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Report

Development of a fishing gear marking system based on passive RFID technology

Łukasiewicz
Instytut Logistyki
i Magazynowania

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Cover photo: Tomasz Markowski

Abstract

This report is a summary of the work carried out by the Lukasiewicz - Institute of Logistics and Warehousing under the Marelitt Baltic project. The introduction to the research conducted in the Laboratory of Identification Technologies of the Institute is a description of fishing gears used on the Baltic Sea and introduction to radio identification technologies (RFID). As part of the project, the Institute dealt with developing a solution that would allow marking all fishing gears available and used on the Baltic Sea. In the course of the works, ready-made solutions on the market were verified, enabling the marking of gears used in difficult conditions (up to 100m below sea level) in connection with existing net elements (floats of different types and sizes), however their cost had a significant impact on the price of fishing gears. As a result of these arrangements, in consultation with project partners and experts cooperating with the project team, Identification Technology Laboratory committed to develop prototypes enabling mass marking of fishing gears while maintaining a low cost of this solution. In further laboratory work, the aforementioned prototypes were developed (both 3D projects as well as physical implementations of these projects using various techniques - 3D printing or polyurethane foam molding). Prepared prototypes were then subjected to laboratory tests and after their positive results, also sea trials, in real environment and most importantly in real fishing processes (both with the use of gillnets and trawl nets). The obtained results confirmed the resistance of prototypes to unfavorable working conditions and the possibility of keeping inventories of fishing nets continuously, during the implementation of fishing processes (during casting or pulling out the nets and during operations in the port).

As a result of the works carried out, solutions were proposed that were accepted by the assessment of the project team for the mass implementation and recommendation of appropriate legal solutions. The method of identification of the owner of a given fishing gear remains an open question, and as a basis, the project team proposed using global identifiers and standardization compliant with GS1 standards (e.g. GRAI or GIAI identifier developed on their basis in cooperation with the GS1 organization).

The result of the project are both 3D prototype projects, prototypes made in the project, as well as this report constituting both the technical documentation of the proposed solution as well as a description of the research and development works carried out.

Table of content

1. Introduction

This report is a summary of the work carried out by the Institute of Logistics and Warehousing under the Marelitt Baltic project. The work carried out sought to develop and test a technological solution that works on the basis of radio waves, allowing the marking of fishing gears. The scope of work included analysis of available solutions, development of RFID tag prototypes for mass applications as well as testing in both laboratory and real-life conditions.

1.1. The legal basis

The basis for the report is the Partnership Agreement of the Marelitt Baltic project of 26 November 2015 between Simrishamns komun, Varvsgatan 4, 272 36 Simrishamns, Sweden - project leader and the Institute of Logistics and Warehousing, located in Poznań, ul. Estkowskiego 6, postal code 61-755.

1.2. The Objective

Development and testing the technological solution for marking the elements of fishing gears (fishing nets) in laboratory and real conditions.

1.3. The scope of the works

Development and research of a technological solution for marking fishing nets based on passive RFID technology - including the selection of the appropriate set of markers for selected elements of fishing nets, laboratory tests and tests in real conditions, the impact of water with different degrees of salinity on RFID technology.

The scope of the project includes the preparation of a report on works in the scope of:

- conducting laboratory tests
- conducting sea trials
- presentation of the description of the work carried out and the chosen solution

1.4. Abbreviations used

The following abbreviations are used in the text of the study, the definitions of which are given below:

RFID - Radio-frequency identification

UHF - UHF (Ultra high frequency) – range of radio waves (radio band) with frequency: of 300–3000 MHz and length of 100–10 cm.

SLS - Selective laser sintering - 3D printing technology, consisting of solidifying successive layers of plastic powder using a laser beam.

2. Introduction to fishing gear techniques

The introduction includes a description of the gears that can be used for fishing of marine organisms in Poland. The types of fishing gears mentioned in the Regulation of the Minister of Maritime Economy and Inland Navigation of 16 September 2016 were taken into account. (Journal of Laws of September 17, 2016, item 1494) on dimensions and protective periods, as well as detailed conditions of commercial fishing:

1) towed gears or trawls, including:

a) Danish seines (SDN) or beach seines (SB),

b) bottom trawls (OTB),

c) pelagic trawls (OTM),

d) bottom pair trawls (PTB),

e) pelagic pair trawls (PTM);

2) gillnets or entangling, including:

a) set gillnets (GNS),

b) set gillnets (Polish: mance) (GNS),

c) set gillnets (Polish: nety) (GNS),

d) trammel nets (GTR);

3) traps, including:

a) pound nets (FPO),

b) fyke nets (FPO),

c) fykes (FPO),

d) pots for cod fishing (FPO);

4) hooks and lines, including:

a) handlines and pole-lines hand operated(LHP) or handlines and pole -lines mechanized(LHM),

b) trolling lines (LTL),

c) pound hooks and lines (LLS),

d) drifting longlines (LLD).

For the fishing of marine organisms intended for use as bait in commercial fishing in a given fishing trip, operated with fishing vessels up to 12 m overall length in a 2 Mm wide strip offshore, the use of live bait nets (MIS) shall be allowed no longer than 5 m between the central point of the headline and the codline.

The abbreviations indicated in the regulation (in brackets) assigned - sometimes incorrectly - to individual types of gears are in line with the International Food and Agriculture Organization (FAO) standard established by **INTERNATIONAL STANDARD STATISTICAL CLASSIFICATION OF FISHING GEAR (ISSCFG) Rev.1 (2013).**

In the guide, in addition to these standard abbreviations, there are also names in English and ISSCFG numbers.

Definitions of fishing gear are included in FAO publications:

– Nédélec, C, 1982. Definition and classification of fishing gear categories. Définition et classification des catégories d'engins de pêche. FAO Fisheries Technical Paper. No. 222. Rome, FAO. 51 p.
– Nédélec, C., Prado, J., 1990. Definition and classification of fishing gear categories. Définition et classification des catégories d'engins de pêche. Definición y clasificación de las diversas categorías de artes de pesca. FAO Fisheries Technical Paper. No. 222. Revision 1. Rome, FAO. 92 p.

Some drawings (of this report) were also taken from the above mentioned papers, while the other drawings were taken from other papers available on the Internet, according to the source quoted.

Description of fishing gear used in the Baltic Sea includes:

– Technical name [name in English],
– Common name
– Abbreviation / ISSCFG number
– Drawing or picture
– Material
– Purpose (gears used in the Baltic Sea)
– Area of exploitation (the Baltic Sea)

More detailed descriptions of the majority of fishing gears and fishing techniques used in the world, including the Baltic Sea, have been published in the book: Świniarski, J., Cetinić P., 1993. Technology of catching marine organisms. Maritime Publishing House, Gdańsk, 472 pages

2.1.Trawls

A. Seine nets, ISSCFG: 02 – seine nets (sheer seines) surrounding and towed bottom gears

a) **Danish seines -** a type of boat seines (sheer seines) for the high seas

Abbreviation / ISSCFG number: SV/02.2 (before 2013 SDN/02.2.1).

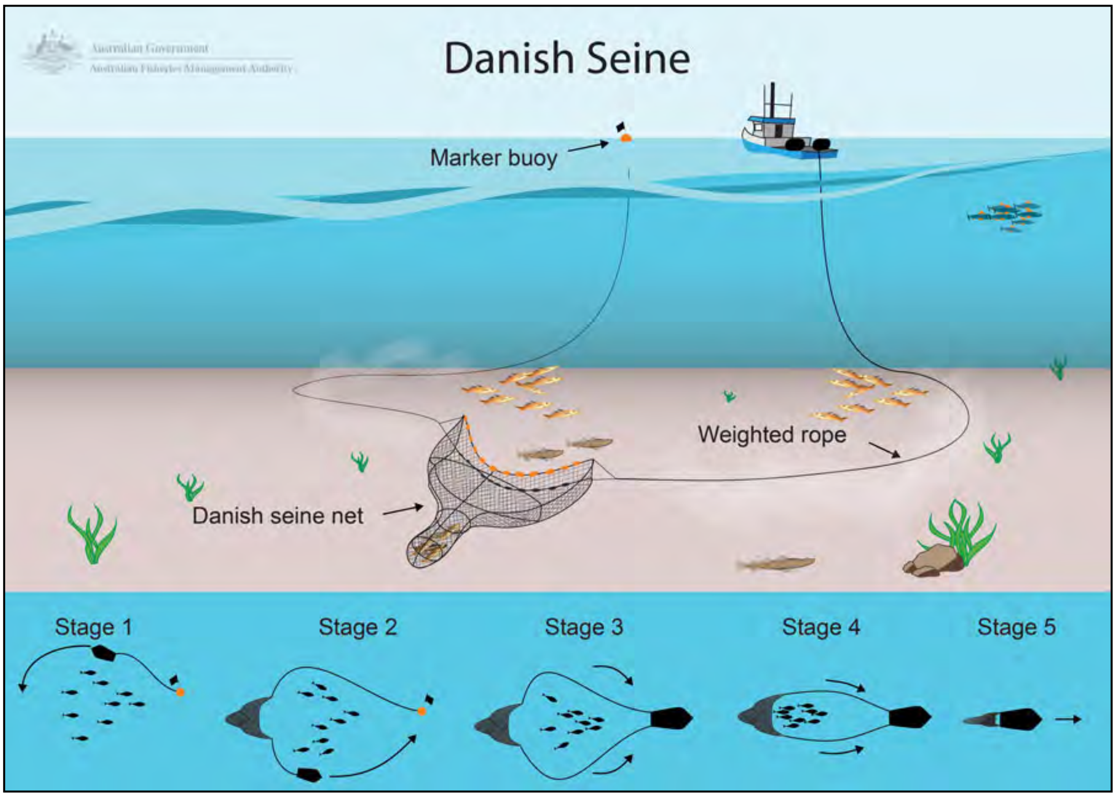


Fig. 1. Danish seines

Material: synthetic fiber yarn (polyamide or polyester), formerly also cotton yarn, most non-seine ropes made of polypropylene (PP) or polyester (PES)

Purpose: fishing for demersal species, especially flatfish and cod.

Area of exploitation: open Baltic Sea, Pomeranian Bay (in Polish fisheries are of minor importance)

b) **beach seines -** means towed to shore by people standing on the beach, may be equipped with a codend or not.

Abbreviation / ISSCFG number: SB/02.1

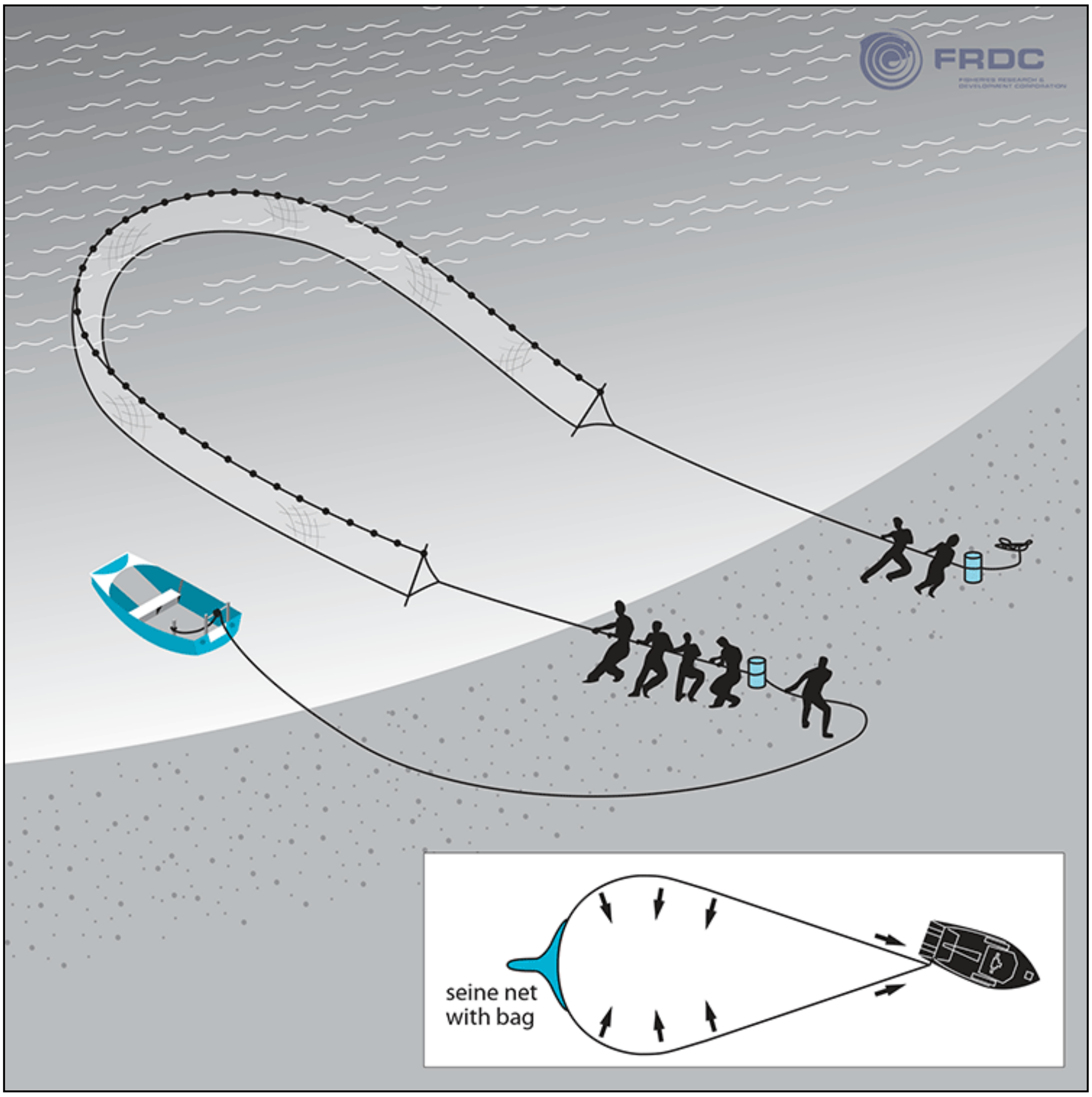


Fig. 2. Beach seines

Material: yarn made of synthetic fibers (polyamide, e.g. stylon)

Purpose: fishing for demersal species living close to the shore, e.g. spring salmon fishing

Area of exploitation: coastal waters (including coastal lagoons)

c) **pair seines** - nets similar to beach seines, only lower and with shorter wings, towed to shore by two boats

Abbreviation / ISSCFG number: SV/02.2

Fig. 3. Pair seines

Material: yarn made of synthetic fibers (polyamide, e.g. stylon)

Purpose: coastal fish e.g. smelts

Area of exploitation: coastal waters (including coastal lagoons)

d) **sheer seines** - seines in general that are used from vessels (abbreviation / **ISSCFG** number: **SV/02.2.0**);construction and fishing method similar to trawls; they can be with or without wings, they can also be equipped with boards

Abbreviation / ISSCFG number: SV/02.2

Material: yarn made of synthetic fibers (polyamide, e.g. stylon)

Purpose: seagoing sheer seines (equipped with otter boards) - fisheries for cod and flatfish, also herring and sprat (pair trawls), eels in the coastal German waters, pike, zander, perch and flat fish

Area of exploitation: coastal areas, including coastal lagoons (in German waters). Currently, they are not on the list of types of fishing gears that can be used for commercial fishing in Poland (Regulation ..., 2016).

