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Oregon Marine Debris and Litter Report

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Companion Documents and Citations

This report to the Oregon Legislature is required by ORS 459A.975, which directs the Oregon Department of Environmental Quality to assess the contribution of covered products to litter and marine debris in Oregon, identify where prevention and cleanup are needed, and assess the extent of that need.

The report draws from the Marine Debris and Litter Study for Oregon: A Statewide Needs Assessment of Plastic Leakage from Covered Products, authored by Eunomia Research & Consulting Inc. under contract to DEQ. Throughout this report, this will be referenced as “the needs assessment.”

To improve readability, no citation is provided for facts, findings, or claims drawn from the needs assessment.

The needs assessment engaged interested parties across Oregon to identify Oregon-specific data sources, expert perspectives, and ongoing initiatives to address litter and marine debris. Outreach was conducted across a broad range of interested parties, including state agencies, local governments, Tribal governments,

industry organizations, nongovernmental organizations, academic researchers, and other subject matter experts. As required by the legislation, DEQ and Eunomia also consulted with the specified local governments, the Oregon Department of Transportation, the Oregon Parks and Recreation Department, producer responsibility organizations, and the Oregon Recycling System Advisory Council. Information gathered through this engagement informed the needs assessment and the findings presented in this legislative report.

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Executive Summary

This report responds to a legislative requirement in ORS 459A.975 directing the Oregon Department of Environmental Quality to assess the contribution of Recycling Modernization Act -covered products to litter and marine debris in Oregon, identify where prevention and cleanup are needed, and assess the extent of that need.

Sources and scale of litter and marine debris

Plastic packaging and food serviceware covered under the RMA account for approximately **2,467 tons of marine debris and litter annually**. This makes up approximately **47% of all materials studied** that leaked into Oregon's environment through littering, illegal dumping, wear, and loss from the waste management system.

- **RMA-covered plastic packaging is estimated to account for approximately 1,444 tons** of leakage into Oregon's environment each year. Flexible and multilayer packaging are the largest RMA-covered sources, with a combined estimated leakage of 1,174 tons per year, representing nearly half of all RMA-covered leakage.
- **RMA-covered plastic food serviceware accounts for approximately 1,024 tons** of leakage annually. Rigid containers (423 tons) and cups and lids (299 tons) are the largest contributors.
- RMA-covered paper products were evaluated but not prioritized in the needs assessment because of their lower overall volumes and lower likelihood of environmental leakage.

Most leakage of RMA-covered sources remains on land, including roadsides, parks, farmland, and urban areas, while a smaller share is transported by wind and stormwater to rivers and the coast. Overall, an estimated **71 percent of leakage ends up in soils and other land-based ecosystems, while 29 percent reaches aquatic environments.**

Environmental and economic impacts

Plastic leakage can degrade habitat and harm wildlife through ingestion and entanglement. Larger plastic items can fragment into microplastics, which persist in the environment and cannot be practicably recovered once dispersed. Microplastics have been detected in most human organ systems and emerging studies suggest potential health impacts, though the evidence base is still developing and the magnitude of effects is difficult to quantify.

The economic costs of leakage extend beyond cleanup. The needs assessment estimates **direct cleanup costs for RMA-covered product leakage at $9.6 million to $22.8 million annually**. Leakage may also result in approximately **$38.3 million in annual losses to Oregon's economy**, as well as substantial ecosystem services and human health costs. These estimates illustrate the potential magnitude of the economic, social, and environmental burden of leakage, rather than precisely attributing costs to specific materials, underscoring the broader benefits of preventing litter and marine debris in general.

Potential solutions

On page 13, this report identifies several policy interventions that could reduce leakage of RMA-covered products into the environment and shift cleanup costs that would otherwise be borne by local governments and ratepayers onto a producer responsibility organization.

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Background

Purpose of this report

The Oregon Marine Debris and Litter Report was conducted under the Plastic Pollution and Recycling Modernization Act (RMA) enacted by the Oregon Legislature (Senate Bill 582, 2021). The RMA leverages the resources of producers to modernize Oregon's recycling system by making recycling more accessible, improving recycling collection and sorting infrastructure, and creating environmental benefits while reducing social and environmental harms.

