

## Science and Knowledge in Plastics Detection and Monitoring

Detection and monitoring of plastic pollution play an important role in improving our understanding of how plastics enter the environment, move through natural systems, transform over time, and persist. Although plastics science is well established, detecting and measuring plastics—particularly at smaller sizes, lower concentrations, or within complex matrices—can present challenges. Variations in how plastics are detected, quantified, and characterized may hinder comparability across studies and monitoring efforts, which can create challenges in data interpretation. For example, it may be difficult to compare the results from a mass-based analytical method to those from a particle count method.

Enhancing sensitivity, specificity, and consistency of detection methods can help support the generation of credible, decision-relevant data. When methods vary, it can become harder to interpret the results, distinguish meaningful trends from background variation or to link observations with real-world outcomes.

Strengthening analytical methodologies, detection limits, characterization and monitoring capacity can also help anticipate emerging issues. This includes supporting earlier identification of new or evolving forms of plastic pollution, improving understanding of environmental and potential human-health implications, informing policy approaches to emerging topics, and helping align actions across sectors. It can also provide insight into where plastics may be leaking into the environment and where mitigation efforts may be most effective, supporting broader circular-economy objectives.

This breakout session provides an opportunity to explore ways scientific monitoring can continue to evolve in support of pollution prevention, environmental protection, and evidence-based decision-making, and how these considerations may be reflected in CaPSA.

### **Discussion Questions:**

#### **Question 1**

**Context:** Analytical methods for very small particles, especially sub-micron and nano-scale, continues to be technically complex, particularly in matrices such as sediments, wastewater, soil, and biota. Current limitations and the availability of

validated, scalable protocols can influence data reliability, comparability across studies, and the extent to which observations may be linked to exposure and effects.

**Question:** How can analytical methods for smaller plastic particles be further advanced so monitoring programs can capture forms most relevant for environmental and human exposure?

**Optional Probing Questions:**

- What aspects of current analytical methods create challenges for identifying particles at the smaller size ranges?
- Where are the greatest opportunities to enhance analytical methods—across environmental compartments or in relation to human exposure—and what steps could help strengthen confidence in results (e.g., improving sample handling)?
- What types of technical, methodological, or collaborative innovations might support expanded analytical capability in the near term?
- How might monitoring programs consider particles that fall below current detection limits while still producing credible and comparable data?
- What scientific developments could support the detection of real-world plastics that are chemically complex (e.g., weathered, additive-rich)?

**Question 2**

**Context:** Monitoring plastics across diverse environments can be complex because each compartment—soils, air, deep sediments, surface waters—behaves differently and is shaped by distinct physical, chemical, and biological processes. Continued enhancement of monitoring approaches can help ensure systems remain representative, comparable, and scalable across these varied settings.

**Question:** What factors in the public and private sectors may influence efforts to develop comprehensive, cross-compartment monitoring systems for plastic pollution—particularly in environments where monitoring activities are still emerging (e.g., soils, air, deep sediments)?

**Optional Probing Questions:**

- What scientific considerations affect our ability to ensure monitoring data and measurements are comparable across different environments, laboratories, and monitoring programs?
- What types of reference materials or calibration resources could help further strengthen confidence in reported results?

- Which validation or quality-assurance approaches might support a more coherent national monitoring evidence base?
- What foundational datasets, harmonized metrics, or shared scientific frameworks would best support fate/transport modelling and policy assessment?
- What measurements or observation strategies could help build linkages across environmental compartments?

### **Question 3**

**Context:** Plastics undergo a wide range of transformations—from pristine to heavily weathered—and may contain, for examples, additives, pigments, coatings, or fillers, etc. As plastics degrade or transform in the environment, their physical parameters also change, which can influence how they are measured and interpreted. Advancing monitoring science to reflect this real-world complexity can support the production of meaningful and comparable metrics for decision-making.

**Question:** How can monitoring science evolve to capture the full complexity of plastics as materials, including weathering, multi-material products, chemical additives, and decreasing particle size, in ways that produce meaningful, comparable metrics?

#### **Optional Probing Questions:**

- Which aspects of material complexity (e.g., weathering state, additive types and concentration, particle size, multi-material composition) create the biggest challenges for current monitoring approaches?
- What kinds of indicators or measurement units (counts, mass, surface area, size distribution, polymer identity, weathering indices, form/shape) best capture the information that matters for fate, exposure, and effects?
- How might multi-modal or cross-platform approaches strengthen the ability to characterize complex materials?
- What shared frameworks or practices could help ensure consistency when monitoring increasingly diverse and transformed plastic materials?