B. **Towed gears - trawls, ISSCFG: 03** - In Poland, there are only **otter trawls and pair trawls** used other type of bottom trawls are **beam trawls** TBB/03.11 (not applied in Polish fisheries)

A separate subgroup of trawls are **twin bottom otter trawls** and **multiple bottom otter trawls** (abbreviation / ISSCFG number: OTT / 03.13 and OTP/03.14, respectively) used to catch shrimps (which are not fished in the Baltic Sea)

a) trawls: single boat bottom trawls, demersal trawls and single boat midwater trawls, pelagic trawls, wing trawls, skagen nets;

Abbreviation / ISSCFG number: OTB/03.12 (bottom) (Fig.), OTM/03.21 (pelagic)

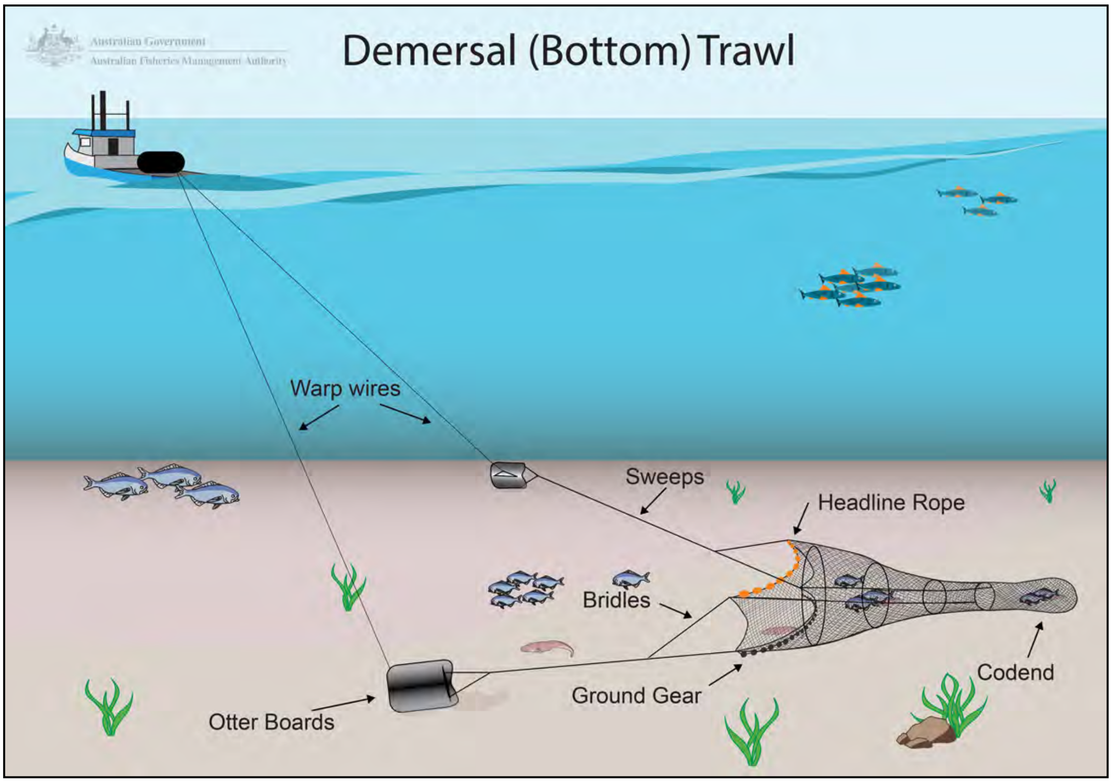


Fig. 4. Trawls

Material: yarn made of synthetic fibers (polyamide, e.g. stylon, also polyethylene)

Purpose: cod fishing and flat fish (bottom trawls), herring and sprat (pelagic trawls)

Area of exploitation: open Baltic Sea (in Poland it is forbidden to use Danish trawls and Danish seines in the coastal zone - according to the Regulation of 2016, west of the 18° 00′ meridian E the ban currently applies up to 6 Mm from the shore)

b) pair trawls

Abbreviation / ISSCFG number: PTB/03.15 (bottom), PTM/03.22 (midwater)

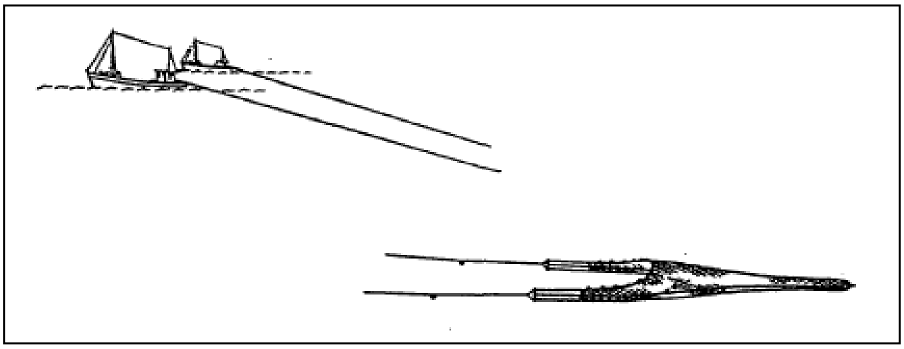


Fig. 5. Pair trawls

Material: yarn made of synthetic fibers (polyamide, e.g. stylon, also polyethylene)

Purpose: cod fishing (bottom pair trawls), herring and sprat, to a lesser extent salmon and sea trout (pelagic pair trawls)

Area of exploitation: open Baltic Sea

c) other trawls

Abbreviation / ISSCFG number: TX/03.9 [Trawls (nei)] (in Regulation 2016 the abbreviation MIS was assigned to this gear but according to ISSCFG Rev.1 (2013) corresponding number is 10.9 [Gear nei]) [1]

Material: yarn made of synthetic fibers (polyamide, e.g. stylon)

Purpose: fishing for coastal fish, e.g. smelts

Are of exploitation: internal sea waters (including coastal lagoons)

2.2. Gillnets and entangling nets, ISSCFG: 07

[1] In the FAO publications (Nédélec 1982 and Nédélec and Prado 1990), as well as in the ISSCFG, no towed gears are listed in the group of gears called Miscellaneous gears (MIS), whereas a subgroup of **unspecified other trawls** is included (in the group of towed tools) - it is not known why other trawls are not included in the Polish regulation ...

a) **set gillnets (anchored), demersal gillnets -** name defining the entire group of gillnets gears (anchored), abbreviation: GNS

Abbreviation / ISSCFG number: GNS/07.1

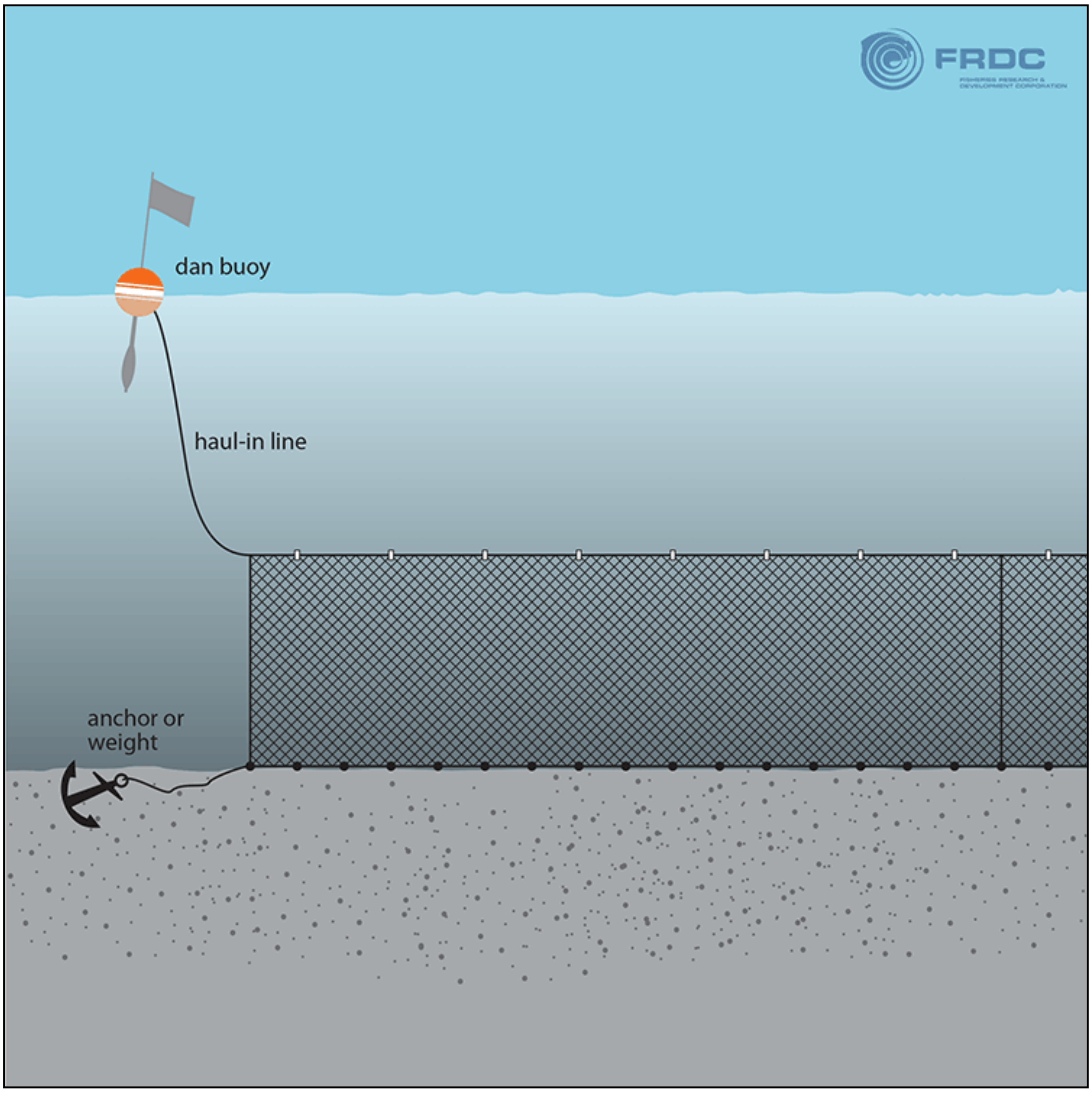


Fig. 6. Set gillnets

Material: line and yarn made of synthetic fibers (polyamide, e.g. stylon)

Purpose: coastal fish (freshwater and migratory), salmon set gillnets can be set with one anchor, in the past they could also be used as **pelagic gillnets**

Are of exploitation: coastal waters (including coastal lagoons) - except of salmon set gillnets, which are used on the high sea

b) **set gillnets** (Polish: mance) used for catching the herring fish

Abbreviation / ISSCFG number: GNS/07.1

Material: synthetic fiber yarn and yarn (e.g. stylon), formerly also cotton yarn

Purpose: herring catches

Area of exploitation: coastal waters (especially during herring spawning)

c**) set gillnets** (Polish: nety) used for fishing flat fish and cod

Abbreviation / ISSCFG number: GNS/07.1

Material: synthetic yarn and line (polyamide, e.g. stylon)

Purpose: sea and demersal fish, including salmon

Area of exploitation: coastal waters (including coastal lagoons)

d) **pelagic gillnets**, drifting gillnets, driftnets - floating (drifting - alone or together with a fishing vessel)

Abbreviation / ISSCFG number: GND/07.2

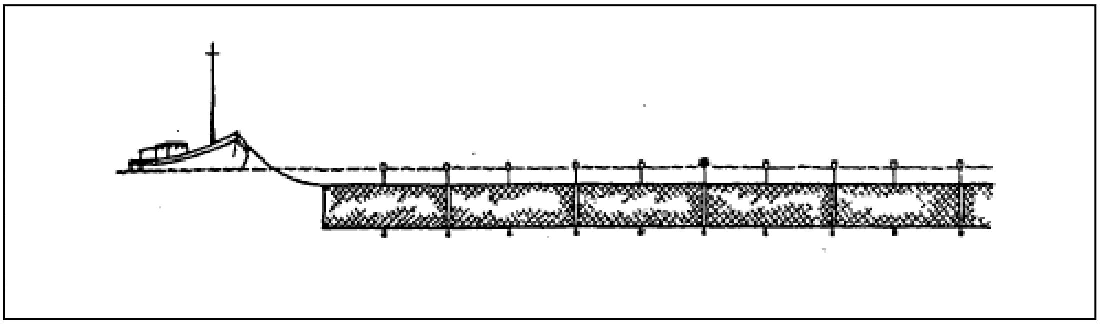


Fig. 7. Pelagic gillnets

Material: synthetic fiber (polyethylene) yarn, formerly cotton yarn

Purpose: used (until 2008) to catch salmonid fish and formerly herring catches

Area of exploitation: open sea (outside the zone of 4 Mm from the shore), not used since 2008 (still, however, can be used as one anchored seines)

e) **trammel nets** - entangling gears, are made of a netting and one or two screens made of a mesh with a larger mesh (so-called bars)

Abbreviation / ISSCFG number: GTR/07.5

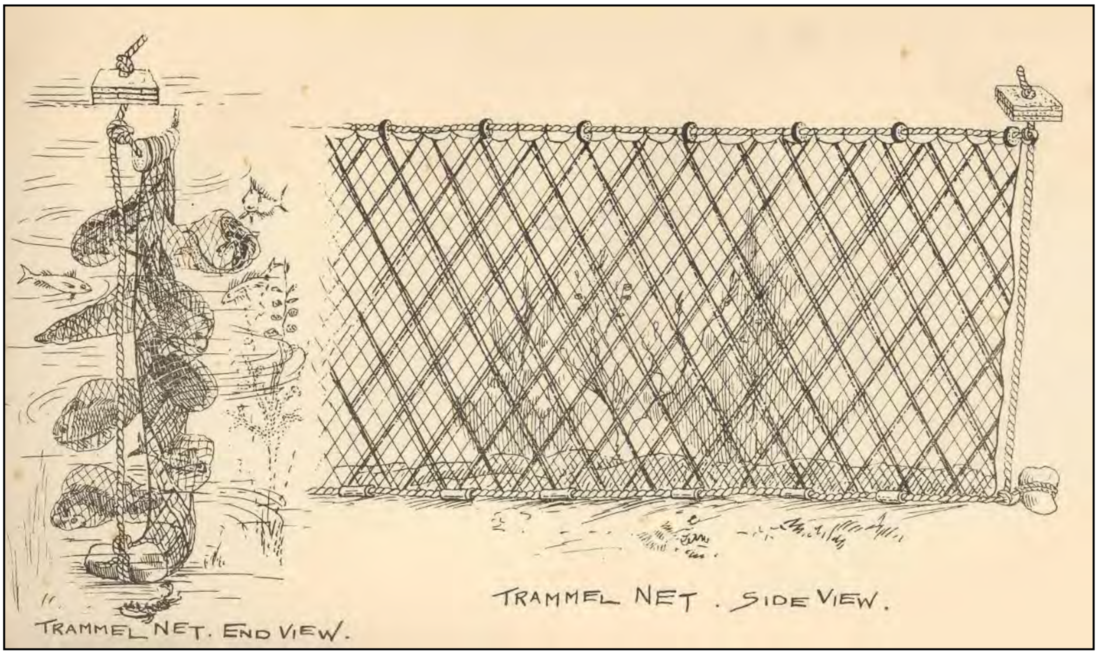


Fig. 8. Trammel nets

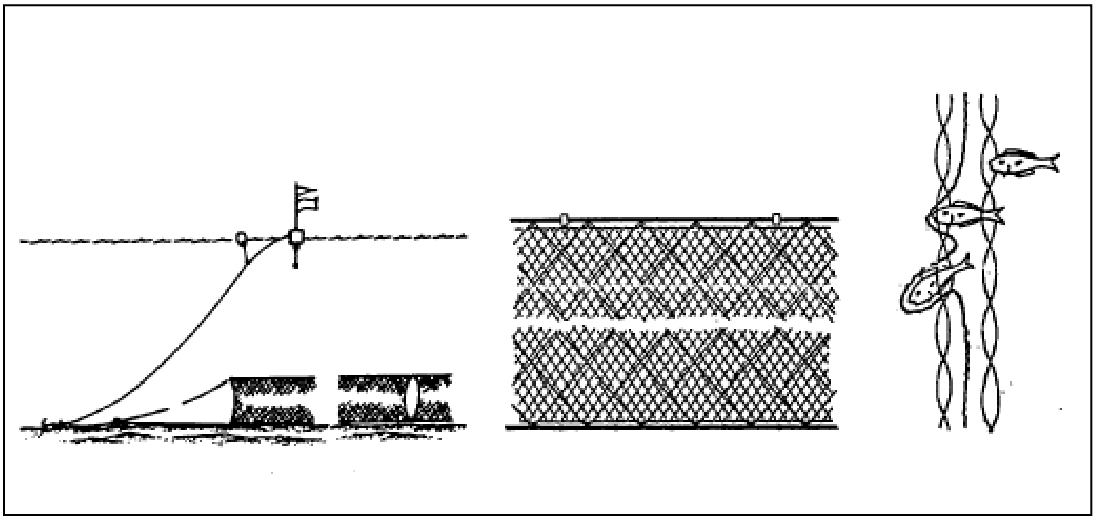


Fig. 9. Trammel nets

Material: yarn made of synthetic fibers (polyamide, e.g. stylon)

Purpose: catches of sea bottom fish (e.g. flatfish), also freshwater fish

Area of exploitation: coastal waters (including coastal lagoons)

2.3.Traps, ISSCFG: 08

A group of passive bottom set gears, sometimes used with bait. In the Polish regulations issued before 2016, this group included: different types of fyke nets, stow nets. When reporting catches with the use of these gears, the abbreviation **FPO** of ISSCFG is often misled, although it is reserved for **wingless covered traps,** so called **pots - 08.2** In the current Regulation of 2016, where stow nets were replaced with **pots** used for cod fishing**,** this abbreviation was "officially" assigned, not only to the pots, but to each of the other trap gears listed there (which is incompatible with the ISSCFG).

a) **fyke nets** - giant hoop nets (see below) used in herring fisheries in coastal waters

Abbreviation / ISSCFG number: FYK/08.3 (in the Regulation of 2016 standard abbreviation FPO is wrongly used)

Material: yarn made of synthetic fibers (polyamide, e.g. stylon)

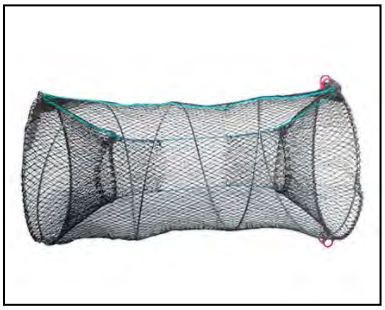
Purpose: spring fishing herrings

Area of exploitation: coastal waters of the Pomeranian Bay and the Vistula Lagoon

b) fyke nets, hoop nets - various types of trap nets (Figure **A)**, i.e. traps that consists of cylindrical or cone-shaped netting bags mounted on rings or other rigid structures. It has wings or leaders which guide the fish towards the entrance of the bags.(Fig. **B)**; often combined into sets;

Abbreviation / ISSCFG number: FYK/08.3

A B



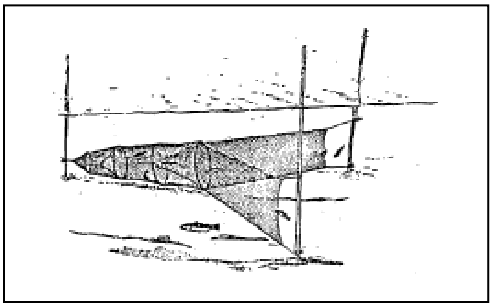


Fig. 10.Fyke nets

Material: yarn made of synthetic fibers (polyamide, e.g. stylon)

Purpose: mainly fishing for eel, but also freshwater fish

Area of exploitation: coastal lagoons

c) **fykes, fyke nets** - another type of fyke nets, equipped with consisting of tubular nets that are supported by hoops, with a chord of first hoop attached to the bottom; can be equipped with a directional wall or wings (photo).