The RMA also includes several provisions aimed at reducing plastic pollution. One of these provisions directs the Oregon Department of Environmental Quality (DEQ) to conduct a needs assessment focused on litter and marine debris. The needs assessment is intended to identify the contribution of different types of covered products to litter and marine debris in Oregon; the general locations where prevention and cleanup of covered products are needed; and the extent of those prevention and cleanup needs. To support DEQ in meeting this requirement, Eunomia Research & Consulting Inc. conducted a statewide needs assessment using available data, literature, modeling, and interested party input. This report is based on the needs assessment and fulfills that requirement by examining the sources, pathways, and scale of litter and marine debris associated with covered products and assessing where additional prevention and cleanup efforts may be needed.

This report details the amount of RMA-covered products (plastic and related material) that enters Oregon's environment, the products contributing to this leakage, the pathways through which they enter the environment, and the resulting environmental impact. In addition, the report quantifies other, non-RMA, sources of plastic leakage to the environment. Results are differentiated across both RMA and non-RMA sources.

In this report, leakage refers to material that reaches the environment through littering, illegal dumping, wear, and loss from the waste management system, rather than material that is landfilled or recycled. Estimates are drawn from an Oregon litter and leakage flows model developed through the needs assessment and are reported as the midpoint of a modeled range. The model focuses on the product and material categories judged most significant for Oregon; lower-priority flows were screened at a coarser level but not modeled in detail. The needs assessment uses order-of-magnitude estimates to support comparisons across materials and pathways, rather than to provide precise measurements of environmental leakage in Oregon. While these estimates carry uncertainty, they are sufficiently robust to identify meaningful differences in relative impacts and inform policy design and prioritization.

Marine debris and litter

Marine debris, litter, and other forms of environmental leakage are a persistent and growing challenge for communities, ecosystems, and public authorities. Materials that are improperly disposed of or unintentionally lost from waste management systems can accumulate in terrestrial, freshwater, and marine environments, generating a range of environmental, social, and economic impacts. Visible litter affects community well-being, tourism, and public spaces,

while less visible forms of leakage can harm wildlife, contribute to pollution, and generate long-term management and cleanup costs.

Plastic materials have attracted particular attention due to their durability and their potential to persist in the environment. Larger plastic items and fragments (5 mm or more in size), commonly referred to as macroplastics, can break down over time into smaller particles known as microplastics and nanoplastics (smaller than 5 mm in size). Macroplastics are usually readily identifiable as products such as packaging, bottles, bags, or containers and more easily recovered through targeted clean-up activities or appropriate disposal and recycling. Microplastics include fragments, fibers, and pellets. Their small size increases the likelihood of ingestion and makes them extremely difficult to remove once dispersed in the environment; as a result, management approaches typically focus on preventing their release before they reach terrestrial or marine environments.

Assessing the Scale and Environmental Impacts of Leakage

Leakage of RMA-covered products in Oregon was quantified by mass (and, for some products, by count) in the needs assessment using established material flow methods and using Oregon-specific data wherever possible. Sources included placed-on-market data to estimate the quantity of products entering use within Oregon, which was then validated using observational datasets. This report does not consider all litter or mismanaged waste in Oregon, instead focusing on RMA-covered materials and other materials identified as high priority through a rigorous scoping and prioritization process.

This section summarizes statewide leakage estimates for RMA-covered products and other priority materials: RMA Packaging, RMA Food Serviceware (FSW), Microplastics, and Non-RMA Plastics. RMA-covered paper products were evaluated but not prioritized in the needs assessment because of their lower overall volumes and lower likelihood of environmental leakage. Paper materials were assessed qualitatively to provide additional context.

This section focuses primarily on leakage from packaging and food serviceware covered by the RMA. This section also examines several other significant sources of plastic leakage that are outside the RMA-covered product categories and are not part of DEQ's specific reporting mandate under the RMA. These categories are included to provide broader context about the sources and pathways of plastic pollution in Oregon and to help identify areas of potential environmental concern. Information presented below is high-level and summary in nature; additional details can be found in the needs assessment.

Estimated scale of marine debris and litter

These broader estimates should not be interpreted as a comprehensive estimate of all plastic leakage in Oregon; rather, they represent a snapshot of the highest-impact categories evaluated in this report. Values are represented as a midpoint; see Figure 1 for high and low ranges of leakage. Tonnage estimates may not reflect the full physical scale of leakage, as lightweight

materials can be widely dispersed across the landscape and waterways while contributing relatively little in total weight.

