Research report

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Pidä saaristo siistinä ry (Keep the Archipelago Tidy Association)

Research Report, Fishing Nets

-This is a translation of the Finnish report.

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Re:Fish

1 Introduction

In spring 2025, a study conducted in collaboration between LAB University of Applied Sciences and the Keep the Archipelago Tidy Association examined the reuse potential of discarded fishing nets.

The study was part of the international Re: Fish project, which aims to reduce plastic pollution in the Baltic Sea and to promote a more sustainable material cycle in the marine environment.

According to the Plastics Roadmap (1) compiled by a working group from the Finnish Ministry of the Environment, the key strategies for achieving a better circular economy for plastics are: reduce, avoid, recycle, and replace.

The measures taken in this study align with the key objectives of the Plastics Roadmap. For example, one of its goals is to significantly reduce plastic litter in key marine areas by 2030, compared to 2022.

The aim of the study was to determine how discarded fishing nets could be safely and efficiently utilised as raw material for new products, in accordance with circular economy principles.

2 Materials

The study analysed samples of discarded fishing nets collected from the Finnish archipelago. These included net sections along with their upper and lower float lines. The nets were dismantled manually, with the float lines being separated from the netting by cutting (Figure 1. Nets unpacked and separated). The separated parts were analysed using various manufacturing and research methods.
Plate-shaped test specimens were produced from the upper and lower float lines using a precision compression press. The materials were first cut to appropriate sizes and layered in the mould to ensure uniform compaction during the pressing process. Compression was carried out under controlled temperature and pressure conditions, allowing the thermoplastic materials to melt and fuse mechanically without the use of additives. After pressing, the samples were cooled and removed from the mould for further processing. The resulting plates were then prepared for visual and structural assessment.
Additionally, tensile test specimens were manufactured from the netting using injection moulding, which is suitable for producing standardised samples for mechanical testing.

Before injection, the net material was pre-dried in a heating cabinet to prevent moisture from affecting the melting behaviour of the plastic or causing defects during the moulding process. The pre-dried material was fed into the injection moulding machine, where it was processed through a heated screw extruder. The molten plastic was injected into a standard test specimen mould under high pressure. The moulded specimens were then cooled and removed with dimensional precision, ready for subsequent testing of tensile strength, modulus of elasticity, and elongation.

The chemical composition of the materials was examined using Fourier Transform Infrared Spectroscopy (FTIR), a widely used technique for identifying the molecular structure of polymers. The method is based on the absorption of infrared radiation by molecular bonds, producing a spectrum characteristic of the material. Samples from both float lines and netting were analysed with FTIR equipment, and the spectral results were compared with reference materials to identify the polymer type. While the method is suitable for qualitative identification, it does not allow for a definitive determination of the precise polymer grade without further analysis.

The safety of the plastics studied was also evaluated through an SVHC (Substances of Very High Concern) analysis, which aimed to detect hazardous substances as defined by the EU REACH regulation. These include carcinogenic, mutagenic, and reproductive toxicants, as well as substances that are persistent, bioaccumulative, and toxic to the environment. The analysis was conducted in an accredited laboratory, which analysed the material samples for the presence and concentrations of such substances. The SVHC analysis is a crucial step in assessing the reusability and safety of recycled materials for both human and environmental health.

Figure 1. Fishing nets unpacked and separated

3 Results

FTIR measurement

The materials of the netting and float lines were analysed using FTIR (Fourier Transform Infrared Spectroscopy), a technique for identifying polymer structures based on their infrared absorption spectra. Samples included the upper and lower float lines, as well as the netting itself.

The analysis showed that the netting and the lower float line were made of polyamide, while the upper float line was composed of polypropylene (PP). FTIR spectra of the different materials are shown below.

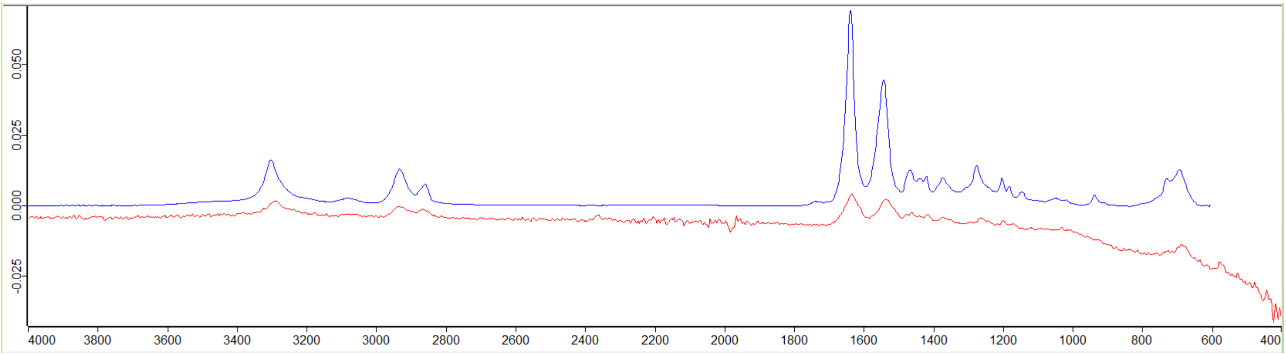

Figure 2. FTIR spectrum of the fishing net material.