Abbreviation / ISSCFG number: FYK/08.3

Fig. 11. Fykes

Material: yarn made of synthetic fibers (polyamide, e.g. stylon)

Purpose: mainly fishing for eel, but also freshwater fish

Area of exploitation: coastal lagoons, however, mainly lakes

3. Introduction to RFID technology

RFID - Radio Frequency Identification- is a technique that uses radio waves to supply, read and identify of an electronic system (RFID tag) and an object marked with it. RFID systems consist of two important parts: transceiver (Fig. 12) and tags used to mark objects. The construction of a typical tag is presented on Fig. 13.

Fig. 12.RFID readers / programmers
Source: Own study based on the manufacturer's materials

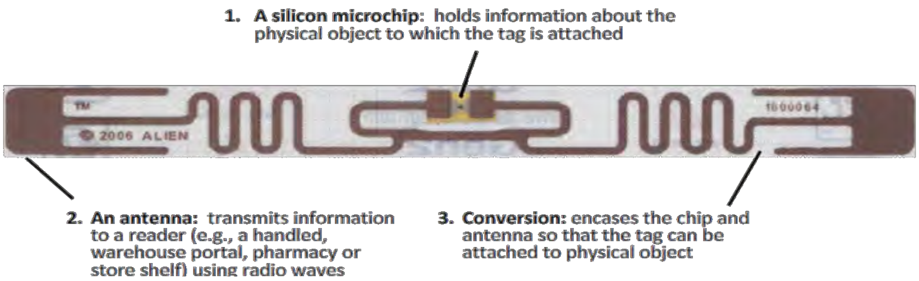


Fig. 13.Construction of RFID tag
Source: Own study

In principle, the tag reading can take place at different distances between the tag and the reader, in the far or near field and the boundaries between these areas are defined depending on the frequency of the radio wave used for transmission.

In the case of RFID systems, when analyzing the above-mentioned areas of the reading range, there are two cases - the first, when the tag reading requires almost direct contact of the reader with the tag (medium and long wave ranges - HF and LF). However, in the second case, by using the frequency of ultra-short waves (UHF), it is possible to read tags up to a few or even several meters - the basic range of waves with parameters assigned to it presents Tab. 1.

When using RFID tags for marking fishing gears, the most interesting case is reading of the tags in the far field, due to the possibility of tags reading placed in the fishing nets, directly from the side of the fishing boat at sea or in the seafront in the port. No direct contact between the tag and the reader is required, which greatly facilitates the identification in typical processes related to fishing.

Tab. 1. Frequency ranges used in RFID systems
Source: Own study

Band	**LF** low frequency	**MF** medium frequency	**HF** high frequency	**VHF** very high frequency	**UHF** ultra-high frequency	**SHF** super high frequency
Frequency	30-300kHz	300kHz-3MHz	3-30MHz	30-300MHz	300MHz-3GHz	3-30GHz
Waves length	10-1km	1000-100m	100-10m	10m-1m	1m-0.1m	0.1-0.01m
Theoretical reading range of the tag	up to 0.9m	-	up to 1m	-	up to 10-15m	-

In the case of the ultra-short waves range, the phenomenon of backscattering of the signal - the tag's response to radio wave stimulation - is used for reading and identification of the tag - the principle of its operation is presented on Fig. 14.

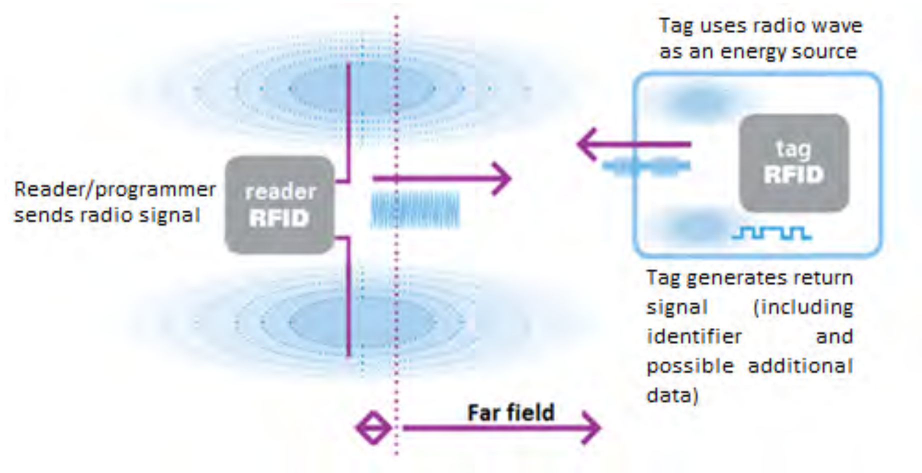


Fig. 14. Transmission in UHF RFID systems
Source: Own study

The frequencies used in RFID systems may also vary slightly depending on the area of their use (geographic location). We distinguish 3 basic regions (Fig. 15) for which the ITU (International Telecommunication Union) has defined separate regulations (regarding, among others, frequency, but also, for example, the power of devices, the permissible period of activity per unit of time, etc.).

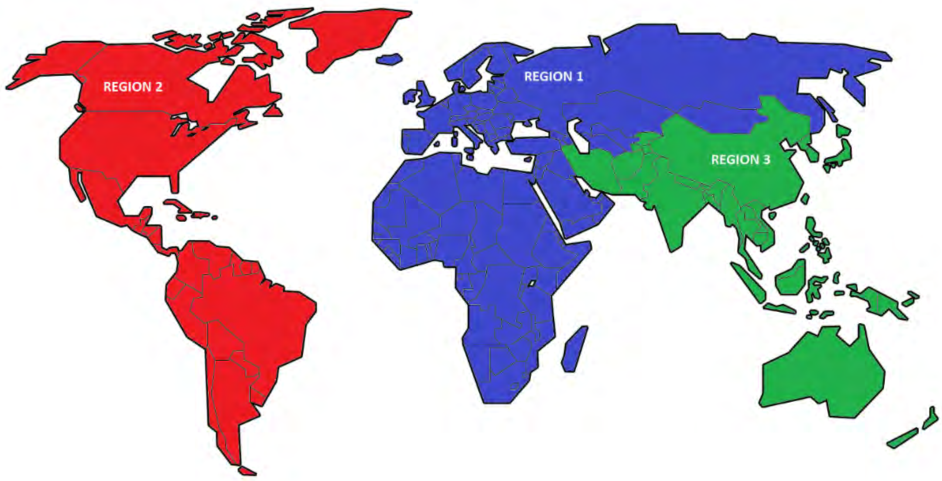


Fig. 15. Areas of division of standards in the field of RFID
Source: Own study

According to ITU regulations, RFID readers / programmers in the UHF waves, used in Europe (Region 1) can transmit with a maximum power of 2W ERP (in the case of stationary devices) and 0.5W ERP for mobile devices - Fig. 16. The number of channels (four for stationary devices, and one for mobile devices - for the first region) as in the frequency and power range varies in different regions. In connection with the above differences, systems operating in different areas need to take these differences into account. This does not mean, however, that tags intended for a specific area can not be read in another area - however, the range and other parameters may be slightly different.

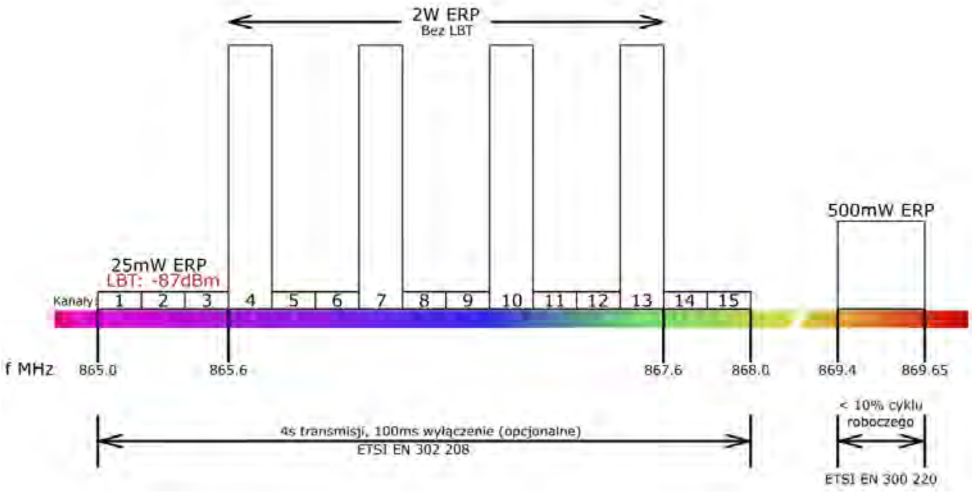


Fig. 16. RFID regulations in the region 1
Source: Own study based on ITU source documents

4. Assumptions regarding the fishing gear marking

The assumptions of fishing gear marking were formulated based on the analysis of the catalog of gears used in the Baltic Sea basin (described in item2) and functional requirements. During the laboratory works, samples of fishing gears were collected, mainly elements that would allow the implementation of RFID tags. The acquired elements were subjected to research and tests for the impact of the material of which they are made on the propagation of radio waves and the possibility of tags implementing.

Functionality requirements were collected both among the project partners, as well as among the communities participating in project meetings, including fishermen, controllers, institutions supervising both fisheries and sport and recreation activities, as well as bodies dealing with nature protection. During the works, the use of radio reading methods was also analyzed in terms of their use of searching for lost nets, however due to the nature of radio waves propagation, it is not possible to read the tag under the water surface for a longer distance, which disqualifies radio identification technology in this application. In the case of the frequency of waves used in RFID systems, the total signal attenuation takes place practically immediately below the surface of the water.

Requirements for RFID tags that could be used to identify nets have been defined as below:

- physical parameters
  - weight - elements for marking should not change the weight of the net and its geometry during fishing
  - shapes - elements must be streamlined, without sharp edges (due to the possibility of nets entanglement)
  - the design and dimensions of the float must allow the placement of an RFID tag in it
  - resistance to hydrostatic pressure up to 60 m depth and
  - resistance to loads from the lifting gear
  - tightness - RFID tags must be protected against access of water
- functional characteristics
  - tag reading possible from several (3-5) meters
  - easy assembly and disassembly on fishing gear (for rope gear)
  - hole for a rope with a minimum diameter of 12mm
  - the material must not cause interference to the radio transmission

The project assumes the development of floats with RFID tags. Floats should be easy to put on and take off on existing fishing nets. In addition, one of the projects carried out relates to a float with a typical construction, i.e. a traditional float through- holed with the net in the production phase of, with the difference that it contains an RFID tag inside.

5. Structural conditions of marking of fishing gear elements

During laboratory work carried out as part of the project, first attempts were made to mark existing elements of fishing gears. New floats were obtained - from the fishing nets producers (MARKUR, MARWIS) and used - delivered by waste processing plants (reTRAWL ApS, Plastix A/ S). Tests were conducted on approximately 20 different types of floats, made of various materials.

Fig. 17. Used fishing gear components
Source: supplier's materials (reTRAWL ApS)

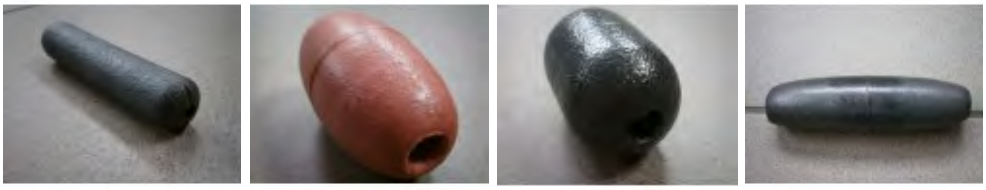


Fig. 18. New fishing gear components
Source: supplier's materials (MARKUR)

Firstly, tests were carried out on the impact of materials from which floats were made in terms of the impact on radio communication and the reading parameters of RFID tags operating in UHF frequencies (800-1000 MHz). The tests were carried out using the Voyantic Tagformance PRO test station with software version 10 for RFID tags tests (Fig. 19) in the anechoic chamber of the Institute of Logistics and Warehousing (Fig. 20).

The conducted tests included measuring basic parameters of RFID tags readings and included: read range, threshold and orientation. Power budget was also analyzed resulting from the mutual dependence between the power and sensitivity of the tag's reader and radio parameters of the RFID tag. The Tagformance PRO test station for RFID tags, subjected to annual calibration, allows to simulate the full range of frequency and power of RFID systems, due to which the conducted tests are comprehensive - RFID tag is subjected to stimuli, which in reality would have to be tested with various types of readers and antennas (stationary and mobile with different powers and sensitivities). Therefore, the results obtained in laboratory tests are reliable and comprehensive.

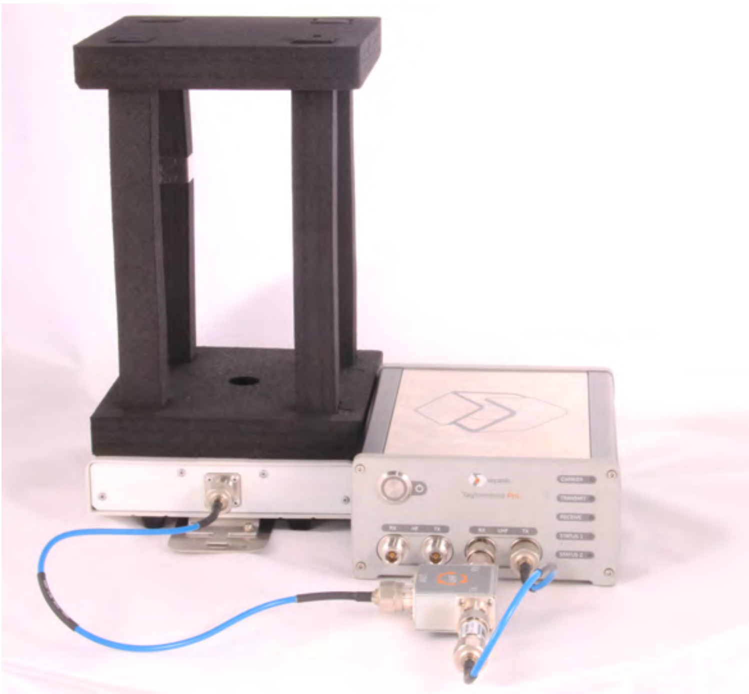


Fig. 19. The Voyantic Tagformance PRO test station
Source: own materials

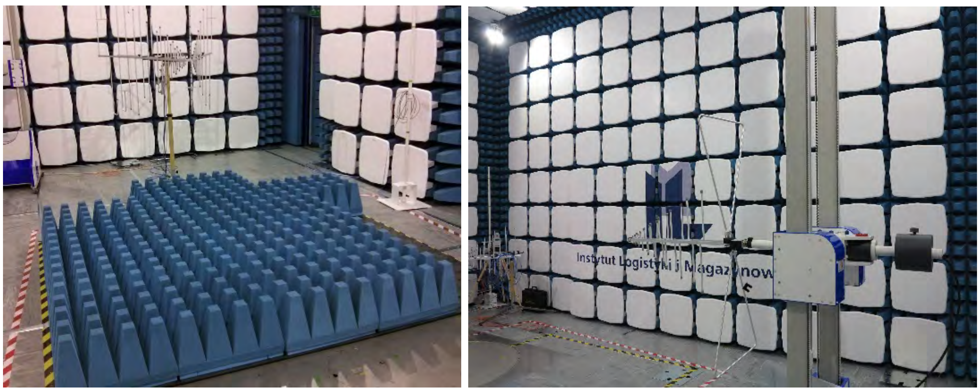


Fig. 20. Anechoic chamber of the Institute of Logistics and Warehousing
Source: own materials

The results of the tests distinguish several types of materials with varying degrees of impact on the parameters of RFID tags reading; however none of the materials used to produce floats obtained during laboratory work completely blocked the reading of the tag implemented inside the float.

6. RFID tag selection

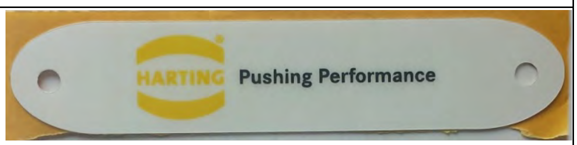
For the needs of the research, a large group of tags was selected covering various systems both in the context of their geometric dimensions, construction and dedicated foundation materials. The list of tags with basic parameters is presented in Tab. 2 while the actual photograph of the tag is shown in Tab. 3.