The products that leak the most by weight are not always those most prone to escaping into the environment. Effective leakage - the share of material placed on the market that ultimately reaches the environment - is highest for plastic bags at nearly 3 percent and for food service cups and lids at about 2.8 percent, against roughly 0.5 percent for most other packaging. Lightweight formats used on the go, which are less likely to be captured by recycling or the deposit system, leak a disproportionate share of what is sold. Both volume and intensity therefore matter in identifying where policy can do the most.

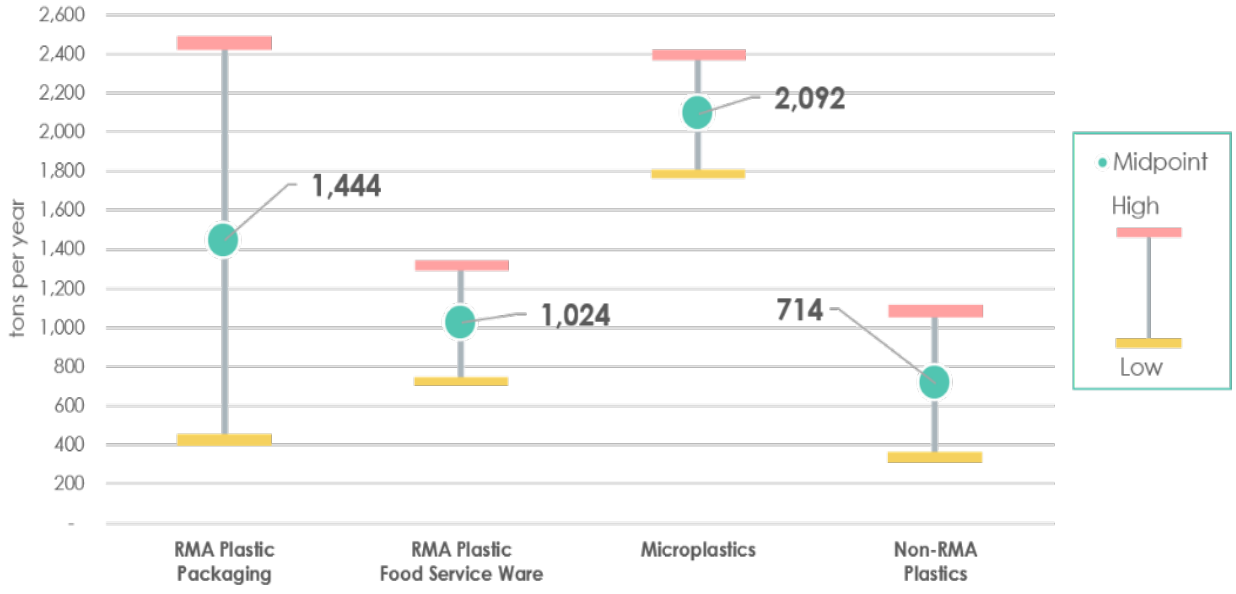
RMA packaging

RMA-covered packaging accounts for approximately 1,444 tons of leakage annually in Oregon, with flexible and multilayer packaging comprising the majority at approximately 1,174 tons annually. While these materials dominate total leakage volumes, plastic bags and pouches exhibit the highest effective leakage rate, with nearly 3% of material placed on the market estimated to ultimately reach the environment.

RMA food serviceware

RMA-covered plastic food serviceware accounts for approximately 1,024 tons of leakage annually in Oregon. Container-based food serviceware is the dominant source of leakage within the FSW category, with rigid containers (423 tons) and cups and lids (299 tons) accounting for the majority of total releases. While most FSW products have similar effective leakage rates of around 2%, cups and lids show the highest leakage intensity. In contrast, cutlery, straws, and stirrers contribute comparatively little because their product-specific leakage rates are lower, despite having similar on-the-go consumption patterns.

Figure 1: Annual Leakage Range Estimates by Product Groups



Microplastics

Microplastic leakage is dominated by tire and brake wear at over 1,500 tons, which represents the largest source evaluated and reflects the continuous release of particles during normal vehicle use. Paints and coatings are the second-largest contributor, demonstrating that some of the most significant sources of plastic leakage are diffuse, largely invisible, and generated through everyday activities rather than the mismanagement of discrete plastic products. Microplastics also form as larger plastic items, including RMA-covered products, break down over time.