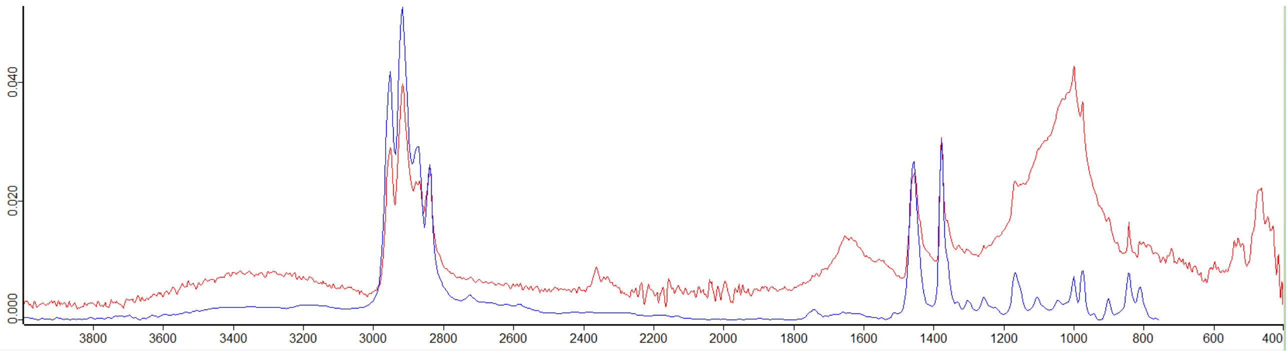

Figure 3. FTIR spectrum of the upper float line material.

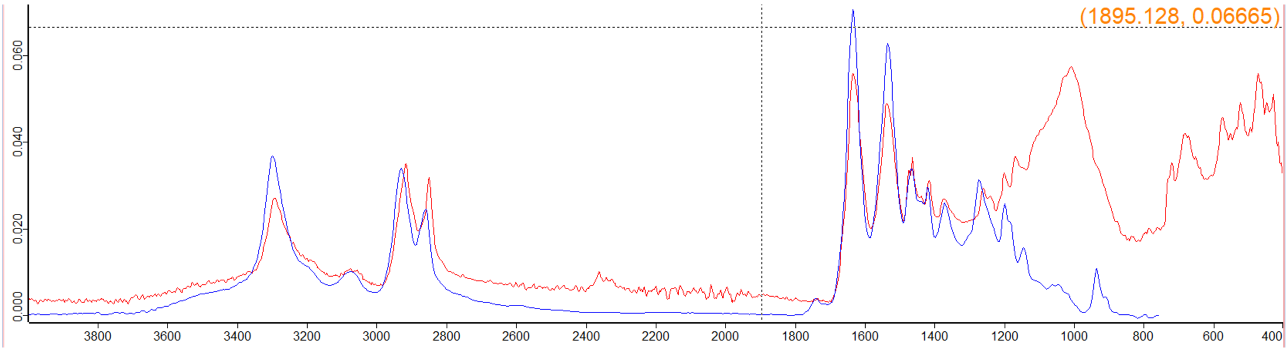

Figure 4. FTIR spectrum of the lower float line material.

Material Manufacturing Tests

The reusability of materials recovered from discarded fishing nets was investigated using two methods. Specifically, the material separated from the netting was injection-moulded into tensile test specimens in accordance with Standard SFS-EN ISO 527-1:2019 (Figure 5). The mechanical properties of the material were evaluated based on these specimens, and the successful production of standardised test pieces demonstrated that discarded fishing nets can be used as raw material for injection-moulded products.

Injection moulding, a widely used method in plastic manufacturing, involves heating pre-dried plastic raw material and injecting it into a mould. It is a versatile technique suitable for producing a wide range of plastic components.

Figure 5. Injection-moulded tensile test specimen made from recycled netting material.