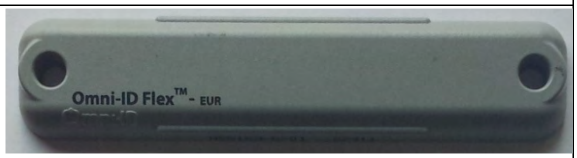
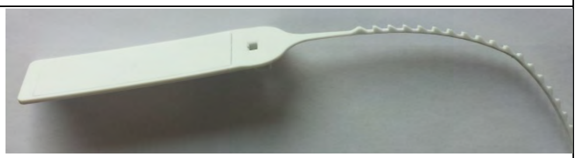
Tab. 2. List of RFID tags selected for laboratory tests
Source: Own study

Number	Manufacturer's identification	The foundation material	Operating range in tests	Maximum range tested	Resistance to damage
1	Exo 800P Flexible	plastic	0.5 m	11 m	low
2	Korea	plastic	0.3 m	1.2 m	low
3	DogBone	Plastic	1-2m	16 m	low
4	Frog3D	Plastic	1.5 m	7.2 m	low
5	DogBone Deister	wood/plastic	2 m	11.4 m	medium
6	OmniIDFlex	Metal	0.3 m	1.5 m	medium
7	Exo800P	Metal	0.5 m	0.9 m	medium
8	OmniIDMax	Metal	2 m	8 m	medium
9	OmniIDFlex Rigid	Metal	1.5 m	6 m	high
10	PROX NG	metal/plastic	0.3 m	1.35 m	medium
11	White clamp band	air	2 m	6.75 m	medium
12	Dura1500	metal/concrete	1.5-2m	9.5 m	high
13	Dura3000	metal/concrete	2-5m	7.2 m	high
14	IQ400	Metal	1 m	1.8 m	medium
15	HADATAP rotor	air	0.3	0.8 m	medium
16	SAG UFO	Metal	0.1 m	2.15 m	high
17	Exo750	Metal	1.5 m	7.5 m	high
18	Xerafy Titanium	Metal	1 m	0.95 m	low
19	TraceTech Satellite	Plastic	0.5 m	0.8 m	Low
20	Exo 800	metal	6 m	7.5 m	high
21	Smartrac WEB	plastic	no data		Low
22	Spine MonzaR6-p				
23	MiniWeb R6				

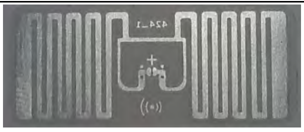
24	Omni-ID Flex LP				
25	HD-IO600N				

Tab. 3. Table of RFID tags' pictures
Source: Own study

No.	**Manufacturer's identification**	**Picture of RFID tag**
1	Exo 800P Flexible	
2	Korea	
3	DogBone	
4	Frog3D	
5	DogBone Deister	
6	OmniIDFlex	

7	Exo800P	
8	OmniIDMax	
9	OmniIDFlex Rigid	
10	PROX NG	
11	White clamp band	
12	Dura1500	
13	Dura3000	

14	IQ400	
15	HADATAP rotor	
16	SAG UFO	
17	Exo750	
18	Xerafy Titanium	

19	TraceTech Satellite	
20	Exo 800	
21	Smartrac WEB	
22	Spine MonzaR6-p	
23	MiniWeb R6	
24	Omni-ID Flex LP	
25	HD-IO600N	

Similarly, as in the case of tests on the impact of float material on the reading range, also in this case the tests were carried out on the basis of the Voyage Tagformance PRO test stand for RFID tags and the results of the reading range measurements are presented in figures Fig. 21, Fig. 22 and in Tab. 4

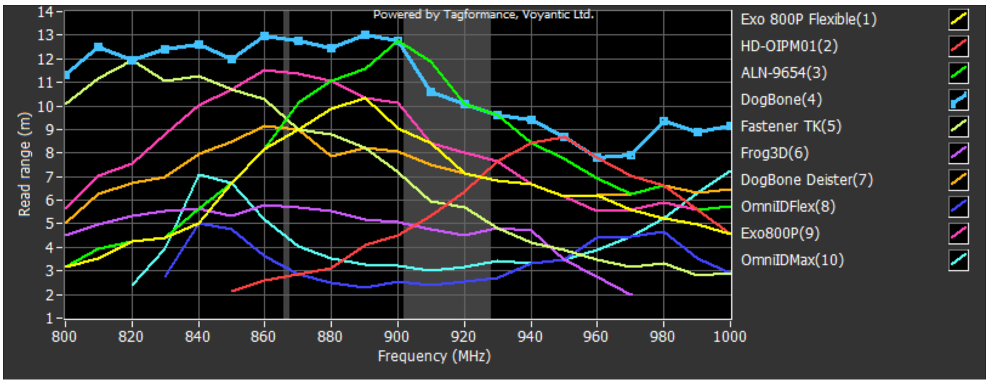


Fig. 21. Graph of the reading range of tags 1-10 on a plastic foundation
Source: Own study

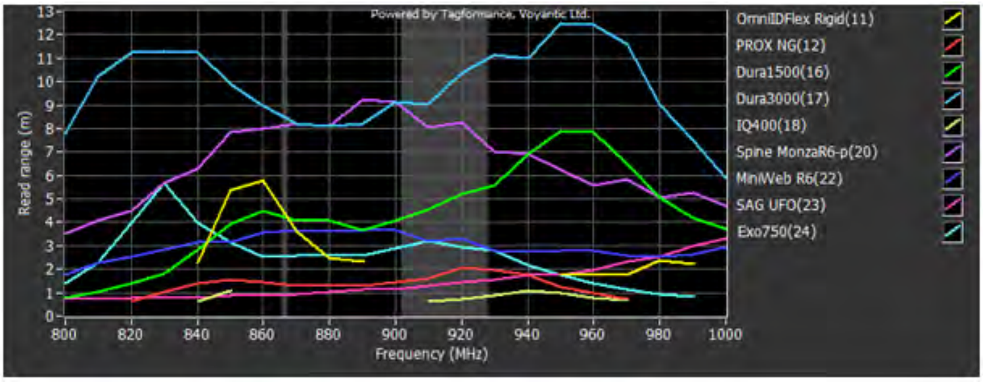


Fig. 22. Graph of the reading range of tags 11-23 on a plastic foundation
Fig. 23. Source: Own study

Tab. 4. Collective measurement results on a plastic foundation
Source: Own study

Id	Name	Reading range
1	Exo 800P Flexible	8.50
2	Korea / HD-OIPM01	2.80
3	ALN-9654	9.50
4	DogBone	12.90
5	RF camp Fastener TK	9.50
6	Frog3D	5.80
7	DogBone Deister	9.00
8	OmniIDFlex	3.10
9	Exo800P	11.40
10	OmniIDMax	4.45
11	OmniIDFlex	4.45
12	PROX NG	1.50
16	Dura1500	4.20
17	Dura3000	8.50
20	Spine Monza R6-p	8.10
22	MiniWeb R6	3.55
23	SAG UFO	1.00
24	Exo750	2.55

Based on the results of the measurements and the assumptions regarding the shapes of the floats, the Spine tag was selected for further tests due to the small geometrical dimensions, the elongated shape similar to the shape of standard floats and very good reading parameters.

For economic reasons, a variant of the Spine tag with the Monza R5 system was used for further tests, instead of the Monza R6-p (used in the preliminary test). Monza R5 is analogous to R6 when it comes to geometrical dimensions. It also offers sufficient reading ranges, at the level of 5-6m in the open air, while it is significantly cheaper than the R6 system. The Monza R6 system has an auto tuning function that allows for better impedance matching of the system to the foundation, which in the case of mass production of floats of one or two types of foundations is of little importance. The auto tuning function is useful when using the same system on variable grounds and waiting in spite of these differences in similar reading parameters.

7. Prototypes of fishing gear elements with RFID tags

On the basis of conducted tests and laboratory tests as well as consultations with fishing communities, prototypes of solutions allowing for the marking of fishing gears using a low cost RFID tag were prepared. The protection of marker systems against adverse environmental conditions was ensured by the construction of a float, which allowed the use of an ordinary, cheap RFID tag, used, for example, in ordinary paper labels.

In the further part of the report, various types of floats are presented, which were tested in the laboratory, as well as in the natural marine environment as part of the project. The prototypes presented differ in shapes, sizes and assembly method for fishing gears. The aim of developing several different proposals was the possibility of comparing them in practice and verifying the effectiveness of operation, functionality and practical use (e.g. ease of assembly and disassembly, or resistance to activities occurring during fishing).

7.1. Prototype 1, two-pieces float - "latch"

The float consists of two separate parts closed with latches. In assumptions, the float is easy to disassemble from the rope, due to the opening side latches that connect both parts of the float. In addition, the whole, after folding, maintains a streamlined shape. The float is equipped with a hole for the tag, which, in order to maintain its tightness, will be impregnated with CW5620 resin. The model is planned for 3D printing in SLS technology, made of PA12 material. Seen on Float 1 two-pieces - “latch” - the view

lower part of the float, will serve as a model for making the mold and then casting.

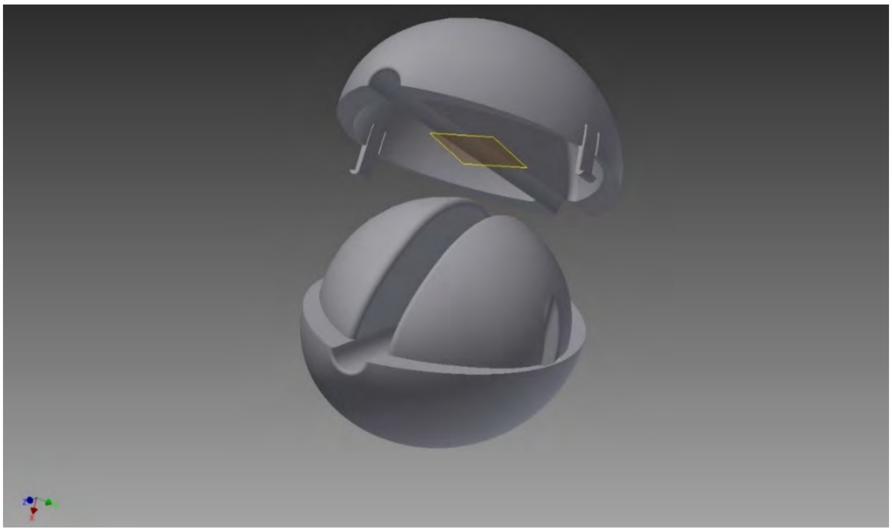


Fig. 24. Float 1 two-pieces - “latch” - the view
Source: Own study

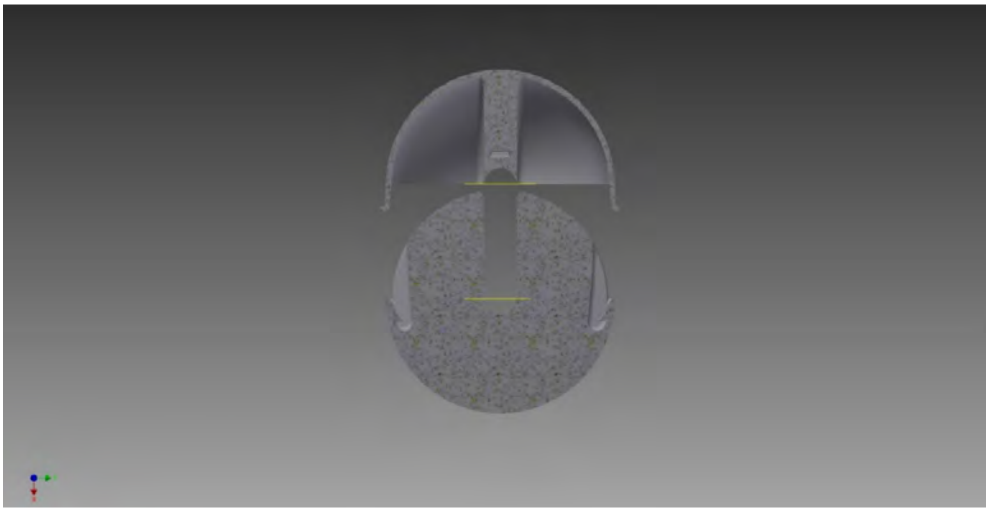


Fig. 25. Float 1 two-pieces - “latch” - the section
Fig. 26. Source: Own study

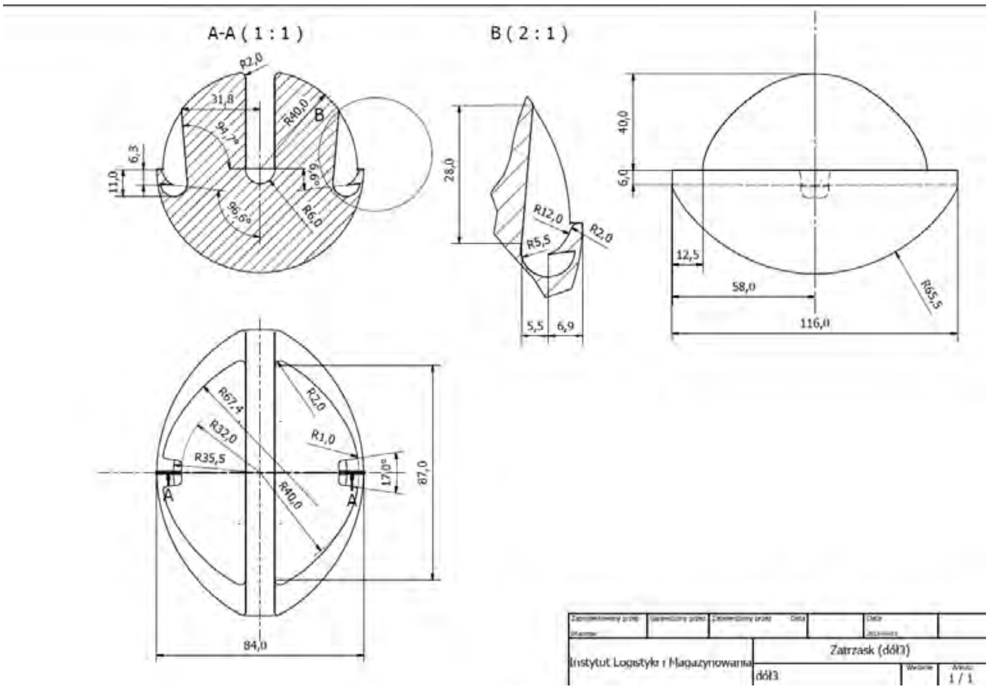


Fig. 27. Float 1 two-pieces - "latch" - the technical drawing.
Fig. 28. Source: Own study

7.2.Prototype 2, two-pieces float - "screwed"

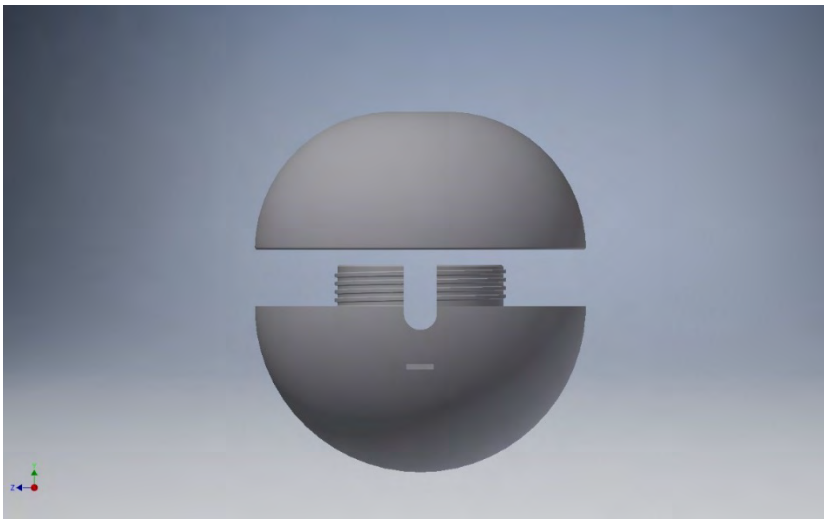


Fig. 29. Float 2 two-pieces - "screwed" - the view
Source: Own study

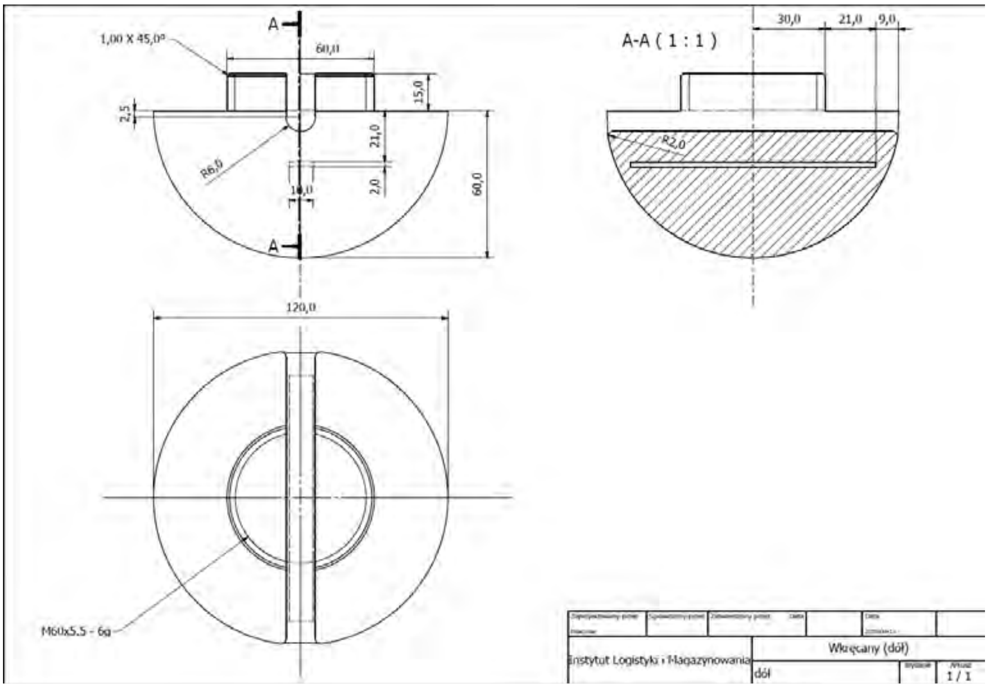


Fig. 30. Float 2 "screwed"-lower part - the technical drawing
Source: Own study

The float consists of two separate parts joined by a threaded connection. The assembly of a float on a rope requires the rope to be laid in the groove of the float's lower part. Next, it is necessary to give a rotary movement around the axis of the threaded connection of the upper part of the float while immobilizing its lower part. It is planned to print a float in 3D SLS printing technology from PA12 material, additionally, casting it in silicone form, using a polyurethane foam resin. On Fig. 31 Construction details of the above-mentioned float are presented.

