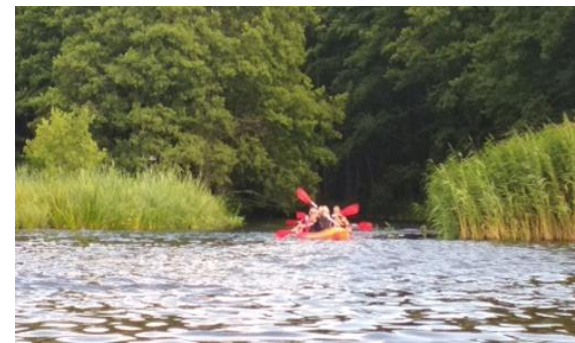


Fig.14. The examples of sampling points