### **Question 4**

**Context:** As monitoring programs continue to expand, they may benefit from strengthened scientific foundations such as tools, reference materials, validation practices, and calibration datasets that help maintain credible and comparable measurements over time and across regions. These elements also support connections between monitoring data, models, exposure assessments, and policy outcomes.

**Question:** What scientific tools, reference materials, or validation approaches could support a next-generation monitoring system capable of informing fate/transport models, exposure assessment, and policy evaluation across all sectors?

**Optional Probing Questions:**

- What types of reference materials or calibration standards would most support detection and quantification across different platforms and laboratories?
- Which validation practices (e.g., interlaboratory comparisons, proficiency testing, uncertainty characterization) are most helpful for credible reporting?
- How might monitoring systems be designed to detect change over time and better understand how those changes relate to specific policy actions or interventions?

## Exposure and Potential Impacts

Under Theme 2 of CaPSA, the overarching goal is to increase understanding of the impacts of plastics and plastic-associated chemicals on wildlife, human health, and the environment.

Understanding the characteristics of plastics exposure, as well as the potential hazards associated with different types of plastics, is essential for addressing scientific and regulatory challenges. Science related to the exposure and occurrence of plastics in humans, wildlife, and the environment provides an improved understanding of where plastics may originate and how they travel through the environment to receptors. Similarly, science to characterize hazards can help our understanding of which subpopulations may be more sensitive to exposure. To characterize the hazards posed by plastics, knowledge of the composition of plastics relevant to potential exposures from food (including traditional subsistence foods), drinking water, and the environment is needed to inform the design and interpretation of toxicological studies.

The goal of this session is to discuss the current and emerging science most relevant to understanding how plastics and plastic-associated chemicals move through environmental systems, which can potentially result in ecological and/or human exposure, and how improved monitoring and data collection can strengthen understanding of plastic pollution and its impacts. This includes consideration of diverse exposure pathways across ecosystems and populations, including Indigenous, northern, remote, and community-relevant contexts.

Advancing exposure science and informed monitoring frameworks supports Canada's broader objectives related to environmental protection, human health, and a circular economy for plastics. This discussion highlights the influence of emerging stressors, and approaches to measurement, modelling, data integration, and interpretation of health-relevant endpoints.

### **Discussion Questions:**

#### **Question 1**

**Context:** Available data investigating the potential ecological and human health impacts of plastics continues to grow, but more studies are needed, particularly for subtle, long term, cumulative, or indirect effects that are harder to characterize.

**Question:** What potential health or ecological impacts of plastics and associated chemicals remain least understood—and what types of scientific approaches or monitoring strategies could help improve our understanding in these areas?

**Optional Probing Questions:**

- What emerging issues require monitoring frameworks, and how can we prioritize those to effectively monitor where plastics have the greatest impact on the environment?

**Question 2 - Potential Impacts Across Ecosystems and Lifecycles**

**Context:** Plastics and plastic associated chemicals interact with ecosystems in ways that may generate impacts that have not yet been fully recognized—from climate change and biodiversity loss or cumulative stress in wildlife to altered ecosystem functions. Further discussion around the science is needed on species, habitats, and exposure scenarios, particularly where impacts arise indirectly (e.g., changes to food webs, nutrient cycling, or habitat conditions). These potential impacts may only become visible when multiple lines of evidence—ecological, toxicological, and observational—are integrated.

**Question:** How do other factors like climate change, biodiversity loss or others contribute to unknowns and the need for science in understanding emerging impacts from plastics pollution or waste? What are other emerging factors influencing impacts, and what is the role for science in identifying and informing responses to those less well known or unknown issues?

**Optional Probing Questions:**

- How can existing and emerging data be used more effectively to support decision-making? What opportunities exist to improve data systems and integration as the science advances?

**Question 3**

**Context:** Exposure assessment continues to evolve as researchers develop new approaches to understanding how plastics and associated chemicals move and change in the environment. As methods advance, there are opportunities to explore how sampling, sample preparation, analytical tools, and modelling practices can best support clear and comparable results. Ongoing work across the scientific community offers many possible paths for strengthening the coherence and interpretability of exposure data.

