FACTSHEET

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Lifecycle Assessment of Fish Boxes in Cold Chain Logistics

Source: RDC Environment, Comparative LCA of Expanded Polystyrene and Alternative Fish Boxes, 2025

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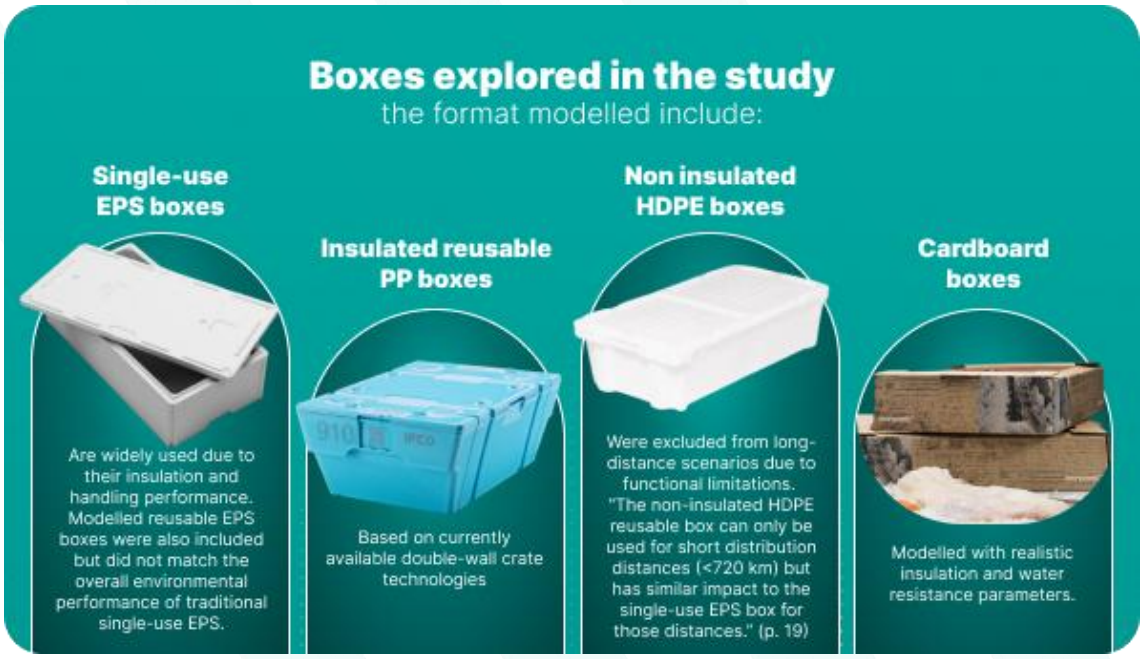
Summary

This fact sheet summarises the results of a comparative lifecycle assessment (LCA) conducted by RDC Environment in 2025. The study evaluates multiple fish box systems used in chilled seafood logistics, including single-use expanded polystyrene (EPS), laminated cardboard, and reusable plastic formats. It assesses each packaging type based on standardised environmental metrics, system-wide logistics, and end-of-life treatment under modelled long-term conditions.

The analysis follows ISO 14040/44 and PEF-compliant methodologies and uses "1 kg of fish delivered under refrigerated conditions" as the functional unit. It includes full-system inputs and outputs; transport, insulation requirements, spoilage risk, washing (where applicable), and disposal or recycling. The study models steady-state operation for all formats and does not include infrastructure readiness or transition costs. This means that any real-world switch to a lower-performing format would entail additional environmental and financial costs not reflected in the LCA outcomes.



The LCA results are scenario-dependent, with transport distance emerging as a decisive variable

At very short ranges (below 200 km), performance across all systems is broadly similar. However, as distance increases, differences become more pronounced.

At distances between 200 and 500 km, EPS and insulated reusable boxes perform similarly on climate impact, while cardboard begins to accrue penalties due to greater ice requirements and spoilage sensitivity. Above 500 km, reusable systems face growing burdens from return logistics and box cleaning, especially if return flows are not optimised. Laminated cardboard continues to lose competitiveness as ice volume requirements increase and food waste becomes more likely.