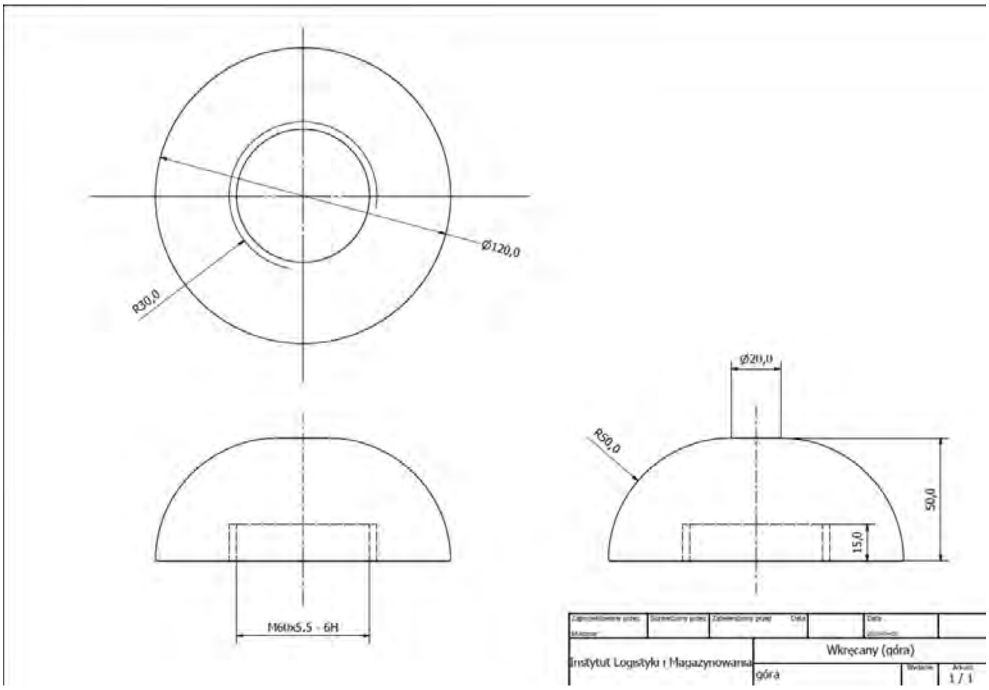


Fig. 31. Float 2 “screwed”-upper part - the technical drawing
Source: Own study

7.3.Prototype 3, two-pieces float - “regular"

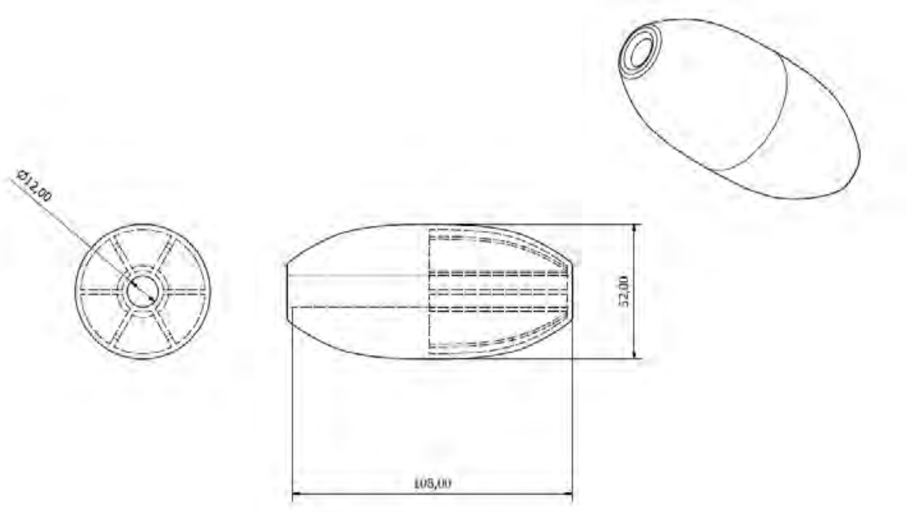


Fig. 32. Float 3 classic - through- hole - the technical drawing.
Source: Own study

Float 3 - “regular”. It is a project, in which it was assumed that assembling on a rope and removing a float from a rope is done by threading method. Hence, it does not meet the assumption of easy disassembly and assembly on the existing fishing net. Inside the cases, a radio marker flooded with

CW5620 blue Arathane impregnating resin was placed along the symmetry axis of the float, in addition, it was planned to cast it in a silicone form using a polyurethane foam resin. The whole is planned to be made in 3D SLS printing technology from PA12 material. This float is shown on **Fel! Hittar inte referenskälla., Error!**

7.4.Prototype 4, one-piece float, “fish"

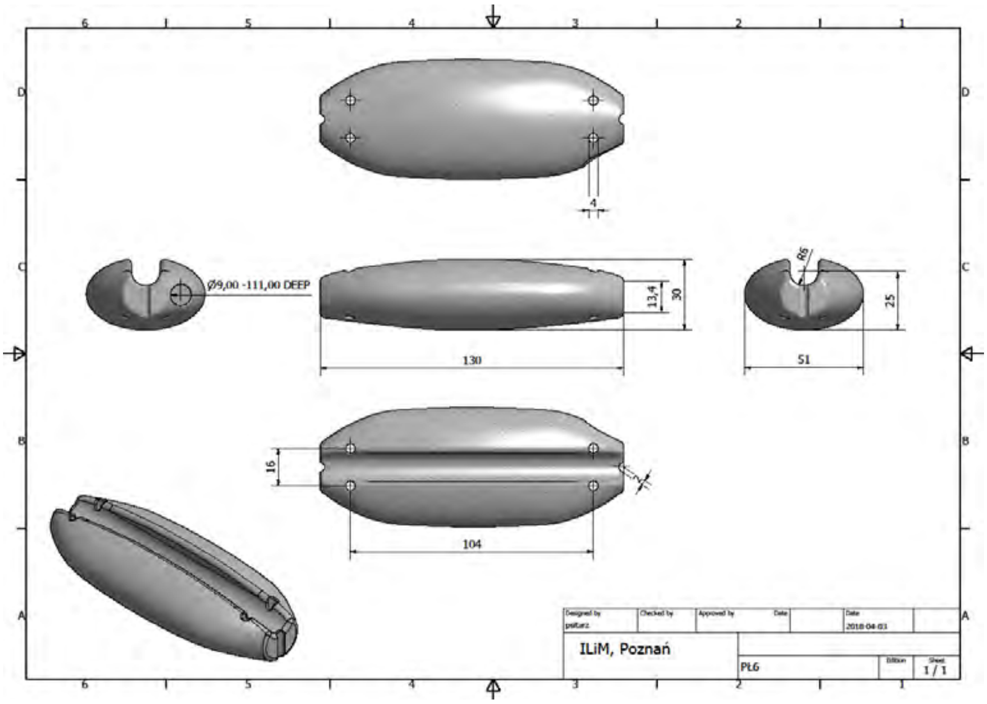


Fig. 33. Float “fish” - the technical drawing
Source: Own study

Float 4 is designed as a one-piece, fastened on its two ends in a tangential position along the rope. Mounting method: two nodes made with a rope. A model printed on a 3D printer using SLS technology is planned. On its basis, it is made in the form of MM922 resin. And then cast from CP9020 foamed polyurethane resin. Tag mounted in a side chamber with a diameter of 9 mm and set down and impregnated by pouring with CW5620 blue Arathane resin. On Fig. 33 the float described is shown.

7.5.Prototype 5, one-piece float - “clip"

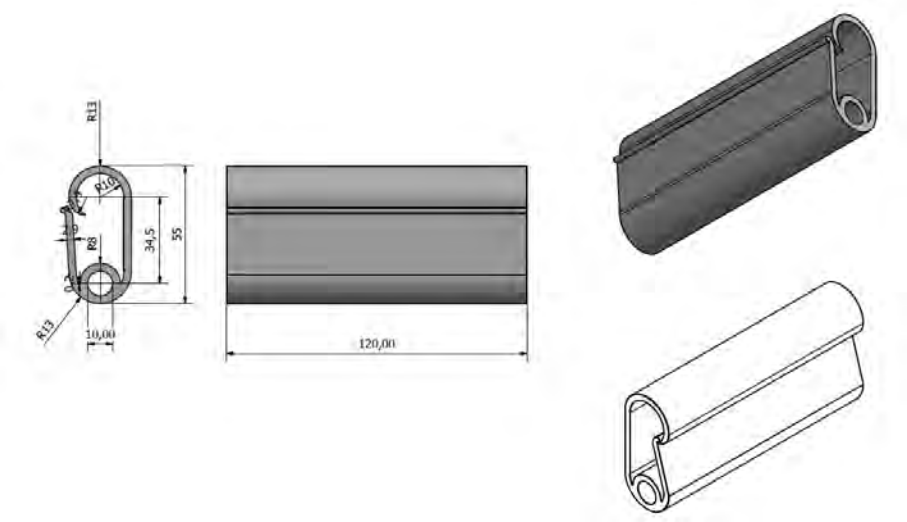


Fig. 34. Float, “clip”- the technical drawing
Source: Own study

Float 5, a one-piece "clip" was designed as a less typical solution for a float with the lowest possible production cost. It provides the possibility of easy assembly and disassembly to the rope being part of the fishing gear (fishing net).

The test model was planned as being made in 3D SLS printing technology. In the peripheral part, it has a round hole in which the impregnated UHF RFID tag is set down by pouring a foamed resin. The hole also constitutes a displacement chamber. The ends of the hole are sealed with a layer of impregnating resin. Installation on a fishing gear involves putting the rope through the longitudinal joint of the float. Next, the float is fastened by pressing the spring element of the float and inserting its edge under the edge of the cooperating float

8. Performance of designed floats.

The process of making prototypes designed under the project included primarily the choice of materials in terms of strength, resistance to very adverse marine conditions, but also resistance to the impermeability of salt, seawater to the electronic system.

8.1.3D printout of float designs

In order to make prototypes of the models described above, we have used the services of 3D LAB Company from Warsaw, which provides comprehensive 3D printing service. SLS technology was chosen as the printing method, i.e. curing the polymer powder with a laser.

Files with projects were prepared in stereolithographic format, for each of the projects, the creation of 4 prototypes was assumed. Due to the construction design of some models, some 3D prints were made as a pattern for obtaining a mold. Such constructions were: the lower part of the float "latch" (see p.3), float “screwed” (see p.7.2) and the project of the float “fish "(see p. 7.4) and “regular" (see p. 7.3)

The remaining projects were printed as a ready-made prototype: the upper part of the float "latch" and the float "clip" (see p.7.5).

Fig. 35. 3D prints of floats
Source: Own study

8.2. Making casting forms

In the next stage, molds for the above described floats had to be made. As a molding material, MM922 silicone was used, which had to be mixed with silicone and hardener. Then it was subjected to the process of venting to avoid the formation of mold defects in the forms of air bubbles.

Due to the use of the vacuum chamber, the venting process was effective and efficient.

After pouring the previously prepared forms, i.e. coating with a separator layer, we needed to wait a day for the complete hardening of the silicone. Then, we could proceed to the demolding of the model from the form.

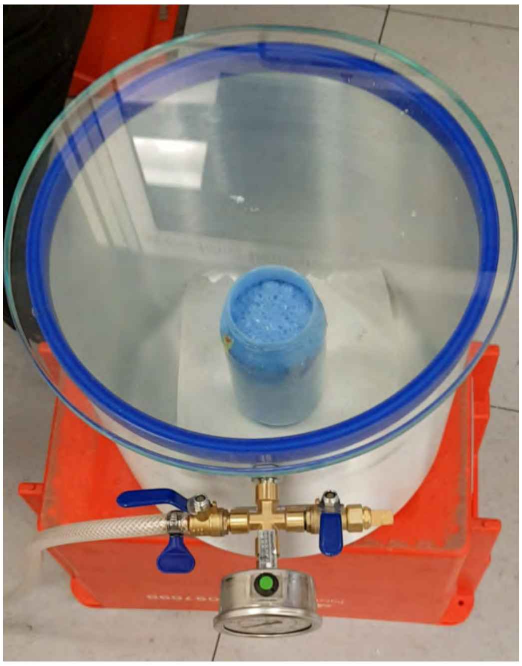


Fig. 36. The process of venting a silicone resin to prepare molds in a vacuum chamber
Source: Own study

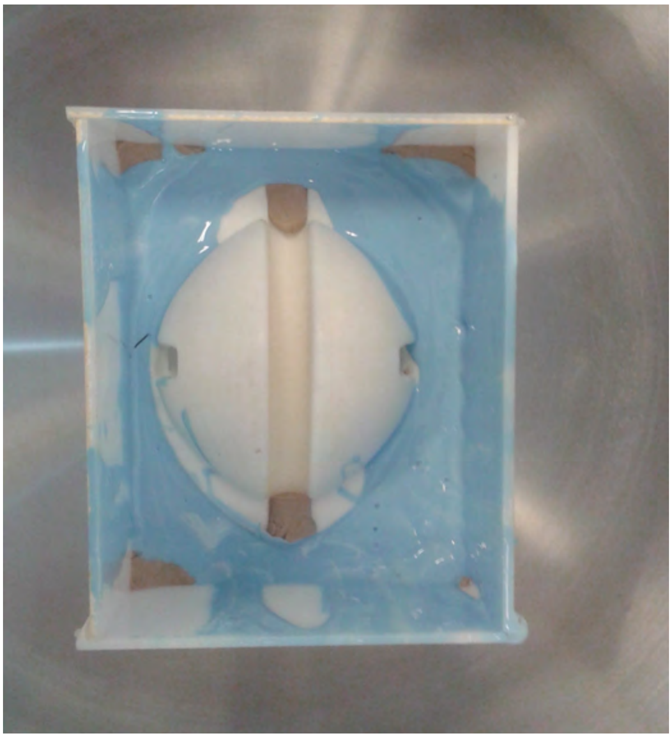


Fig. 37. Preparation of the casting mold visible casting model in the molding box.

Source: Own study

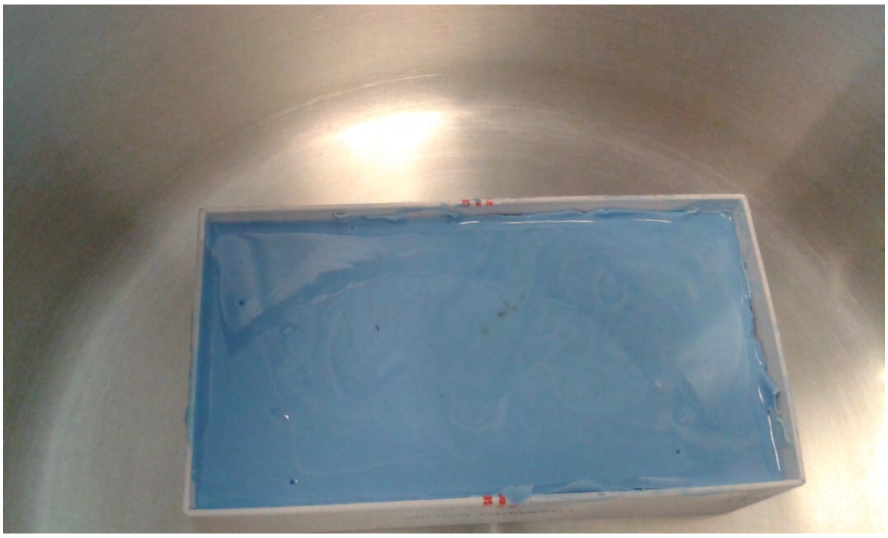


Fig. 38. Preparation of silicone resin molds - a complete two-part mold.

Source: Own study

8.3. Casting floats in silicone molds

The next stage in the manufacture of floats was pouring the molds with a mixture of substances producing rigid polyurethane foam. The test casts were carried out in a 200ml cup. Initially, a dye was added to protect the resin from the UV rays, but it significantly affected the structure of the foam, which was, in effect, too soft. It was decided not to continue this operation.

The effect can be seen in the pictures below. UV protection was implemented by covering the float with a layer of yellow acrylic paint.

In the later stage, RFID tags were mounted to the floats produced. In the case of printed models, there was no problem, because at the design stage, special pockets were created, in which RFID tags would be located. With cast models, they had to be prepared by hand.

There was also the question of protecting antennas in RFID tags against possible contact with water. For impregnation, they were immersed in polyurethane (non-foamed) CW 5620 Arathane blue resin, and then placed in pockets or drilled holes and re-covered with polyurethane foam EKO PRODUR CP 4090.