**Question:** What scientific or technical factors currently make exposure assessment challenging, and where might improvements be most helpful?

**Optional Probing Questions:**

- In what ways do sampling, sample preparation, or analytical methods, create uncertainty?
- Where and what type of information on fate, transport, degradation, or bioavailability is needed to support clearer interpretation of exposure and impact findings?
- What would help improve our ability to assess combined or long-term exposures, and what should be prioritized to advance work in these areas?

**Question 4**

**Context:** Many different Indigenous groups, communities and knowledge systems contribute important perspectives to understanding environmental exposure and impacts. Each brings its own methods, experiences, and ways of knowing, offering a range of insights.

**Question:** How do differences across Indigenous groups, communities and knowledge systems influence how we understand environmental impacts, and where are opportunities to collaborate or co-develop?

**Optional Probing Questions:**

In what ways do academic, regulatory, industry, or Indigenous community approaches differ, and how might these differences affect interpretation or synthesis?

- How could observations and knowledge from Indigenous communities be respectfully bridged, braided, and woven with Western scientific approaches to highlight exposure contexts that may be overlooked?

**Question 5**

**Context:** Improving how studies align with one another can be just as important as developing new technologies. Tools and mechanisms like shared reference scenarios, harmonized data collection, inter-lab comparisons, and established protocols can help enhance consistency across research efforts and increase the decision-relevance of existing studies.

**Question:** What parts of your research process offer the most practical opportunities for improving consistency across studies, and what steps could help support progress in the near term?

**Optional Probing Questions:**

- What are some adjustments in study design or reporting that could help strengthen environmental exposure characterization or modelling?
- Where might coordinated monitoring or shared methodological approaches be especially helpful?
- Could interdisciplinary or cross-sector working groups play a role in enhancing alignment?
- What types of partnerships, supports, or governance structures might help move this work forward?

## Plastic Design and Alternatives

Under Theme 3 of CaPSA, the overarching goal is to decrease the environmental footprint of plastics, including improving their design and enabling value recovery (e.g., reuse, repair, remanufacturing, recycling, and composting).

Innovation in the design and manufacturing of plastic resins, additives, and products is ongoing, and there are thousands of different plastics and plastic containing products on the market. Plastics and plastic products are often developed to meet specific performance requirements, such as to increase strength and durability, extend the shelf life of perishable food, or reduce transportation- and manufacturing-related greenhouse gas emissions by reducing their size and weight. These are important objectives to inform plastic design; however, decreasing the environmental footprint of plastics also requires understanding how to advance science and continue to apply zero plastic waste principles into innovation and design.

Design choices made early in a product's life—such as material selection, additive use, and how components are combined—influence how plastics behave in the environment. The science on plastic pollution has grown and linkages to real-world environmental effects continues to evolve, requiring further consideration as we explore emerging issues around Canada's Plastic Science Agenda. Many studies evaluate individual polymers, additives or stressors in isolation. As a result, there is limited understanding of how design decisions influence exposure, environmental fate, and risk across a product's life cycle. Strengthening the integration of multidisciplinary scientific knowledge in plastic design can improve our understanding of the potential challenges and benefits associated with different materials and alternatives.

As our understanding grows, insights into how different plastic design elements influence durability, shedding, fragmentation, and chemical release can contribute to more informed choices. Given that decision-relevant data can differ across studies and contexts, assessments of whether a proposed alternative provides meaningful improvements—or may shift impacts—often involve working with some degree of uncertainty.

Advancing the science behind plastic design and alternative materials also presents an opportunity to explore ongoing challenges including understanding life-cycle impacts more fully and gaining clearer insight into how design decisions perform under real-world conditions. This session creates space for experts from multiple disciplines to

consider these questions together and to identify where additional scientific clarity or innovation could be most helpful. By integrating diverse perspectives, we hope to strengthen our ability to identify scientific information that informs designs and alternatives that reduce overall environmental impacts, while being mindful of potential trade-offs. The goal is to build on CaPSA and continue moving towards a more coherent, data-driven approach that continues to support sustainable alternatives in a circular economy.