Non-RMA plastics

Agricultural plastics are the largest source in this category, while beverage containers remain a notable contributor, despite Oregon's deposit return system, due to their high consumption volumes. Fishing and aquaculture gear, cigarette filters, and flushable products contribute less leakage by mass but represent important sources because of their direct marine, litter, and wastewater pathways and disproportionate environmental impact.

Three significant sources fall outside the scope of the RMA and would require policies beyond the RMA to address. Tire and road wear is the single largest source of leakage in the state, but tires are not a covered product and not addressed under the RMA. Fishing and aquaculture gear accounts for only about 100 tons a year but causes disproportionate harm to marine wildlife and ecosystems. Cigarette filters are the most-littered item by count, while contributing little by weight.

Environmental impacts of covered product leakage

Through an analysis of the environmental impacts of marine debris and litter, the needs assessment identifies where leaked materials are most likely to accumulate or be transported through the environment and where prevention and cleanup is needed.

Approximately 71% of all leaked materials are estimated to remain on land, across both built and natural terrestrial environments, including roadsides, transportation corridors, stormwater infrastructure, soils and public spaces. These areas can serve as points of accumulation while also providing pathways for litter to move into freshwater and marine environments. Freshwater systems can both accumulate leaked materials and transport them downstream to marine environments through rivers and stormwater outfalls. In coastal and marine environments, beaches, shorelines, and nearshore areas are important locations where marine debris can accumulate and move through coastal ecosystems.

Marine debris and litter create a wide range of environmental impacts through physical, chemical, and ecological pathways. Larger plastic items (macroplastics) can harm wildlife through ingestion and entanglement while accumulated debris can degrade habitat and be remobilized during high-flow events. Flexible items like bags, straps, and netting pose particularly high entanglement risks. In Oregon, these harms are not theoretical - Cassin's auklets stranded along the Oregon and Washington coasts were found with industrial plastic pellets and fragments from consumer products in their stomachs, illustrating how marine debris

is already entering coastal food webs. Steller sea lions on the central coast have been found entangled in plastic bands and fishing gear, while Willamette Riverkeeper has documented amphibians, herons, and waterfowl trapped in fishing line and other fibrous debris.

Over time, macroplastics fragment into microplastics, expanding their environmental reach and making cleanup substantially more difficult. Microplastics have been detected throughout Oregon's freshwater and coastal systems including every sample in a multi-river study of the Columbia, Willamette, Deschutes, and Rogue Rivers. These particles can be ingested by a wide range of organisms, from small invertebrates to commercially and culturally significant species. For example, nearly all sampled oysters and razor clams along the Oregon Coast contained microplastic particles, and gray whales off Oregon have been found to ingest millions of microparticles, including synthetic fibers. Scientific studies show microplastics can alter feeding, growth, reproduction, and survival in exposed organisms, though Oregon-specific population-level effects remain difficult to quantify. Once these particles enter waterways or soils, they are difficult and expensive to remove, making prevention the primary mitigation approach.

Marine debris and microplastics also create chemical exposure pathways. Plastics can both contain additives and also accumulate pollutants - plasticizers, flame retardants, stabilizers, heavy metals, and persistent organic pollutants - that can leach over time or be transferred when ingested. These chemical impacts extend beyond aquatic ecosystems, affecting soil quality, microbial communities, and potentially the health of wildlife and people. Although human health impacts are not fully quantified, microplastics have been found in multiple human organ systems and emerging research suggests associations with cardiovascular and inflammatory effects.

Beyond ecological harm, marine debris and litter affect Oregon's social and economic well-being. Plastic pollution in rivers, beaches, and coastal public spaces can reduce recreational quality and deter tourism, industries essential to many Oregon communities. Local groups such as Willamette Riverkeeper repeatedly clean large quantities of debris from river corridors, only to see those areas reaccumulate litter soon after. Plastic pollution also affects culturally important fisheries and intersects with tribal treaty-reserved rights, as salmon and other species are exposed to microplastics and tire-related chemicals in waterways that are central to tribal subsistence, culture, and ceremonial practices.

The overall picture in Oregon is one of persistent, multi-pathway environmental harm, driven both by macroplastic debris that can be removed and by microplastics that usually cannot be practicably recovered once dispersed. Rivers, estuaries, and nearshore marine areas act as both sinks and conduits for plastic pollution, exposing wildlife and habitats directly while transporting debris downstream to the coast. Terrestrial environments are major initial leakage points before plastics move into aquatic systems. While some impacts can be addressed through cleanup, many plastics persist, fragment, or transform over time, emphasizing the importance of preventing leakage at the source.