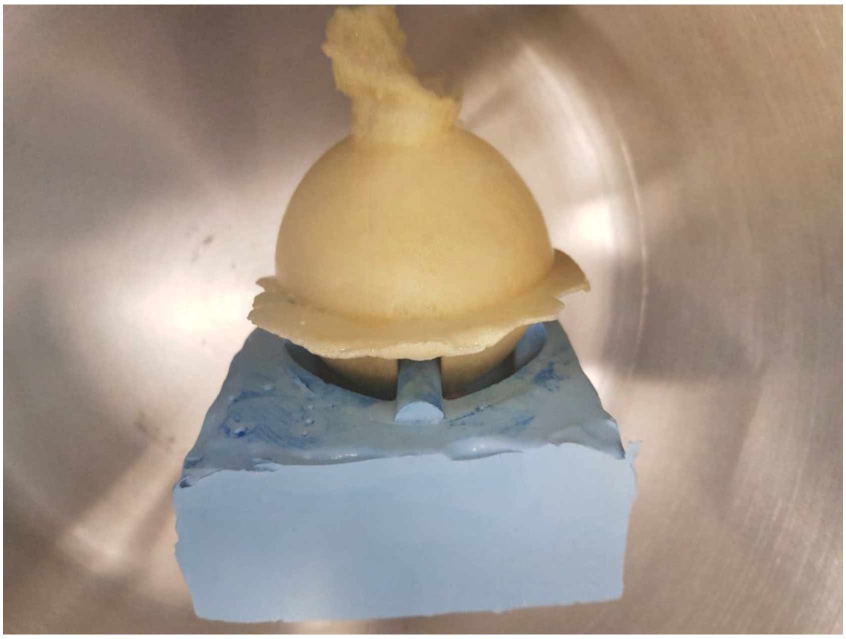


Fig. 39. Casting of polyurethane foam removed from a silicone mold (visible excesses)

Source: Own study

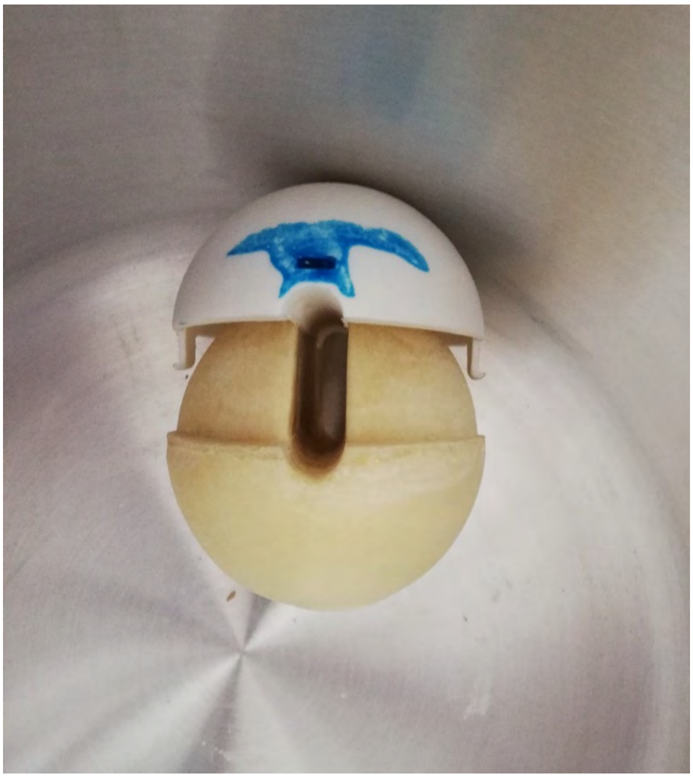


Fig. 40. Compilation of both parts of the float 1 "latch" (before painting)

Source: Own study

Fig. 39 shows the operation of demolding of casting of float 1 - "latch". Fig. 40 presents a complete float consisting of printed from PA12 plastic, upper part with set RFID tag and a lower part cast from foamed polyurethane (polyurethane resin EKO PRODUR CP 4090).

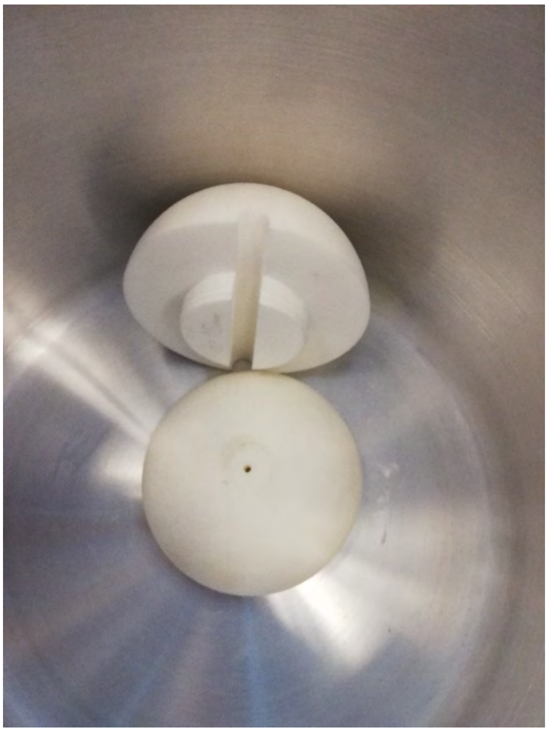


Fig. 41. Float No.2 “screwed” 3D SLS print
Source: Own study

Float No. 2 "screwed" (seeFig. 41) due to thermal shrinkage during 3D printing, did not obtain the right geometrical dimensions of the thread, which resulted in the inability to attach the float on the rope and the connection of both its parts. Hence the float 2 "screwed", was not used in the first stage of sea tests. After design changes, it was printed again and sent for sea tests on trawls carried out in the second stage.

Fig. 42. Float No. 3 "traditional" 3D print on the left, casting inside, casting covered with yellow acrylic varnish on the right.
Source: Own study

Float No.3 “traditional” is presented on Fig From the left: model printed in SLS technology, in the middle: raw casting from foamed rigid polyurethane CP4090, on the right: float covered with acrylic yellow paint, to protect the surface from exposure to ultraviolet radiation. The UHF RFID tag was installed during the float casting operation.

Float No. 4 "fish" was first printed (see Fig. 43) in the form of a model that was used to make a silicone mold.

Fig. 43. Printed cast model of 4 float "fish"
Source: Own study

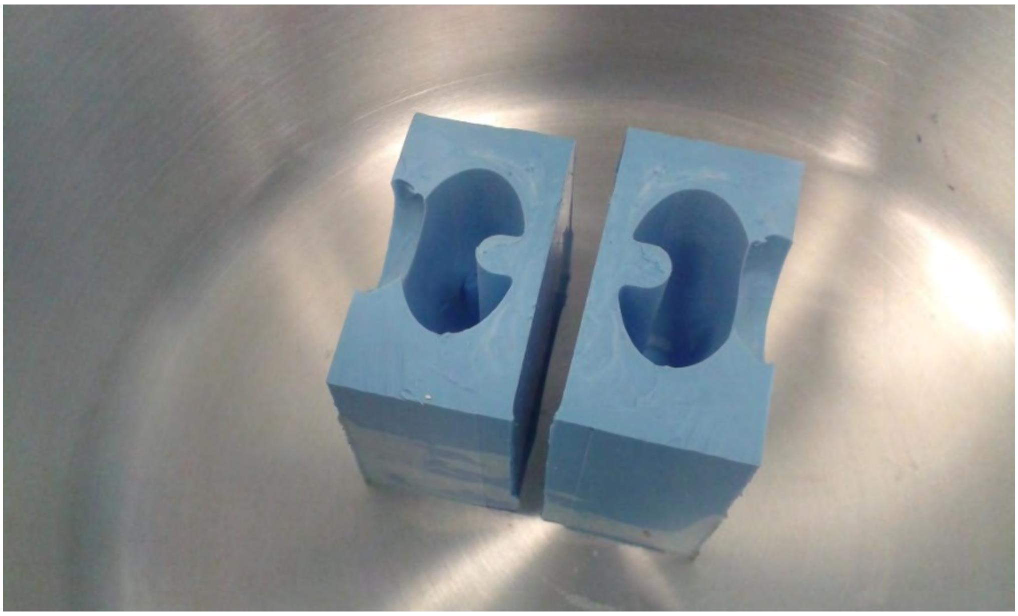


Fig. 44. Silicone casting mold of 4 float fish"
Source: Own study

Fig. 45. Polyurethane casting of float No. 4 "fish" with installed UHF RFID tag (visible blue resin impregnating the tag)
Source: Own study

Fig. 46. Printed prototype of float No. 5 "clip"
Source: Own study

Float with a "clip" cross-section was made in SLS print technology. You can see the blue circle of ARATHANE CW5620 resin that protects the RFID tag against moisture.

A tag was also attached to an existing float available on the market. A hole was drilled in the round float, then the inside of the float was filled with rigid polyurethane foam to avoid its flooding in the event of a leak, as well as to obtain the correct position of the radio tag inside the float.

Finally, the impregnated RFID UHF tag was set down in the float

Fig. 47. Installation of RFID tag impregnated with CW5620 Arathane blue resin, to the round float.

Source: Own study

To create floats and casting models, 3D SLS printing technology was used.

The decision was made, taking into consideration the need to obtain functional elements with adequate strength, elasticity and dimensional accuracy.

8.4. Features of 3D SLS printing technology

Features of 3D SLS printing technology (based on laser sintering of plastic powders) in the aspect of short-run production:

- The ability to certify biocompatibility and suitability when in contact with food, for material PA2200 (PA12)
- durable technical materials (about 80-90%) of PA12 polyamide strength from injection)
- relatively low cost of material and operation, compared to other 3D printing technologies
- freedom of design, due to the lack of the need for supporting structures
- simple cleaning of details from non - sintered powder
- high speed of work when building a lot of details compared to other 3D printing technologies
- high durability of machine elements
- the possibility of reusing of non-sintered powder
- dimensional accuracy class DIN EN ISO 286-1 class 12-13, depending on the size of the detail (in practice it is from +/- 0.15 for details up to 100 mm to +/- 0.3 for larger details, in relation to type of geometry and arrangement in the working chamber). When mass production of one detail, the process can be optimized and obtain the accuracy better than +/- 0.1 mm.

The most popular materials used in SLS technology are polyamides (mainly PA12 and PA11), as well as polystyrene and mixtures of polyamides with fillers (glass flour, short carbon fibers, aluminum powder and others). The most commonly used material is PA2200 (PA12)[2].

8.5. 3D printers in SLS technology

The operation of 3D printers in SLS technology resembles to some extent the SLA technology (solidification with the laser beam, but instead of liquid material, layers of powdered polymer are applied to the work table. In the next stage, it is melted selectively through a focused laser beam, working in the long infrared band (mainly CO2 laser). Before the laser beam hits the 2 mirrors of the galvanometer scanner, so that its focused energy does not damage the mirrors, it is pre-enlarged. The radius passes through the lens of the F-theta flat field. After reflection from the mirrors, it is focused on the surface of the powder, where through the movement of the mirrors

[2] https://www.bibusmenos.pl/oferta/drukarki-3d/technologie/technologia-sls/

the contouring and filling paths are selectively melted until the shape of the appropriate layer is melted. The work table is then lowered and the arm equipped with a roller or blade applies a further layer of powder. The entire process takes place in a nitrogen atmosphere so as not to burn the material.

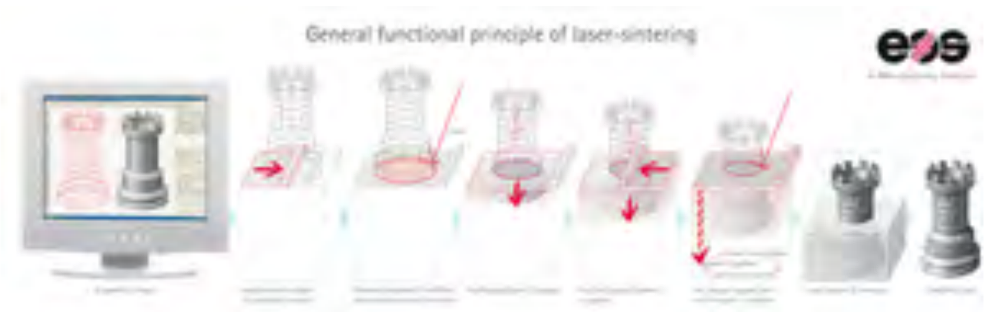


Fig. 48. Operating principle of SLS technology
Source: https://www.bibusmenos.pl/oferta/drukarki-3d/technologie/technologia-sls/

Fig. 48presents the principle of SLS technology, starting from 3D CAD data to finished detail.

SLS technology has huge production potential, but now belongs to one of the most difficult 3D printing methods. The reason is that the process takes place at high temperatures close to the melting point of the material (to minimize the shrinkage of the details being built - for example for PA2200 (PA12) it is approx. 170 ° C)[3]

[3] The technology description https://www.bibusmenos.pl/oferta/drukarki-3d/technologie/technologia-sls/

9. Laboratory tests

The laboratory tests carried out aimed at initial verification of parameter maintenance by RFID tags after being implemented in the prototypes of floats. The range of tags read was primarily examined, as the most important parameter in terms of functionality.

The selected tag, implemented in all produced float prototypes was tested - taking two floats for the test (in order to compare the stability of the results) - Fig. 49 – Fig. 50. The research was carried out using a Voyantic Tagformance PRO test stand for RFID tags and analogue settings used in the tag selection tests. The measurement results are presented in Tab. 5 – Tab. 7and graphically on Fig. 51 – Fig. 53. Differences in the operating ranges shown in the tables and in the abovementioned figures result primarily from the type of reader used, its power and sensitivity. The tests used profiles of simulating devices: (1) stationary reader with the power of 2W ERP and mobile readers - (2) standard reader with 0.5W ERP power and (3) reader also used in later sea tests - ATID AB-700 (with increased sensitivity).

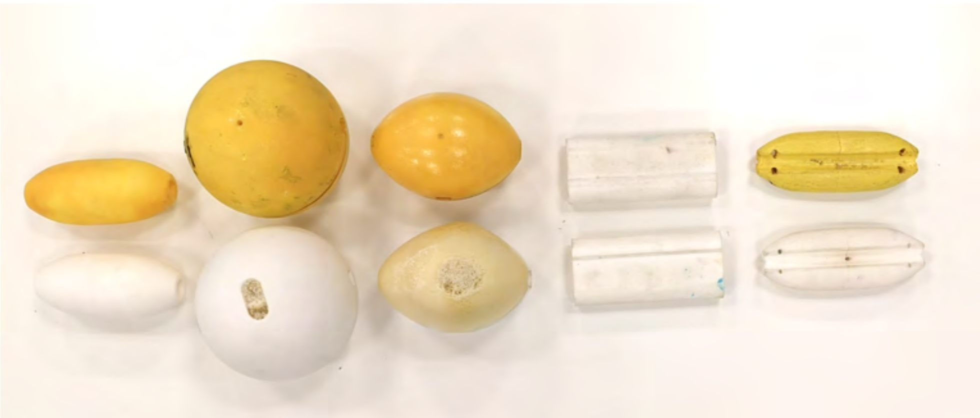


Fig. 49. Tags subjected to laboratory tests
Source: Own study

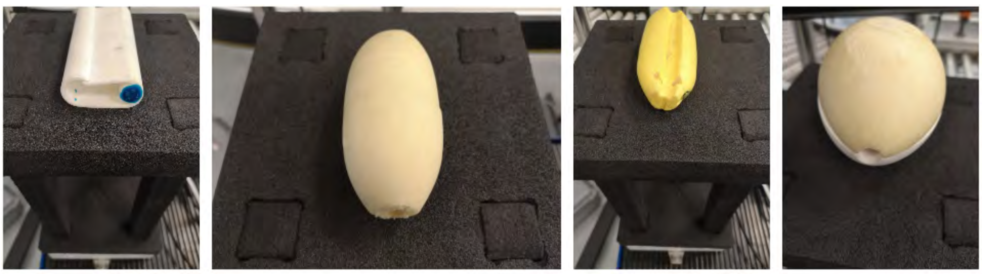


Fig. 50. Measurements of the reading range of prototype tags
Source: own materials

Tab. 5. Collective measurement results ofprototype floats with implemented tag - reading with 2W ERP stationary reader (1).
Source: Own study

No.	Float	Reading range	
		Sample 1	Sample 2
1	Prototype 1, two-pieces float - "latch"	7.10	8.00
2	Prototype 2, two-pieces float - “screwed”	7.70	7.80
3	Prototype 3, two-pieces float - “regular"	5.50	5.50
4	Prototype 4, one-piece float, “fish"	10.50	7.50
5	Prototype 5, one-piece float - “clip"	8.00	7.80

Tab. 6. Collective measurement results of prototype floats with an implemented tag - reading with a 0.5W ERP mobile reader (standard - 2)
Source: Own study

No.	Float	Reading range	
		Sample 1	Sample 2
1	Prototype 1, two-pieces float, "latch"	3.50	4.00
2	Prototype 2, two-pieces float, “screwed”	5.10	5.10
3	Prototype 3, one-piece float, “regular"	2.50	2.60
4	Prototype 4, one-piece float, “fish"	4.40	4.85
5	Prototype 5, one-piece float, “clip"	4.0	3.80

Tab. 7. Collective measurement results of prototype floats with an implemented tag - reading with a 0.5W ERP mobile reader (used in sea tests - ATID AB700 - 3)
Source: Own study

No.	Float	Reading range	
		Sample 1	Sample 2
1	Prototype 1, two-pieces float, "latch"	2.70	2.50

2	Prototype 2, two-pieces float, “screwed”	3.60	3.60
3	Prototype 3, one-piece float, “regular"	2.00	2.00
4	Prototype 4, one-piece float, “fish"	3.20	3.20
5	Prototype 5, one-piece float, “clip"	2.70	2.75

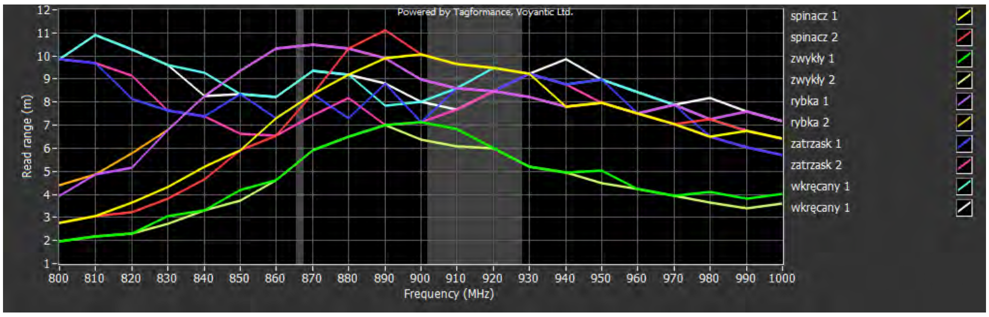


Fig. 51. The results of read range of the tag for the 2W ERP stationary reader
Source: own materials