Performance Evaluation of Fish Boxes – various distances

Distance (km)	Formats Remaining Viable	Format with Best Overall Impact	Dropout Notes
0–200	EPS, Cardboard, Insulated PP, Non-Insulated HDPE	*All similar*	Performance parity under optimal reuse conditions (short return loop, low loss, high reuse cycles)
200–500	EPS, Insulated PP	EPS	Cardboard begins to accrue higher climate cost due to ice volume and spoilage risk
500–900	EPS, Insulated PP	EPS	Non-insulated HDPE excluded due to failing to maintain required temperature beyond ~720 km
900–1250	EPS, Insulated PP (still modelled)	EPS	Reusable PP increasingly burdened by transport, return logistics, and washing
1250–2800	EPS	EPS	EPS shows the lowest environmental cost and climate impact across all impact categories and cost metrics

This table summarises model-based viability and climate performance across distance segments. Results assume steady-state systems with optimised conditions for each format. Real-world deviations in reuse cycles, return logistics, or spoilage rates may shift relative performance.

At 900 km, EPS becomes the lowest-cost and lowest-impact option based on the LCA's monetized footprint model. Beyond 1250 km, EPS is the only format that maintains low total climate and environmental costs across all modelled assumptions. For distances typical of intra-European seafood distribution (1250–2800 km), EPS consistently ranks as the format with the lowest environmental impact per kilogram of fish delivered.

Environmental Impact and Costs.

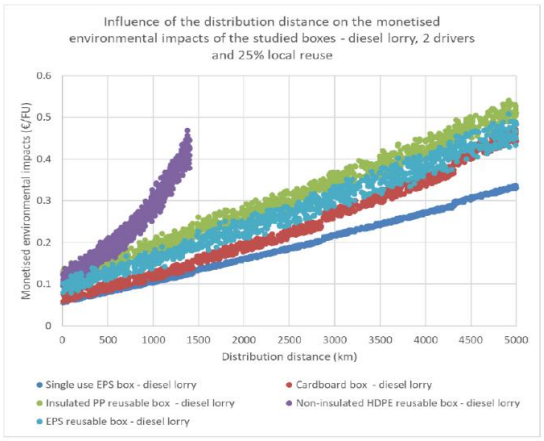


Figure 7-3. Influence of fish distribution distance on the studied boxes' impact on monetised environmental impacts (euros / FU) – 25% local reuse and 2 drivers

The environmental cost estimates, calculated through the study's monetisation model in line with ISO 14008 and EU cost-benefit guidelines, further illustrate the broader pattern:

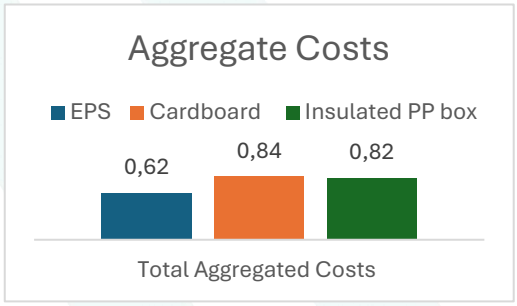
The results demonstrate that no single format dominates across all distances and conditions.

However, at the distances—where transport burdens increase and spoilage prevention becomes critical—EPS offers the most robust combination of climate performance, system cost, and operational simplicity under the modelled assumptions. In the base case, EPS outperforms all alternatives.

This does not mean that EPS outperforms alternatives on all parameters, which is illustrated by figure 4.1 from the LCA, which compares the performance of the evaluated fish boxes on different environmental performance indicators.

The EPS boxes have the lowest impact on 4 out of 5 examined indicators.