For Oregon, this means that plastic leakage should be understood not only as a visible litter or cleanup issue, but as an ongoing source of ecological exposure. This strengthens the case for

prioritizing prevention, reducing leakage at the source, and addressing recurring accumulation in sensitive ecosystems.

Economic Costs of Leakage

The economic costs associated with RMA-covered product leakage are difficult to estimate comprehensively, particularly for indirect impacts that may not be readily quantified. To provide a sense of the potential magnitude of these losses, the needs assessment considered a range of direct and indirect costs associated with leakage in Oregon. Direct costs represent expenditures incurred to manage leaked materials after they enter the environment, while indirect costs capture broader economic losses and societal and ecological impacts that are not reflected in these expenditures. Taken together, these ranges provide an indication of the scale of the economic burden associated with marine debris and litter, rather than a precise estimate of total costs.

Direct costs of leakage

Litter and debris cleanup is a routine and ongoing expense across Oregon. Litter cleanup is undertaken by state agencies, local governments, regional bodies, community organizations, businesses, and volunteers. However, data on how cleanup is funded, reported, and tracked are fragmented. Through a targeted literature review, outreach to interested parties, and the collection of Oregon-specific data, the needs assessment conducted a bottom-up scaling of available local cleanup data to estimate statewide expenditures. The analysis estimates that **current cleanup expenditures across Oregon range from approximately $12.6 to $16.9 million per year.** As cleanup activities, funding arrangements, data collection, and reporting practices vary considerably, these estimates provide an indication of the order of magnitude of current statewide cleanup expenditures, rather than a comprehensive accounting of actual costs. The needs assessment also estimated the **potential direct costs to clean up leakage of RMA-covered products at $9.6 to $22.8 million.**

Every ton of RMA-covered product requires resources to collect, transport, and dispose of it. Even at the lower-bound estimate, collecting, transporting, and disposing of leaked covered materials requires substantial resources each year. Preventing leakage can avoid substantial cleanup costs, as well as the broader indirect costs discussed in the following section.

Indirect costs of leakage

The indirect costs of covered product leakage cannot be reliably estimated using the same methodology applied to estimate direct cleanup costs. The needs assessment instead examined the types of indirect costs that may occur and the potential magnitude of the impacts.

Internalized indirect costs arise when covered material leakage results in financial losses or increased costs for households, businesses, or public institutions. These costs extend beyond the direct expenditures to remove leaked materials and may include damage to vehicles or infrastructure, additional maintenance requirements, property damage, or other financial losses from litter and marine debris. Scaling national estimates to reflect the relative size of Oregon’s

marine industries suggests **annual losses of approximately $38.3 million across tourism and recreation, marine shipping, fisheries, and aquaculture.** The estimate is intended to indicate the potential order of magnitude of these losses, rather than a measured, Oregon-specific loss attributable solely to covered products.

Externalized indirect costs arise when the impacts of material leakage are borne by society, rather than reflected in market transactions. These costs represent the broader environmental and societal losses that affect people, businesses, communities, and ecosystems. Available evidence indicates that material leakage can generate financial losses along with impacts on recreation, ecosystem services – for example, fisheries, water quality, and wildlife habitat - and human health. The needs assessment used available studies to scale to Oregon's GDP and population and estimated an illustrative range of $12.9 million to $1.03 billion attributed to the loss of ecosystem services and $5.2 million to $51.9 million annually attributed to direct human health effects from micro- and nanoplastics. (For detail on methodology and approach, see the needs assessment.)

Addressing the Challenge of Litter and Marine Debris

This report identifies several policy interventions that could reduce leakage of RMA-covered products through Oregon's existing Extended Producer Responsibility (EPR) framework under the RMA, as well as additional options to expand producer responsibility for covered product leakage.

A detailed evaluation of these recommendations can be found in the needs assessment, including the full long list of recommendations, the criteria and process used to prioritize recommendations, and integration of equity considerations.