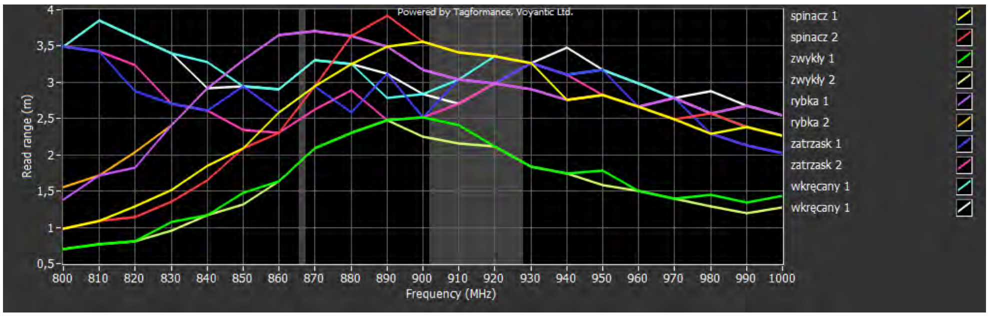


Fig. 52. The results of read range of the tag for the 0.5W ERP mobile reader (the standard)
Source: own materials

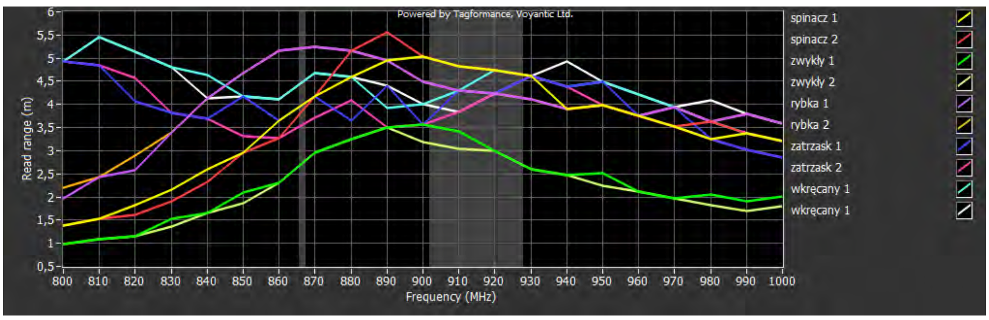


Fig. 53. The results of read range of the tag for the 0.5W ERP mobile reader (used in sea tests - ATID AB700)
Source: own materials

Based on the measurement results, it can be stated that the reading range depends primarily on the type of reader used (even a double change in range), while the type of materials used has a slight influence on the reading range. Possible deviations from the results obtained in the open air and in various float materials for the selected tag may also result from slight differences in the orientation and spatial orientation of the tag in relation to the reader / programmer antenna.

Before the sea tests, unique numbers identifying the tag with a hand-held reader were stored in the EPC memory of each tag. The correctness of radio reading of tag identifiers installed within floats was checked in conditions of shallow (15cm) immersion in water. The reading was made with a handheld reader with a power of 0.5W from a distance of about 30 cm. The correct operation of the float closures was checked.

10. Sea tests

Under the project, sea tests of developed prototypes were carried out on two types of nets - gillnets and towed nets. In the first case, the following prototypes were tested: 1(latch), 3 (regular), 4 (fish), 5 (clip) and in the second case prototype No. 2 (screwed). Test were carried out on the UST-31 fishing boat.

10.1. Gillnets

During the cruise, the gillnets were marked (Fig. 54) with tag prototypes No. 1, 3, 4 and 5 (Fig. 55, Fig. 56). Marked nets were deployed and collected after approx. 2 hours. Both the deploying (Fig. 57, Fig. 58) and collecting nets (Fig. 59) ran without problems - however, due to the test nature of the cruise, the nets were deployed with lower than usual speed.

Fig. 54. Gillnets used in test
Source: own materials

Fig. 55. Gillnets used in test
Source: own materials

Fig. 56. Assembly of prototype No. 4 (fish)
Source: own materials

Reducing the speed was to prevent of possible entanglement of the nets by protruding prototype elements. In the opinion of the crew of the fishing vessel, prototypes no. 3 and 5 could potentially cause entanglement. The nets were hauled with the use of winch mounted on the side of the fishing boat.

The prototypes of tags were towed along with the net by the winch press rollers - no negative impact on prototypes was found.

The reading of tags during the test was carried out with the use of the ATID AB-700 handheld reader, obtaining tags reading, as predicted, just above the surface of the water.

Fig. 57. Deploying of gillnets during the test
Source: own materials

Fig. 58. Deploying of gillnets during the test
Source: own materials

Fig. 59. Winch of the fishing boat used during the test
Source: own materials

All tags during the test were read repeatedly, both before the nets were exposed (in bags), during deploying and during pulling and when pulled in bags (in the wet state). All tags were read with no problems. The only inconvenience observed during the test cruise was the reading of all tags on the board during each scanner run, due to the metal canopy of fishing boat and numerous reflections. Only putting the tags in the metal box in the hold of fishing boat allowed for the elimination of fake readings. For this reason, it would be the most favorable to place the antenna to read the tags off the side of the fishing boat and read automatically when deploying and pulling out the nets.

10.2. Towed nets

Prototype tests on trawl nets were made to determine the effect of higher depths and higher pressures on the tag prototype. Tests were carried out in two areas (Fig. 60):

Area No. 1 with a depth of 26m to 32m, coordinates of the region are, as follows:

- 54*46`N 016*47`E,
- 54*46`N 016*47`E,
- 54*46`N 016*47`E,
- 54*46`N 016*47`E.

Area No. 2 with a depth of 76m to 91m, coordinates of the region are as follows:

- 55*14`N 017*06`E,
- 55*14`N 017*06`E,
- 55*14`N 017*06`E,
- 55*14`N 017*06`E,

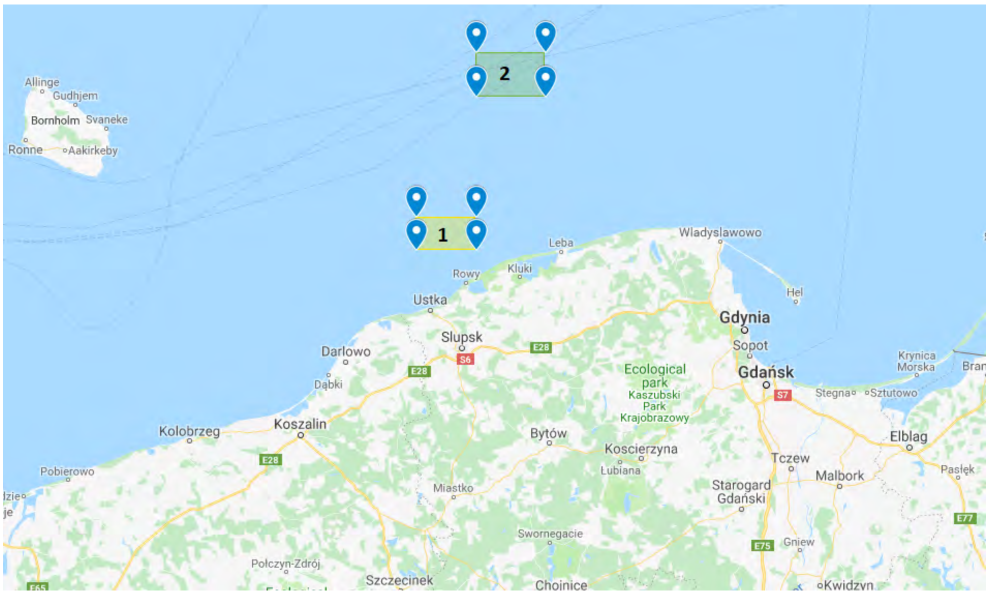


Fig. 60. Areas of the trawl nets test
Source: own materials

Prototype No. 2 (screwed) was placed on the trawl net, which was used during a routine fishing trip (Fig. 61). Due to the longer period of using the nets and the length of the voyage and unstable weather as well as the acceptable number of crew (the standard crew took part in the cruise due to the conducted fishing), the employees of the Institute of Logistics and Warehousing were not able to take part in the cruise. Tags have been implemented and dismantled by the crew of the fishing boat.

Measurements of the prototype reading range before the cruise and after the cruise did not show any changes in this respect. Therefore, it is possible to state that fishing at depths available in the Baltic does not affect the prototypes of tags made in the project.

Fig. 61. Towed nets used in test
Source: own materials

11. Nets identification

In logistics, the Global Identification of Individual Resources (GIAI) is used to identify individual resources. Individual resources are treated as specific physical units with specific characteristics (e.g. fixed assets of any value that require unambiguous identification, such as: computers, desks, machines, vehicles or their components).

Structure of the GIAI number

IZ	GS1 company prefix	Individual resource designation
8004	590 N1 N2 N3 N4	an1..an23
8004	590 N1 N2 N3 N4 N5	an1..an22
8004	590 N1 N2 N3 N4 N5 N6	an1..an21
8004	590 N1 N2 N3 N4 N5 N6 N7	an1..an20

Having a unique identifier by each of these resources provides the company with the ability to identify, track and manage throughout the entire life cycle. GIAI is a quick way to find resources in a database in order to record their use, location or status (e.g.in the case of inventory of the resource). It also serves to update the resource maintenance register or to register a new version of the software or assign the user or location to the resource.

Analogies between individual resources and fishing gears are obvious. The use of a GIAI identifier to identify fishing gears is possible, but GS1 as a global organization supports bottom-up initiatives that allow to match or create a new identifier for a specific industry or application. In the opinion of the authors of the report, it would be advisable to take the initiative of developing a gear and fishing equipment identifier, taking into account local specifics, not only for the Baltic Sea basin, but also other fishing areas. The preparation of such an identifier with GS1 support would enable the implementation of a global labeling system and, at the same time, local fishing industry support for its implementation at the level of national units (national organization GS1) in the local language.

Identification based on global GS1 standards is also used in fisheries - the manner of the standards used is described in the document: Implementing traceability in fish, seafood and aquaculture supply chains using the GS1 standards for identification, data capture and data sharing (GS1 Foundation for Fish, Seafood and Aquaculture Traceability Guideline)[4] an the scope of its used is presented on Fig. 62**Fel! Hittar inte referenskälla.**

4 https://www.gs1.org/sites/default/files/docs/traceability/GS1_Foundation_for_Fish_Seafood_Aquaculture_Traceability_Guideline.pdf, available from 5.12.2018r.

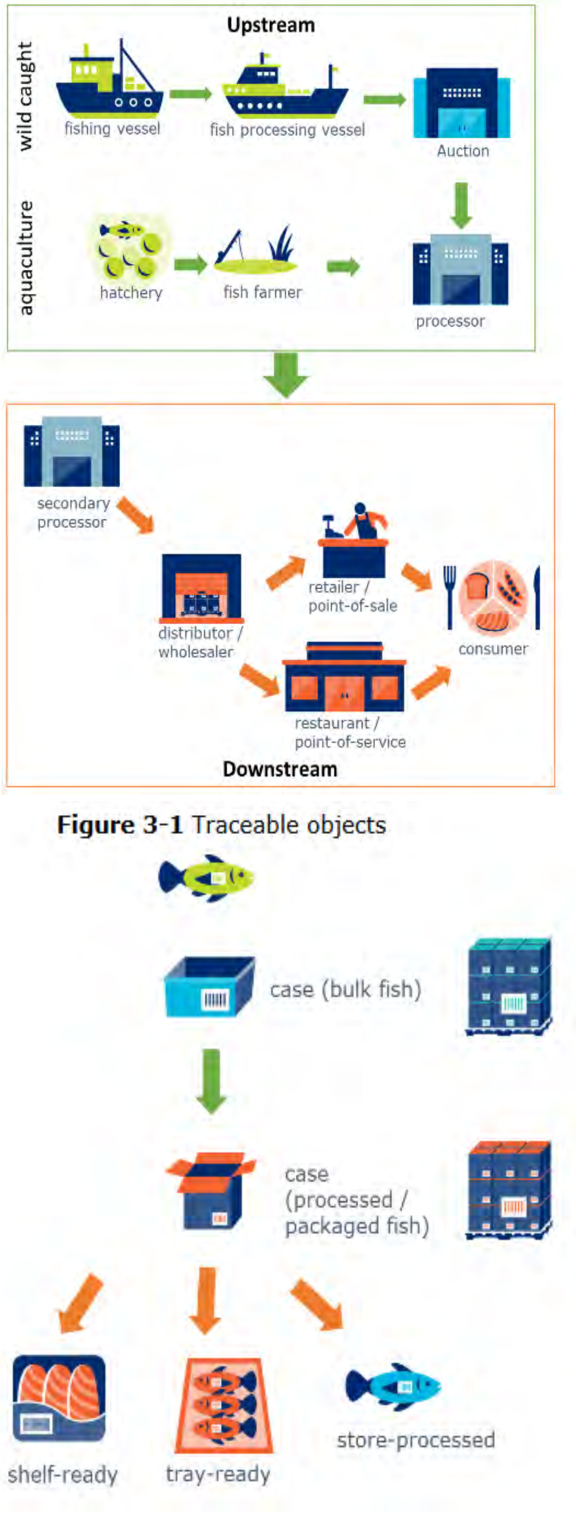


Fig. 62. GS1 standards used in fisheries
Source:
https://www.gs1.org/sites/default/files/docs/traceability/GS1_Foundation_for_Fish_Seafood_Aquaculture_Traceability_Guideline.pdf

12. Recommendation

The research and tests carried out under the project aimed at finding a solution that would reduce the phenomenon of litter piles cluttering the environment of the Baltic Sea. The current situation, in accordance with the findings of the Marelitt Baltic project, but also other projects and research carried out by organizations dealing with the protection of natural resources, is very bad. At the bottom of the Baltic there is a huge amount of abandoned, lost and damaged fishing gears. They constitute a pollution that radically affects living organisms, and their removal is a very big problem. The methodology of cleaning the Baltic bottom developed under the project allows for the introduction of activities that will improve this situation and allow for the successive treatment of the Baltic Sea.

On the other hand, it is also important to stop the phenomena that cause further pollution of the Baltic bottom, including elements of fishing gears. According to the authors of the study, systemic changes are needed in this area. One of the tasks of the project of work package No. 3 was to develop a solution that will allow, first of all, to determine the number of gears that goes to the waters of the Baltic Sea basin but also to introduce mechanisms to reduce this phenomenon.

A perfect solution would be one that would allow to determine what kind of nets (or other gears) were in the bottom, exactly where and who is responsible for it. Looking at this problem from the perspective of the Institute of Logistics and Warehousing and the Laboratory of Identification Technologies, the team involved in the project designed solutions allowing comprehensive marking of fishing gears used on the Baltic Sea.

The starting point for the study was the analysis of fishing gears used on the Baltic Sea and solutions allowing for their massive marking and automation of reading processes. Radio technologies, to which attention is naturally addressed, are covered by the key limitations resulting from the physical parameters of the electromagnetic wave relating to the propagation of the wave in the water. There are known solutions based on acoustic wave, which theoretically allow to find such an element in water, but its battery power limits the time, in which it is useful. For this reason, RFID passive solutions have been deeply analyzed, allowing for automated and remote reading. Solutions operating in the UHF frequency, allowing readings from a few to several meters have been adopted, as a potentially interesting solution. In principle, this solution is not suitable for searching for lost gears (no reading under water), but has the potential to be used for mass marking of fishing gears and process of presence control. The main advantage of UHF RFID solutions over acoustic solutions is the ability to use passive tags that do not require the use of batteries and significantly lower costs.

As part of the design work, an expanded collection of UHF RFID tags was analyzed by selecting tags with at least a few-meter reading range and small geometrical dimensions for further research. After the first round of tests and consultations with project partners and organizations interested in the project results, it was found that the desired solution should not be based on a ready, tight, marine-resistant tag - the tag selected in this way would be too expensive for mass application and too problematic to use in one form on a larger group of fishing gears.

Therefore, the efforts were made to develop an element that would allow the use of low-cost UHF RFID tags in a standardized manner, while not interfering with the functionality of fishing gears and not causing the over-fishing activities of fishermen and other parties in the fishing industry.

As part of laboratory and project work, designs have been developed that on the one hand allow for use on existing nets and on the other allow for the implementation of the solution already at the production (or repair) stage of the nets. The cheap and popular UHF RFID tag has been implemented in designed and made in the Laboratory of Identification Technologies elements of fishing gears imitating both visually and functionally existing elements of the network in the form of floats. The prototypes produced in the Laboratory allowed both laboratory and sea tests to confirm suitability in identification processes. Obtained ranges of the work system will allow the implementation of the solution for daily activities without interfering with the process and without radical changes in the process.

The solution developed is characterized of a low implementation cost, due to the use of tags with negligible cost in relation to the cost of the nets. Tags are implemented in the floats that have functionalities and parameters identical to existing floats and a comparable cost, thus not affecting the implementation cost.

According to the authors of the study, only mass implementation of nets marking will allow limiting unfavorable practices and will help stop the pollution of the Baltic Sea environment caused by new elements of fishing gears.

The solution recommended by the authors would consist in marking both existing and new fishing gears in order to register their use in fishing processes. The net tags should be read at least when released for departure from the port and return to port. Registering (or not registering) the presence of the nets at both points of the process will indicate the possibility of losing gears and the need to undertake search action. Of course, at the same time, the net markers can also be used to control the legality of fishing operations, their volume, duration, etc. Automatic registration of nets expossure from the boat's side and taking them (with completeness control) will allow effective and detailed documentation of processes.