### **Discussion Questions:**

#### **Question 1**

**Context:** Design features and materials play a role in how plastics and other chemicals break down in the environment. These considerations are increasingly informed by information generated on the potential health and environmental impacts of plastics across their lifecycle. It also draws on insights gained from examining production and waste streams, and from understanding end-of-life options that can support future value recovery. Growing awareness of which plastic products are commonly found in the environment, such as microparticles from textiles or tire wear, can also help inform product design in ways that can reduce unintended release and enhance opportunities for recycling.

**Question:** How can science and innovation inform materials, design or manufacturing processes to further support value recovery and/or circularity?

#### **Optional Probing Questions:**

- In what sectors or areas of design, materials, or manufacturing might science and innovation offer the greatest value?
- Where do opportunities exist for collaboration across sectors, including between public and private partners?

#### **Question 2**

**Context:** Plastics are materials composed of a combination of chemicals, primarily synthetic polymers made from repeating units known as monomers. In addition to polymers, plastics typically contain additives (e.g., plasticizers, flame retardants, stabilizers, pigments), processing aids (e.g., catalysts, heat stabilizers, lubricants), and non-intentionally added substances. These additives and other substances can potentially migrate and/or transform over time, including during use and from aging

processes. To support more informed choices, it can be helpful to think about mixtures as dynamic rather than static—so designers and assessors can better understand which substances may be present, change or form during real-world use.

**Question:** What scientific advances or processes could help deepen our understanding of real-world release, persistence, and the cumulative impacts of additives and chemical mixtures throughout the plastic lifecycle?

**Optional Probing Questions:**

- What kinds of future studies or observations would help us better understand how additives behave as products are used, washed, worn down, or discarded?
- Where do we need more information about how different chemicals or by-products interact with one another over the life of a product?
- What shared tools or simple resources (e.g., common vocabulary, data formats, examples) would make it easier for people from different sectors to compare findings and learn from each other?

**Question 3**

**Context:** Designing plastics that are both functional and sustainable involves navigating considerations such as material performance, additives, and recyclability, and often involves trade-offs between performance, cost, and environmental impacts. Understanding these factors more clearly can help identify where research and innovation may have the greatest potential impacts.

**Question:** What factors make it challenging to design plastics that balance functionality and sustainability, particularly when considering material selection, additives, and recyclability? Further, what research is needed on the development of alternative products that provide the beneficial functions of plastics while also reducing negative environmental and potential health impacts?

**Optional Probing Questions:**

- Where would clearer or more consistent testing (e.g., for shedding or break-down) help support design decisions across different product types?
- How might we develop simple and equitable approaches to assess common design trade-offs, such as those between durability and microfibre shedding, or between material reduction (e.g., lightweighting) and end-of-life recyclability?
- What kinds of information early in the design process would help people make more informed choices about materials or additives?

#### **Question 4**

**Context:** Keeping plastics out of the environment is a systems-level effort involving production, trade, retail, and end-of-life management. Extended producer responsibility (EPR) approaches may help support this shift when informed by strong scientific evidence about what effectively reduces environmental impacts.

**Question:** How might scientific evidence and life-cycle information help inform the design of extended producer responsibility (EPR) systems that keep plastics out of the environment and encourage safer materials, reduced packaging, and more circular designs?

#### **Optional Probing Questions:**

- Which indicators—beyond recycling rates—might help us understand the broader environmental performance of products in an EPR system?
- What types of information from producers, recyclers, or other partners would make it easier to compare products fairly across regions?
- How could tools like Life-Cycle Thinking be used in simple, practical ways to help evaluate different design choices within EPR programs?

#### **Question 5**

**Context:** Alternatives such as new materials, coatings, formats, or refill/reuse systems can offer the functions of plastic while potentially reducing environmental and potential health impacts. However, it is equally important to consider how these alternatives perform in other areas (e.g., durability, recyclability, end-of-life behavior) so that new challenges are not introduced unintentionally.

**Question:** What value can alternatives bring to support products that are informed by environmental protection goals, and what considerations or criteria could help assess and validate these alternatives?

#### **Optional Probing Questions:**

- What technical, economic, or infrastructure factors influence the ability to scale alternatives such as bioplastics, and how might scientific advances help address these considerations while avoiding unintended impacts?

**Question 6**

**Context:** Emerging research on alternatives and on the potential impacts of chemical additives in plastics can contribute to efforts to reduce plastic pollution. Collaboration across sectors can help align research with broader goals such as zero-waste approaches and life-cycle impact reduction. A shared vocabulary and consistent ways of presenting results can also make it easier to compare findings and support decision-making.