Environmental Cost Estimates of Different Boxes



Based on Figure 7-4. Aggregated environmental and socioeconomic impacts by life cycle phase for the base case (euros / FU)

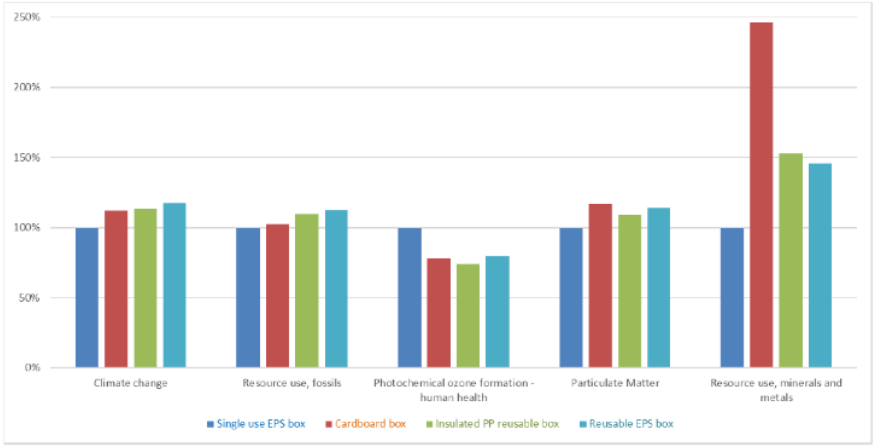


Figure 4-1. Environmental impacts of the studied boxes. Reference scenario (100%) is the single use EPS box

Food safety

Seafood, especially fresh fish, is one of the most nutritious foods available. Rich in protein, omega-3 fatty acids, vitamins, and minerals, it plays a vital role in a healthy and balanced diet. Unlike other perishable goods, fresh aquatic food is highly sensitive to temperature changes and spoilage, making reliable cold-chain logistics essential.

The RDC study confirms that EPS fish boxes support this by enabling efficient long-distance transport with minimal environmental cost and spoilage risk. Compared to alternatives, EPS performs better in maintaining stable, low temperatures, protecting food quality from source to plate. As single-use, food-grade certified packaging, EPS also avoids hygiene concerns linked to reuse, including microbial risks such as Listeria monocytogenes. Preserving the quality and safety of fish is not just a technical issue; it is about protecting access to one of Europe's healthiest and most sustainable protein sources.

Note on System Segmentation and Policy Implications

The LCA does not model or assess the environmental or logistical effects of operating multiple packaging formats in parallel (e.g., reusable systems for short distances and EPS for longer distances). While the modelled results indicate performance parity between EPS and alternatives at short distances, implementing multiple packaging lines would introduce additional facility, logistics, and operational burdens—such as increased space, energy use, and handling infrastructure—which fall outside the study's system boundaries.

The LCA therefore does not provide a scientific basis for mandating dual systems segmented by transport distance. Any decision to operate differentiated lines would be a commercial or logistical choice by individual operators rather than a conclusion supported by lifecycle modelling. As modelled, EPS offers consistent environmental and economic performance across a wide range of transport distances without requiring system duplication.

While the study does not make regulatory recommendations, its findings provide quantitative evidence that environmental performance in fish box logistics is context-specific. Blanket targets for reuse may not reduce total impact unless the return system operates under tightly controlled conditions. For high-volume, long-distance seafood transport, EPS performs consistently well in terms of climate metrics, circularity modelling, and functional reliability.

These conclusions are based strictly on modelled system behaviour and do not factor in transition costs, infrastructure investments, or real-world operational readiness. As such, a switch to alternatives in practice would involve additional costs and impacts beyond those already modelled—without offering environmental advantages in most long-distance scenarios.

This factsheet was published by:

- AIPCE-CEP – Association of Fish Processors and Traders in the EU & European Federation of National Organisations of Importers and Exporters of Fish
  (AIPCE = Association of the Fish Processing Industry in the EU; CEP = Comité des Organisations Professionnelles d'Importateurs et Exportateurs de Poisson de l'UE)
- EUMEPS – European Manufacturers of Expanded Polystyrene
- FEAP – Federation of European Aquaculture Producers
- UMF – Union du Mareyage Français (French Fish Wholesalers' Union)
- NEPSA – Alliance of Nordics EPS Associations and Companies in Norway, Sweden, Denmark and Finland
- Norwegian Seafood Federation – Officially known as Sjømat Norge (Seafood Norway)
  (Norwegian national trade and employers' organisation for the seafood industry)