The upper and lower float lines were compressed into plate-like material using a precision plate press. First, the cords were cut into pieces approximately 30 cm long for the compression tests. After that, the cords were arranged in two layers, one longitudinal and the other crosswise. Accurate placement was challenging because the cords were curved. Next, the blanks were pressed in a precision sheet press. The temperature used was 135°C, and the pressure steps were 2 MPa, 9 MPa, and 5 MPa. The total compression time was 10 minutes. The aim was to melt the plastic materials so they would bond together, thus eliminating the need for additives such as glue in board manufacturing. Figure 6 shows the float lines before and after hot compression moulding.

Figure 6. On the left, unpressed lower float lines; on the right, a compression-moulded plate made from lower float line material.

After pressing, the edges of the plates were trimmed to achieve straight sides. The surface of the plates is slightly uneven, and their thickness varies between 5 mm and 8 mm. Figure 7 below shows the trimmed plates.

Figure 7. On the left, a plate pressed from the lower float lines; on the right, a plate pressed from the upper float lines.

During the manufacturing process, it was noted that the lower float lines contained a higher proportion of meltable thermoplastic material. This resulted in a stiffer, more cohesive, and higher-quality compression-moulded plate. In contrast, although the plate produced from the upper float lines remained structurally intact without the use of adhesives, it was visibly and mechanically weaker than the plate formed from the lower float line material.

Technical features

The mechanical properties of the material, particularly tensile strength and elastic modulus, were examined using tensile test specimens made from the netting (see Appendix 4). The table below presents the average strength values measured from the tensile specimens.

Table 1. Mechanical properties

Material	Maximum Force (N)	Tensile Strength (MPa)	Maximum Elongation (mm)	Modulus of Elasticity (MPa)
Fishing net (average)	17823	46	10	2369

Compared to materials made from virgin raw materials, for example, a commercial-grade Polyamide 6 (2) has a tensile strength of 79 MPa, approximately twice that of the fishing net and an elastic modulus of 3300 MPa, which is about 1000 MPa higher. Another commercial polyamide tested had a tensile strength of 80 MPa and an elastic modulus of 3000 MPa (3), showing very similar characteristics to the first.

In contrast, Polyamide 12 has a tensile strength of only 53 MPa and an elastic modulus of 1800 MPa (4), meaning that the fishing net material exhibits a higher modulus than this commercial variant. Based on preliminary testing, the material recovered from discarded fishing nets can thus be considered mechanically comparable to commercial polyamides.

SVHC analysis

Material samples from discarded fishing nets were analysed for Substances of Very High Concern (SVHC), as defined by the EU REACH regulation. The analysed sample was taken from the netting portion of a batch provided by the Keep the Archipelago Tidy Association. The analysis was commissioned by LAB University of Applied Sciences and carried out by Measurlabs. The sample was submitted to an ISO/IEC 17025-accredited external laboratory on May 2, 2025, and the analysis was completed on May 23, 2025 (see Appendix 3).

Methodologically, the analysis encompassed a broad range of organic and inorganic substances. Volatile and non-volatile organic compounds were identified using gas chromatography (GC) and liquid chromatography (LC), while inorganic elements were determined by inductively coupled plasma optical emission spectrometry (ICP-OES).

The results confirmed that none of the identified substances exceeded the threshold values defined in the REACH regulation. A total of 247 SVHCs were screened for, each with a regulatory concentration limit of 0.01%. The analysis found that the total SVHC content in the sample was below 0.1% by weight. This indicates that the material complies with REACH safety requirements and does not contain substances that would trigger a notification obligation under REACH.

These findings support the conclusion that the recycled netting material poses no significant chemical risk to users or the environment and is therefore suitable for reuse. Detailed analytical methods and results are provided in Appendix 3.

Table 2. Summary of all the exams

Test	Description
FTIR Analysis	FTIR spectroscopy was used to identify the materials of the netting and float lines. The netting and lower float line were identified as polyamide, while the upper float line was polypropylene.
Injection Moulding Tests	Tensile test specimens were manufactured from the netting using injection moulding. The purpose was to assess the mechanical properties of the recycled material.
Compression Moulding Tests	Plate-like samples were produced from the upper and lower float lines using a precision compression press without the use of adhesives. The lower float lines resulted in more uniform and stiffer plates.
Tensile Testing	Tensile strength and elastic modulus were measured from the injection-moulded specimens. The results were compared with commercial polyamide materials.
SVHC Analysis	No substances of very high concern (SVHC) exceeding the REACH regulation threshold values were found in the samples. The material is chemically safe for reuse.

4 Analysis of results

Based on the FTIR analysis, the upper float line was made of polypropylene, while the netting and lower float line were made of polyamide. As shown in Figures 2 and 4, the spectra are not identical; therefore, it was not possible to determine the exact polyamide grade of the materials. This indicates that the netting and the lower float line may consist of different types of polyamide. Polyamides exist in several grades, each with distinct mechanical and chemical properties (3).