**Question:** What emerging scientific opportunities could help inform efforts related to plastic alternatives, and what considerations might support scaling up these efforts?

**Optional Probing Questions:**

- How might plastics manufacturing and design approaches take into account related environmental issues such as climate change and biodiversity loss?

## Plastics Waste Diversion & Value Recovery

Under Theme 5 of CaPSA, the overarching goal is to enhance the capture and value recovery of existing and future plastics.

Science can support the development of mechanisms and technologies that increase the capture of used plastic products and prevent their release into the environment. Improving the capture of plastics will require a better understanding of the current practices and opportunities for innovation, particularly in sectors that produce large amounts of plastic waste including the Industrial, Commercial, and Institutional (ICI), Construction, Renovation, and Demolition (CRD), and automotive sectors. A better understanding of how all sectors produce, use, collect, sort, and dispose of plastics is needed. This knowledge will inform the development of innovative systems, best practices, and incentives to improve diversion and enable value recovery, including the prevention of pellet and scrap loss during manufacturing or recycling. Waste diversion and value recovery depend on both the characteristics of materials entering the system and the effectiveness of the collection, sorting, and processing infrastructure that determines if materials are reintegrated into markets.

Although understanding has improved, further questions remain on where plastics flow, how material quality changes, and why performance varies across regions. Without this information, it is difficult to compare outcomes or identify the points in the system where improvements would have the greatest impact.

Strengthening the characterization of material flows, input quality, and treatment outcomes—and improving the linkage between product design and recoverability—enhances confidence in comparing outcomes and clarifies where different interventions are most effective. By bringing together expertise in materials science, analytics, operations, and modeling, this session aims to clarify what information already exists, highlight where additional research would be valuable, and identify practical indicators or reference points that could make comparisons more consistent across contexts. The goal is to move from isolated successes toward more coherent, decision-relevant insights that better connect design, infrastructure, and markets—supporting higher diversion, more reliable value recovery, and sustainable end-of-life choices.

**Discussion Questions:****Question 1**

**Context:** Science is important to support more efficient recovery of plastics from key entry points into the environment, such as microfibers lost to the environment through wastewater and its by-products. For plastics that have already been lost to the environment, technology and innovation are needed to collect and process plastic debris, such as fishing gear, from terrestrial and aquatic environments.

**Question:** How can science and technology improve plastics diversion and recovery before it enters the environment? For plastics already in the environment, what advancements have been made in collection or processing, and what more can be done to reduce plastic pollution, leakage, waste, or other plastic-containing streams from entering the environment?

**Optional Probing Questions:**

- Which design features (e.g., materials, surfaces, product construction methods) most affect sortability, contamination, or quality loss?
- What simple, shared information would make design insights more transferable without limiting innovation?
- Where can data and information from recovery operations (collection, sorting, reprocessing) be linked back to design guidance?

**Question 2**

**Context:** Mapping plastic material flows can be challenging because each stage of the system captures different kinds of information and relies on its own measurement conventions. Much of the available data on what enters, moves through, or exits the system is often collected for operational rather than analytical purposes, using formats that can be difficult to align. Many flow datasets also include limited details on losses, contamination, or changes in material characteristics. This can add complexity to the comparison of flows across different settings and make it harder to identify where improvements would have the greatest impact.

**Question:** How can we build a clearer picture of how plastics change and move through the system — from product use through collection, sorting, and treatment — so we can identify where the most significant losses, transformations, or recovery opportunities occur?

**Optional Probing Questions:**

- Which parts of the flow system (e.g., in use, collection, sorting, treatment) are the least understood yet the most decision-relevant?
- What minimal data and simple categories would make flow estimates more comparable across places and over time?
- How could information from different disciplines (design, analytics, field studies, modelling) be brought together to reduce key uncertainties?

### **Question 3**

**Context:** End-of-life options vary widely in performance and are often evaluated using different assumptions across the various recycling, recovery, and disposal pathways. This can make it difficult to compare results or determine when an option provides net benefits. Developing more standardized datasets on how materials behave during treatment—and on the quality and usability of recovered outputs—would support more balanced and reliable comparisons across end-of-life pathways.

**Question:** How can we more systematically measure and compare performance—across mechanical recycling, chemical recycling, composting, energy recovery, and disposal — in terms of material transformations, yields, degradation products and environmental outcomes?