Equity is a core, cross-cutting consideration throughout all recommended measures because litter burdens and cleanup resources are not distributed evenly across communities. Lower-income and underserved communities often experience higher levels of litter, fewer cleanup services, and greater environmental impacts, and upstream reductions in plastic leakage can benefit these communities. At the same time, some interventions, such as reuse systems or digital return infrastructure, risk creating new inequities if they are less accessible to rural residents or small businesses. Ensuring equitable outcomes therefore requires intentional design choices: directing infrastructure and funding to communities with the greatest need, avoiding regressive cost burdens on households, and maintaining transparency and meaningful participation and consultation, including with tribal governments whose treaty-protected fisheries are directly affected by microplastics and other aquatic debris.

Recommendations that can be implemented within Oregon's existing EPR framework

The following recommendations could be implemented through the Recycling Modernization Act after additional engagement with interested parties.

1. Implement eco-modulation and source reduction targets for high-leakage packaging formats.

Eco-modulation is a current feature of Oregon's EPR framework under the RMA, designed to incentivize more sustainable products with lower environmental impacts. Oregon could expand the use of eco-modulation and further adjust the per-unit fee paid by producers according to a format's leakage risk, using existing authority under the RMA. Formats assessed as higher-risk for littering, such as on-the-go food and beverage packaging, would attract a higher fee; lower-risk formats would attract a lower one. This approach would increase costs for high-risk, high-litter materials and reduce fees for lower-risk alternatives, encouraging shifts in product design and material selection. When paired with a defined source-reduction target, eco-modulation can operate as a structured compliance mechanism capable of materially reducing the volume of plastic packaging entering the environment.

2. Require producer responsibility for litter and marine debris cleanup costs

Cleanup of RMA-covered-product leakage in Oregon is estimated to cost $9.6 million to $22.8 million a year, compared with current statewide cleanup expenditure on all litter of $12.6 million to $16.9 million. Litter and marine debris cleanup in Oregon is currently funded primarily through public-sector resources, including state and local government funding. Oregon could establish financial contributions from producers toward the costs of litter and marine debris management, in proportion to the presence of their products in the environment. Such an approach aligns with the principles of extended producer responsibility and provides sustainable long-term funding for cleanup and mitigation. Although it would not directly reduce the volume of leakage, it would increase statewide cleanup capacity.

Additional measures to expand producer responsibility for marine debris and litter

The following recommendations could be established as additional responsibilities under Oregon's EPR framework, with producers supporting the implementation and costs of measures that address leakage from RMA-covered products.

3. Establish a statewide reuse policy for priority high-litter product categories

A coordinated statewide reuse policy can help to advance reusable systems for food serviceware and other on-the-go items that consistently contribute to litter. This measure could include producer-funded infrastructure, return systems, and public education and behavior change, and apply to both dine-in and take-out contexts. By reducing reliance on single-use items, this approach could decrease leakage from some of the most frequently littered materials.

4. Expand litter interception and cleanup through targeted funding and infrastructure standards

Given that certain plastic materials will continue to leak into the environment even under strong prevention policies, Oregon can consider investing in downstream litter interception and cleanup, especially in sensitive ecosystems. This could include improving bin density and servicing, enhancing stormwater capture mechanisms, expanding street-level litter collection, and supporting targeted cleanup grants. These actions can reduce the amount of plastic reaching waterways and coastal environments and strengthen local government capacity to manage existing pollution.

5. Establish a statewide plastic leakage monitoring framework.

Accurate, Oregon-specific data is essential for effective implementation of the above recommendations. A statewide plastic leakage monitoring framework could provide consistent information on leakage quantities, material types, and marine debris and litter hotspots. This framework could support the design of fee structures, investment direction, evaluation of program performance, and help ensure accountability. While not itself a reduction measure, it is a critical prerequisite for informed policy development and implementation.

The five recommendations above take different approaches to addressing plastic leakage. Recommendations 1 and 3 focus on preventing materials from entering the environment in the first place. Recommendation 4 and the litter-cleanup component of recommendation 2 primarily aim to manage material after it has entered the environment.

These approaches serve different purposes and should not be viewed as interchangeable. The appropriate balance between prevention, interception, and other interventions is ultimately a policy and funding decision.

RMA-covered plastic packaging and food serviceware account for an estimated 2,467 tons of leakage each year. **Against this total, recommendations 1 and 3 could reduce leakage from RMA-covered packaging and food serviceware by an estimated 6% to 35%**. The wide range reflects the different policy design and fee-setting choices available, rather than uncertainty in the underlying leakage estimates.