The compression moulding tests showed that plates made from the lower float line were stiffer and more durable than those made from the upper float line. The plate thickness ranged between 5 and 8 mm, and surface irregularities remained within an acceptable level for a prototype product. These findings suggest that simple mechanical and thermal processing methods can produce new materials without the need for additional additives.

Forming the netting into tensile test specimens succeeded after several trials, provided the material was pre-dried to remove bound moisture that would otherwise interfere with processing. When comparing the mechanical properties of the tensile specimens to those of commercial polyamides, the recycled fishing net material outperformed virgin polyamide in some respects. Specifically, its mechanical properties were comparable to those of Polyamide 12. Since the exact type of polyamide used in the original netting is unknown, it is not possible to compare the results directly with its original properties. However, it can be concluded that the recycled material retains mechanical strength comparable to that of virgin polyamide.

SVHC analysis

Based on the SVHC (Substances of Very High Concern) analysis, no harmful substances were detected in the material. Therefore, the recycled material is not classified as hazardous, and products manufactured from it can be considered safe for use. The material complies with the requirements of the EU REACH Regulation and does not contain substances that are subject to mandatory notification. This confirms that the material is safe to use from the perspective of EU chemicals legislation and is therefore suitable for reuse.

Circular economic perspective

The study supports key principles of the circular economy as follows:

- Value Retention

Materials used in fishing nets can be efficiently recovered and processed further, helping retain their value within the material cycle. This reduces reliance on virgin raw materials and supports the conservation of natural resources.

- Closing and Extending Material Cycles

The reuse and recycling of materials are central to the circular economy. Converting discarded fishing nets into new plates serves as a concrete example of closing the product life cycle and extending the usability of the materials.

- Culture of Experimentation and Innovation

An experimental manufacturing method was developed during the study that enables the production of composite plates without the use of additives. Such innovations may serve as a foundation for new commercial products and industrial applications.

Based on the findings, it can be concluded that the material used in fishing nets is both mechanically and chemically reusable, and the experimental processing methods developed in this study support the goals of the circular economy in a promising way.

5 Conclusions and areas for further development

The study analysed a sample of discarded fishing nets collected from the Finnish archipelago. In the laboratory, the nets were dismantled into their components, and the reusability of their plastic parts was successfully tested. The results showed that the upper and lower float lines could be transformed into solid composite plates, while the netting itself could be processed into a raw material suitable for reuse. Additionally, the SVHC analysis confirmed the material's safety and suitability for further use.

The study demonstrated that discarded fishing nets can serve as raw material for new products. Items often regarded as waste may hold significant value when properly examined and processed. The research concretely promotes the circular economy, providing practical solutions to environmental challenges while laying the groundwork for new business models and sustainable innovations in resource use.

As previously noted, no harmful substances were found in the material that would hinder its reuse. The material was successfully processed and demonstrated clear potential for manufacturing new products. Utilising discarded nets also contributes to reducing environmental burden and marine litter, which has been identified as a key objective in the Finnish Plastics Roadmap 2.0.

Finally, it is essential to emphasise that this study represents only a preliminary exploration of the topic. The results are promising and point towards opportunities for further development. However, numerous aspects of the issue remain to be explored.

Future studies could focus on upscaling recycled production, blending different materials, testing recycled materials in various product applications, and assessing the prerequisites for commercialisation. These efforts would help advance the implementation of circular economy principles in managing and utilising marine plastic waste.

Sources

1) Plastics Roadmap 2.0 of the Ministry of the Environment. Available: Vähennä+ja+vältä,+kierrätä+ja+korvaa.+Muovitiekartta+2.0.pdf
2) Aikolon Oy. Available: https://www.aikolon.fi/tuotteet/tekniset-muovit/pa-6
3) Vink Finland Oy. Available: https://www.vink.fi/pa_muovi/#:~:text=Polyamidi%20eli%20PA%20ovat%20ryhm%C3%A4%20teknisi%C3%A4%20muoveja%2C,lujuus%2C%20sitkeys%2C%20pieni%20kitkakerroin%20sek%C3%A4%20hyv%C3%A4%20ty%C3%B6stett%C3%A4vyys.
4) Aikolon Oy. Available: https://www.aikolon.fi/tuotteet/tekniset-muovit/pa-12

Attachments

Appendix 1. Report on the processing of the upper and lower float line

Appendix 2. Network Processing Report

Appendix 3. SVHC analysis

Appendix 4. Net tensile tests