#### **Optional Probing Questions:**

- Which measurements of performance and quality would most help compare end-of-life options across contexts?
- How can uncertainty be shown so comparisons remain transparent and credible?
- Where could field data from operations and monitoring be paired with lab tests to verify expected outcomes?

### **Question 4**

**Context:** Comparing results can be challenging when perspectives differ on which environmental outcomes are deemed most important or how they should be tested. Establishing clearer priorities for what to measure—and under what basic conditions—would help make data more comparable across pathways. This includes understanding how materials change, what may be released, and any by-products that could affect environmental health.

**Question:** Which measurements and reference conditions would be most helpful to prioritize so that results are more comparable across pathways and better support policy and investment decisions?

**Optional Probing Questions:**

- Which environmental outcomes would be most helpful to track across pathways (e.g., how materials change, what may be released, and any by-products)?
- What basic test conditions could support making results more comparable across different facilities and technologies?
- What information about inputs and processes should be documented so others can interpret or build on the results?
- How could uncertainty be communicated in a way that keeps comparisons transparent and credible?
- What short, practical trials could help validate how materials behave under real operating conditions?

**Question 5**

**Context:** Recovered plastics come from many different sources and do not enter processing as uniform materials. They can include a mix of polymers, additives, residues, colorants, and can have various histories of use and environmental exposure. During reprocessing, heat and shear can change their properties—such as viscosity, strength, and odor—while contamination and mixing may limit where outputs can be used. Because studies track these factors in different ways, it can be difficult to compare results or understand how quality will hold up over multiple cycles.

**Question:** What scientific research is needed to better understand how polymer properties, additives, contamination, and processing conditions affect recyclate quality through multiple cycles—and how these factors shape which end uses are technically feasible?

**Optional Probing Questions:**

- Which input characteristics (e.g., polymer type, additives, residues, colour) best predict the quality of outputs after reprocessing?
- What practical quality metrics would help buyers and sellers compare the performance and quality of recyclate materials across suppliers?
- Under what shared testing conditions should materials be evaluated so results are comparable and helpful for selecting end uses?
- Where could controlled trials provide insight into how specific design choices (e.g., labels, inks, closures, multilayers) affect output quality and potential end-use applications?

**Question 6**

**Context:** Data relevant to plastics—covering design, feedstock characteristics, processing conditions, and end-of-life outcomes—often sits in separate systems and uses different labels and units and varies in how well it is documented. If important descriptors are missing, it can make it difficult to reuse datasets, test models, or compare studies across regions and facilities.

**Question:** What data structures or reference conditions would best support plastics-science research—so that measurements of polymer properties, processing conditions, contamination profiles, and end-of-life outcomes can be compared, modelled, and reused across studies?

**Optional Probing Questions:**

- What minimum metadata would allow others to reuse a dataset without locking in one method or model?
- Which benchmark scenarios (materials × system settings × treatment options) would anchor method and model development?
- What basic practices would make datasets easier to find, understand, and reuse across disciplines?
- What simple QA/QC practices (e.g., basic checks, clear documentation) would help raise confidence when studies are compared side-by-side?

## Emerging Issues

Throughout the symposium, we've heard a wide range of perspectives on plastics—how they move, transform, interact with systems, and appear in unexpected places. Taken together, these discussions point to areas where emerging science — including new research directions, methodological innovation, and advancing technologies — will be needed to continue to support evidence-based decision making.

CaPSA is a framework that represents the priority science needed to identify and address the effects of macro-, micro- and nanoplastic plastic pollution, and to achieve a circular economy for plastics. CaPSA's science goals and needs are categorized into five complementary themes, highlighting areas requiring more collective attention going forward. We've discussed these themes at length, which include:

- **Detection, quantification, and characterization of plastics in the environment** – Harmonizing / standardizing the detection, monitoring, and characterization of the sources, pathways, concentrations, and fate of plastics in the environment
- **Impacts on wildlife, human health, and the environment** – Increasing understanding of the impacts of plastics on wildlife, human health, and the environment
- **Plastic design and alternatives** – Decreasing the environmental footprint of plastics by improving their design and enabling value recovery
- **Sustainable use of plastics** – Supporting the informed and responsible usage and sustainable management of plastics
- **Waste diversion and recovery** – Innovating to enhance the capture and value recovery of existing and future plastics

While these themes cover a significant range of plastics science needs, the purpose of this breakout group is to reflect on the discussions throughout this symposium in the context of whether these themes should continue to exist as they are or if there are areas for improvement, expansion or potentially removal. Further to these themes, CaPSA covers key principles to support implementation including:

- **Collaboration:** A "whole-of-society" approach, involving federal, provincial, territorial, and Indigenous partners, academia, industry, and non-governmental organizations.
- **Knowledge Mobilization:** Ensuring research outputs are accessible and directly inform policymakers, industry, and the public.