An important aspect of the application of automatic identification technology is the use of solutions known from logistics (also partially used in the fishing industry - in the processes of identifying the origin of seafood - the so-called "traceability"). Systems implemented in logistics processes are, in a significant part, based on the use of global standards, which allows for easy data exchange and cooperation in supply chains. Automatic identification solutions based on GS1 standards are widely used and their scope is constantly increasing. Regulations introduced to the economy increasingly require control of production processes (including food production, including seafood), and automatic identification systems are increasingly and more often used in connection with the reduction of implementation costs.

A classic example of the use of GS1 standards is tracing the origin of seafood based on the identification of returnable packaging, in which the caught seafood is transported. By identifying the containers, it is known exactly, which unit and in what region of the catch was made.

We recommend introducing the marking of fishing nets also based on global GS1 standards, which will allow to optimize the use of the necessary technical components, on the one hand automatic reading of fishing gears and on the other hand to support the registration and tracing processes of the origin of caugth seafood. Consistency of these systems will ultimately ensure better use of the necessary expenditures for the implementation of both solutions.

13. Conclusions

Under the Marelitt project, Work Package No. 3, the Institute of Logistics and Warehousing has analyzed the type and conditions and rules for the use of fishing gears on the Baltic Sea. On the basis of the analysis, solutions have been proposed which, in the opinion of the project team, respond to the needs formulated by project partners and participants of meetings and conferences organized under the project. Among other things, the mode of operation of RFID technology and possible solutions in the field of marking fishing gears have been presented and discussed. RFID technology has been proposed in response to the requirement to automate the registration of fishing gears, e.g. in ports.

As a result of discussions and comments submitted by project partners and experts, prototypes of functional solutions for implementing RFID technology on fishing gears were prepared, which were subsequently tested in both laboratory and real-life conditions.

Performance of prototypes included the preparation of 3D models of new elements of fishing gears, allowing the implementation of RFID tags. In the course of project analysis, RFID tags were selected that meet both the performance criteria (reading from a specific distance in real conditions) and cost constraints. The chosen solution is to, in its assumptions, allow for a massive marking scale without a significant change in the cost of fishing gears.

As part of the work, 3D models of gear elements in the form of floats were made, which were then made using 3D printing techniques and casting of polyurethane foam resins. This report provides detailed information and technical requirements for the relevant aspects of the proposed solution.

The prototypes were tested in both laboratory and real sea conditions, in which practical identification of gears was confirmed

14. Appendix

Data sheets of materials and equipment used to manufacture floats:

14.1. Polyurethane resin, rigid foamed

EKO PRODUR CP 4090 is a two-component polyurethane system for the production of rigid foam. The system is cured at room temperature. EKO PRODUR CP 4090 does not contain foaming agents that disrupt the ozone layer, in accordance with EU regulations on the circulation and use of controlled substances - Regulation (EC) No. 2037/2000.

APPLICATION: EKO PRODUR CP 4090 is intended for the production of molded parts and molded products of greater hardness. - floats - wobblers - garden fountains - architectural products

RECOMMENDED CONDITIONS OF PROCESSING. Ratio of components A: B A 100 : B 110 (by weight) A 100: B 100 (by volume) The temperature of raw materials and the environment should be 18 - 22°C. The molding time depends on the size of the mold and the temperature of the mold. The full mechanical property of the foam is obtained after 24 hours.

CHARACTERISTICS OF FOAMING IN LABORATORY CONDITIONS

Reaction times and apparent density in laboratory conditions (20°C) during manual foaming - stirrer approx. 1200 rpm, mixing time approx. 8 sec.

Starting process time 40 ± 5 s

Gelation time 120 ± 20 s

Dry face time 190 ± 30 s

Apparent core density of 90 ± 20 kg / m3

Growth from 1kg about -10L laboratory data 1

The reaction times are measured from the start of mixing.

Starting process time - until the mixture starts to grow.

Gelation time - up to the moment of gelled fibers extraction from the foam.

Dry face time - until the surface of the foam does not stick when touched.

The apparent density of the core is measured after cutting out the rectangular cube from the foam.

The product has a Hygienic Certificate PZH: HK/B/0187/01/99

EXAMPLE PROPERTIES OF FOAM IN A PRODUCT

Foam obtained by pouring in a mold with electrical agitator - 1200 r.p.m.

Total density of the molder 100 kg / m3 mass [kg] / mold volume [m3]

Apparent core density of 92 kg / m3 PN-EN 1602:1999

Compressive strength 560 kPa PN-EN 826: 1998

Water absorption (24 h), V/V - 0.2% PN-93/C-89084

Change in linear dimensions (+80°C, 24h) + 0,1 % PN-EN 1604+AC:1999 (-24°C, 48h) - 0,1 % PN- EN 1604+AC:1999

The floats were cast from a polyurethane foamed resin with the trade name EKO PRODUR CP 4090. This resin is used, among others for filling buoyancy chambers of vessels (as well as floats and wobblers).

Source: manufactures' materials

14.2. Polyurethane resin used for impregnation of electronics (RFID tags)

Polyurethane electro-insulating resin Arathane (polyol) CW5620 blue and Arathane (isocyanate) HY5610

Polyurethane composition modified with epoxides, halogen free, for priming, impregnation of electronic components. Processed and hardened at room temperature. Low viscosity.

Soft universal polyurethane system for pressure sensitive components.

APPLICATIONS - Transformers, sensors, modules, filters, connectors, pressure sensitive elements, etc.

PROCESSING - pouring/ impregnation. Manual or with the aid of an automatic mixing and dosing device.

PROPERTIES - A system that does not contain any halogens. Excellent flow properties. Good thermal conductivity. Non-abrasive pouring system. Good temperature resistance.

NOT FLAMMABLE: V-0 6mm according to the UL-94 method

COMPONENTS DATA (MIXTURE) proportion resin: hardener by weight - 100: 22 viscosity at 25 ° C mixture (mPas) - 1300 gelation time 25 ° C Gelnorm (min) - 70 generated in shopGold program Time to obtain viscosity 5000 mPas Rheomat (min) - 25 Change in the hardener content in proportion to the resin changes the final mechanical parameters of hardened composition:

A) Proportion CW5620 / 5610 100: 15 - very flexible (50ShA)

B) Proportion CW5620 / 5610 100: 25 - hard (around 60-70 ShD)

PROCESSING DATA LIFE / TIME OF "LIFE" OF MIXTURE (time to reach 5000 mPas) min 25

MINIMUM CURE CYCLES 24h at room temperature or 6 hours at 80 ° C

PROPERTIES AFTER HARDENING (laboratory measurements at 23 ° C).

Hardening: 24h at room temperature + 6 hours at 80 ° C

Glass transition temperature ISO 6721 (° C) - 20 Density ISO1675 (g / cm3) - 1.44

Tearing strength ISO6721 (MPa) - 55

Module under compression ISO 527 (MPa) - 21

Compressive strength ISO 527 (MPa) - 7

Ultimate elongation ISO527 (%) - 70

Coefficient of linear thermal expansion ISO11359-2 (ppm / K) below Tg - 55 above Tg - 150 Flammability UL-94 class V-0 (6mm)

Resistance to ignition using a wire (GWFI / GWIT) 850 ° C - passed

Maximum working temperature IEC60085 - 150 ° C

Temperature index IEC60216 in tests> 150 ° C

Water absorption: 1 day at 23 °C (%) - 0.15 10 days at 23 °C (%) - 0.5 30 min. at 100 °C (%) - 0.33

Tan loss coefficient δ at 50 Hz and 23 ° C IEC60250 (%) - 11

Dielectric constant εr at 50 Hz and 23 ° C IEC60250 - 6

Dielectric strength of IEC60243-1 kV / mm - 25 was generated in the shopGold program

Electrolytic corrosion IEC60426 - A/1

Resistance to creeping currents IEC112 / 79 - CTI> 600

Volume resistance at 25 ° C IEC60093 Ω * cm - 1013

CW 5620 contains filler that has a tendency to deposit after a certain time. Therefore, it is recommended to thoroughly mix the entire contents of the container before use. In the tanks of the production equipment, the products before filling should be mixed from time to time to avoid sedimentation and mixing abnormalities.

Source: manufactures' materials

14.3. Silicone resin for foundry molds

MM922 is hardened at room's temperature, two-component condensation of silicone composition.

The hardened product is an elastomer with high tensile strength and very good mechanical properties.

It is intended for making molds of patterns, even with very deep undercuts and for other demanding molding applications. The silicone composition is recommended for making molds for the production of resin products (polyester, epoxy, polyurethane) or materials such as plaster, concrete or wax.

Silicone is a highly flexible anti-adhesive material designed for multiple, accurate reproduction of even very complex shapes.

Various modifying catalysts are used for MM922: BLUE AND CLEAR - STANDARD Mixing proportions - 100 5 Color - blue (coloring facilitates homogenization with silicone) Colorless - color of the mixture - white Life time - 45 to 120 min Demolding time (minimum) - 8 to 12 h Total curing time - RED - FAST.

Mixing proportions - 100: 5 Color - red (coloring facilitates homogenization with silicone) Life time - 15 to 30 min Demolding time - 1 to 2 h

Form: - liquid with medium viscosity

Color (A + B) - depending on the catalyst (pink or blue) Mixing ratio (A + B) - 100/5 (by weight) Viscosity (A + B) - 19,000 mPa * s

Linear shrinkage after 5 days (ISO 4823) Max 0.4% Density - 1.26 kg / dm3

Hardness (DIN 53505) - 22 Shore A

Tensile strength BS903 A2 - 3.64 MPa

Elongation at break BS903 A2- 497%

Young's module - 1.5 MPa

Module at 100% elongation BS903 A2 - 0.93 MPa

Tearing strength BS903 A3 - 26.24 kN/m

Coefficient of thermal expansion:

By volume 738 ppm / °C

Linearly 246 ppm / °C

Min. Working temperature -50 M°C Max. Working temperature AFS 1540B - 200 °C

APPLICATION: Making forms with complicated shapes (with many undercuts) for multiple use. Production of articles, decorative panels, concrete castings (balustrades), wall tiles, statuettes, artistic ceramics, candles, molds for footwear soles, technical parts, etc.

PREPARATION OF THE MODEL: The model can be made of resins, foams, rubber, wood, metal, glass, ceramics, plaster, wood, model plates, etc.

Materials with porous surfaces should be covered with a pore-clearing agent (e.g. polyvinyl alcohol based agent, lacquer, nitrocellulose lacquer, polyurethane paint, wax paste, thickened soap) using a brush or a tampon. This operation is necessary to avoid problems during demolding. We recommend that the pore trowel is a very liquid material (it will not cause distortion of the surface).

Application and curing:

Pour the mixture into the mold in one place, so as not to aerate the material. It is best if the mixture is poured in the lowest point of the form / box. Cure for a minimum of 12 hours before removing from the mold. For maximum properties and removal of any catalyst residues, leave the cured rubber partially to cure at room temperature for at least the next 12 - 24 hours.

Source: manufactures' materials

14.4. Separator in the form of a paste:

CIRE 827 is a separator based on synthetic waxes.

Recommended as a separator in the construction of multi-part silicone molds. Perfectly suited for the production of polyurethane foam products as a separator of mold - foam.

IT IS RECOMMENED

resin - resin silicone - resin (mold durability is significantly extended)

silicone - silicone (construction of multi-part molds).

Double porous models should be covered with a "pore clog" - polyvinyl alcohol PROPERTIES

Form - pasta

Color - white

Scent - intense (petroleum)

Boiling point - 140 ° C

Flash point - 200 ° C

Density - 0.71 g / cm3 Solubility in water - insoluble STORAGE In tightly closed packaging at temperatures between + 10 ° C and + 30 ° C

Keep the flammable product away from the source of fire.

APPLICATION:

Apply 2-3 layers with a brush or a soft cloth at intervals of 10-15 minutes. When applied to rigid molds, it can be polished. Regularly used, extends the life of the mold. Separator can react with some surfaces, therefore it is recommended to carry out tests with a small amount. The product can be processed without risk, provided that appropriate precautions for chemicals are maintained.

14.1. Separator in the form of spray:

The silicone separator for PUR 400 polyurethanes gives a high lustre.

Characteristic

PUR 400 is a specialized silicone-based separating agent used in plastics processing. It creates a smooth film that provides a high lustre of surface and easy and effective release of details.

PUR 400 is widely used, among others, in the production of footwear and in the automotive, modeling and stucco industries.

The preparation is made on the basis of fast evaporating solvents, which makes it effective also at low process temperatures.

It does not build up in the mold and creates growths allowing for good surface quality.

Special features - mild fragrance - effective also at low temperatures - creates a smooth film and gives a high gloss - does not accumulate and does not create growths in the mold - working temperature up to 200 ° C - efficient and easy to use in the form of a spray.

Application to: - polyurethane products in the form of elastomers and rigid resins - integral PUR foam - rigid PUR foam - for protecting silicone molds. Directions for use: Apply a thin layer with a continuous stream from a distance of approx. 25 to 30 cm. Frequency adjust to the given working conditions and needs. Warnings: In the case of further surface treatment and other processes such as: - dyeing, - varnishing, - printing, - metallizing, - welding - gluing, the use of AMBERSIL-free silicone separating agents. Technical data: Appearance - transparent liquid Odor - non-acrid

Source: manufactures' materials

14.5. Technical plasticine for foundry molds.

Plasticine is used for technical purposes in the construction of split molds, both silicone and resin. The special composition, the lack of dyes and traces of sulfur allow to work with resins of plastics without risk of disturbing the curing process.

The diluent is designed for diluting both condensation and addition silicones. Dosing max. 10% in proportion by weight to the mixture of addition silicone with catalyst and 5% for condensation silicones. A special formula allows to dilute the silicone to a very small extent by interfering with the technical parameters of the silicone after curing. After applying the preparation, the silicone becomes more slippery which favors the de-aeration and penetration of very small details during the mold construction.

Source: manufactures' materials

14.6. Vacuum chamber VP2RS-3

The vacuum chamber set is used in the degassing process of molding products such as: silicone, resin (polyurethane, polyester, epoxy), gypsum, wax.

The increased chemical resistance of this chamber allows it to be used with resin to stabilize wood and bones by alcohol, ethanol, acetone and acrylic-based monomers or polymers.

Vacuum chamber tank is made of aluminum, its capacity is 20 l, and internal dimensions: diameter 30cm, height: 28 cm. The lid of the chamber is made of thick safety glass. The tank is equipped with a vulcanized, edge-glued silicone gasket.

The transparency of the lid allows observation of the degassing process. Two ball valves allow to freely control the course of the degassing process, and the mounted glycerin vacuum gauge indicates the current vacuum in the chamber. The chamber is equipped with an intake air filter that prevents dirt from getting into the degassed material. The chamber is connected to the pump by means of a quick connector, on which a reinforced hose with an inner diameter of 8 mm and a length of 1.5 m is installed.

Vacuum pump VP2RS-3 - two-stage, oil pump with a capacity of 170l / min (6CFM) and a partial vacuum of 0.3psa. The vacuum pump is characterized by high efficiency, very high value of vacuum achieved and quiet operation. All pumps in the RS series are equipped with an oil mist filter and a one-way mechanical valve. This valve prevents the oil from backing up from the pump into the tank.

The tightness of the vacuum system guarantees that the vacuum will be maintained for at least the next several dozen hours after the pump is disconnected. Leakage of vacuum not more than 0.2 bar / 24h.

Source: manufactures' materials

MARELITT Baltic

Interreg Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

The MARELITT Baltic project

Derelict fishing gear (DFG) is addressed worldwide as a source of marine litter with extensive hazardous effects on the marine ecosystem. From 5.500 to 10.000 gillnets and trawl nets are lost every year and despite intense media focus – the problem is poorly known in the fisheries industry and among politicians.

The MARELITT Baltic project is one of the first transnational initiatives in the world to provide an operation oriented all-in-one solution for how to approach DFG. It will turn a diffuse problem into a clear and apprehensible topic that can contribute to an enhanced international readiness to act.

The project is divided into five work packages (WP), where package 2, 3 and 4 are the major parts concerning the cleaning, prevention and recycling of lost fishing gear.

Cleaning the sea and planning future action at sea
The aim of WP 2 is to plan and execute DFG retrievals in Sweden, Estonia, Poland and Germany both on the seafloor and wrecks. The activities will be based on methodologies and techniques tested in earlier national projects. These experiences will contribute to a common methodology which is crucial given the extreme hydrographic and morphological variation in the Baltic Sea. The new operation platform will make cleaning operations both transparent and demonstrate if the task is physically possible.

Responsible fisheries prevention scheme
The aim of WP 3 is to develop an overall approach to mitigate the problem of lost fishing gear in the future. It can roughly be divided into three types of actions. Firstly, the project will increase knowledge on fishing technological and strategic changes over time and how these changes have influenced the evolution of gear loss. In the second step, the project will focus on the potential causes to why fishing gears are lost. The third category of action includes development of preventive methods such as gear marking technologies helping to track irresponsible fishermen or assisting responsible fishermen to locate lost gears.

Marine litter reception facilities and recycling
The aim of WP 4 is to identify the options for a safe and fully sustainable handling and recycling of the lost fishing gear in a circular approach. Within this work package the phase from reaching the harbour through cleaning, sorting, transport until processing of recycling of the nets will be dealt with. The work encloses a variety of approaches such as creating a knowledge baseline about the transnational status and capacities of harbours, waste handling systems and industries in the Baltic Sea countries.

Project partners

Sweden
Municipality of Simrishamn, Lead partner
Keep Sweden Tidy

Germany
WWF Germany

Poland
WWF Poland Foundation
Maritime University of Szczecin
Kolobrzeg Fish Producers Group
Institute of Logistics and Warehousing

Estonia
Keep the Estonian Sea Tidy
Estonian Divers Association

More information

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