- **Circular Economy Transition:** Shifting from a linear "take-make-dispose" model to a circular economy where plastics are kept in use.
- **Capacity Building:** Investing in infrastructure, training, and young researchers to increase Canada's scientific expertise in plastic pollution and management.

This discussion will also consider important mechanisms that can facilitate Canada's continued leadership in plastics science, ensure alignment with and timely consideration of emerging science, and continue to inform evidence-based policy decisions into the future. In doing this, we consider both emerging science challenges and how those are situated within CaPSA, as well as other broad considerations that may influence not just the themes, but the foundational principles that support implementation, including the potential for a future international agreement on reducing plastics in the environment. Lastly, we must also think about cross-cutting issues like climate change, biodiversity loss and pollution, and how we work together to effectively develop solutions through science and innovation that do not give way to negative environmental or human health outcomes.

#### **Discussion Questions:**

##### **Question 1**

**Context:** Plastic science continues to evolve, exposing new and emerging challenges. Plastics pollution is not a static issue and research will need to advance in tandem with policy and infrastructure planning. Across disciplines, scientific understanding in how plastics behave, appear, or interact with systems is shifting.

**Question:** What are some of the key challenges in science, innovation, and technology that potentially affect scientists' and practitioners' ability to keep pace with plastics pollution and waste issues?

##### **Optional Prompts (use only if needed):**

- What actions are required to mitigate some of these challenges, and are the mechanisms noted above (collaboration, knowledge mobilization and capacity building) comprehensive enough to facilitate and implement the goals of CaPSA or to ensure pace with this evolving issue?

##### **Questions 2**

**Context:** Plastics are turning up in remote, northern and Arctic regions. As plastics pollution reaches these regions and communities, new scientific challenges concerning fate, distribution and effects arise as well as the need to find innovative and meaningful solutions.

**Question:** How can science support environmental protection goals and how can we further ensure that Indigenous knowledge and science are meaningfully considered alongside western science?

### **Question 3**

**Context:** Several parts of plastics science are advancing or shifting rapidly — from the development of new polymer chemistries to our evolving understanding of degradation pathways under climate stressors, exposure mechanisms, and environmental transformation processes. Understanding which scientific domains are changing fastest helps identify where new issues could form before they can be recognized in monitoring or through an assessment process.

**Question:** Which areas of plastics science appear to be advancing or shifting most rapidly, and what scientific developments or environmental pressures are helping to drive those changes?

#### **Optional Prompts:**

- Where are you seeing rapid changes in our understanding of degradation behaviour, transport pathways, or transformation mechanisms?
- Are exposure science or detection methods revealing new patterns?
- What environmental or climate-related pressures (e.g., heat waves, wildfire smoke, UV extremes) are accelerating plastic transformation in unexpected ways?

### **Question 4**

**Context:** Emerging issues often become important not simply because of the initial signal we observe, but because they reveal moments when science, monitoring, or governance systems may need to be ready to shift their direction or adapt their understanding in response to new conditions.

**Question:** Where do you see the greatest need to scientifically or operationally pivot in the next 5–10 years?

#### **Optional Prompts:**

- What part of the system feels least monitored or least understood?
- Where might our current understandings be limiting how we respond as conditions continue to change (e.g., environmental conditions, plastics industry, trends, etc.)?

### **Question 5**

**Context:** This question is meant to draw attention to the scientific capacities we need in order to spot early signals of change and respond in a measured, informed way—keeping the discussion focused on what enables action rather than on any specific emerging issue.

**Question:** What kinds of evidence, tools, or coordination would most improve our ability to detect and respond to emerging plastics issues early?

**Optional Prompts:**

- Which scientific capabilities would help us prepare proactively for surprises?
- Where could new methods, shared definitions, or cross-sector collaboration aid science?
- What would make early signals clearer or more actionable?