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2025 Research Triangle Environmental Health Collaborative Summit on Local Solutions to a Global Problem: Microplastics in North Carolina

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Cover photo: Microplastics that cannot be recycled. Credit: iStock.com/Svetlozar Hristov

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Introduction

Plastics are a complex set of materials with thousands of different polymer formulations that also incorporate a large variety of chemical processing aids and additives. Microplastics are smaller than 5 micrometers (µm) and originate either from intentional manufacturing at that size (primary microplastics: personal care products, paints, glitter, etc.) or from the fragmentation of larger plastics in use or after disposal (secondary microplastics). Microplastics are ubiquitous contaminants in the environment, existing in aquatic and terrestrial ecosystems, in the atmosphere, and even in our drinking water and food. The recent discovery of microplastics in various biological systems, including human bodies, raises critical questions about long-term effects in ecosystem health and human well-being.

The exponential rise in plastic and microplastic pollution set the stage for this 2-day meeting, at which participants explored the current state of knowledge regarding the source and fate of microplastics, with a focus on environmental and human health impacts in North Carolina. The goal was to highlight (1) recent research in microplastic and plastic pollution and (2) actionable steps North Carolina can take to address these problems. To identify actionable steps, participants reflected on three guiding questions:

1. How might we integrate microplastics considerations into research in North Carolina?
2. How might we change manufacturing and procurement processes to reduce microplastics now?
3. How might research on microplastics inform better policies?

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Summit Overview

The summit gathered 100+ experts from government, industry, and academia to explore key issues, examine emerging solutions, and identify research gaps to reduce microplastic pollution. All of the completed speaker abstracts and the majority of the presentations can be found on the Research Triangle Environmental Health Collaborative website.

Day 1 featured 10 technical presentations, and three expert panels focused on the sources, identification, and fate of microplastics, as well as their environmental and human health impacts. These sessions provided critical context and established a common knowledge base for all participants.

Day 2 focused on moving beyond the surface to explore deeper insights. The agenda included two technical presentations and three "fireside chats" that offered participants a more personal look into the experiences and perspectives of the featured experts. The day concluded with dynamic, interactive breakout sessions. During registration, participants selected one of three breakout tracks—policy, industry, or academia—thereby allowing them to engage in discussions through the lens of their chosen stakeholder group.

Each breakout group addressed the same core question related to interventions for microplastic pollution, but from the perspective of their respective sector. Within these sessions, participants collaboratively generated and prioritized a set of innovative solutions. Each proposed intervention was evaluated based on feasibility and potential impact, resulting in the identification of both "quick wins" suitable for near-term implementation, and longer-term strategies requiring sustained investment and coordination. The findings from this structured and participatory process are presented beginning on page 9.

Call to Action: From Dialogue to Collective Impact

Over the course of this 2-day summit, participants from academia, industry, and government came together to grapple with one of the most urgent and complex environmental challenges of our time: microplastic pollution. Through open dialogue, collaborative brainstorming, and shared problem-solving, participants identified not only where efforts align, but also where combined strengths can generate the greatest impact.

These discussions made clear that no single sector can address microplastics alone. The solutions are inherently multidisciplinary and require coordinated governance, shared resources, and mutual accountability. What emerged was a road map grounded in consensus and driven by urgency.

- **Immediately actionable priorities** include cross-sector investment in programs that encourage consumers to adopt low-waste habits, scaling of reuse-and-refill systems, and enhancement of public awareness through improved communication strategies.
- **Medium-term goals** focus on expanding and refining Extended Producer Responsibility (EPR) policies, scaling technologies that are already working, and improving regulatory frameworks to support innovation and compliance.
- **Long-term transformation** calls for institutional reform, development of breakthrough technologies, and alignment of national policies with global environmental and public health goals.

The ideas generated during this conference are starting points for collaborative planning, sustained partnerships, and strategic implementation. The energy and insights shared must translate into action—grounded in science, informed by lived experience, and scaled through policy and innovation.

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DAY 1 – JANUARY 29, 2025

Opening Plenary – Global Context Setting

Speakers: LaShanda T. J. Korley, PhD, Director of Center for Plastics Innovation, University of Delaware; Danielle Holly, North American lead at the Ellen MacArthur Foundation; Sandy Skolochenko, North Carolina Department of Environmental Quality's Recycling and Materials Management Section

Key Insights

- **Dr. LaShanda Korley** emphasized that mixed materials, multilayer packaging, and chemical additives severely hinder plastic recyclability, underscoring the need for engineered solutions to build a truly circular plastics economy.
- **Danielle Holly** highlighted that despite growing investment in circularity, only 2% of plastics are recycled in closed-loop systems, stressing the importance of binding policy and corporate ambition working in tandem.
- **Sandy Skolochenko** illustrated North Carolina's resilience post-China's National Sword Policy, noting that 34% of recycling now stays in-state and supports a $3.21 billion recycling economy employing over 15,000 people.

Dr. LaShanda Korley set the stage by providing an overview of plastics' importance in society, exploring polymer and material function, discussing additives and complexities they present that hinder circularity, and discussing the importance of building a circular plastics economy through engineering and innovation. Dr. Korley also explored the complexity of plastic waste streams, which include mixed resin identification codes, multilayer packaging, and chemical additives. These factors make it difficult for recyclers to efficiently process materials. She noted that contamination from food waste further degrades the quality of recycled plastics, limiting their reuse in high-value applications. Dr. Korley concluded by showcasing emerging research from the Center for Plastics Innovation, which focuses on rethinking materials by linking chemistry and polymer physics to performance, redesigning production processes, and redirecting plastics toward new products by reimagining value chains.

Danielle Holly expanded on the systemic issues in the global plastics economy, noting that the circular economy is gaining momentum, as evidenced by 55% of US businesses announcing circular-economy targets and an estimated $140 billion in capital mobilized for the circular economy. A major challenge is that 40% of plastic waste ends up in landfills, while only 2% is effectively recycled in a closed-loop system. Ms. Holly shared the Ellen MacArthur Foundation's view for a new plastics economy, which hinges on six principles, including eliminating problematic or unnecessary plastic packaging; ensuring that all plastic packaging is free of hazardous chemicals; and guaranteeing that the health, safety, and rights of all people involved are respected. Ms. Holly discussed the *ambition loop*, meaning that binding policy and accelerated business action mutually reinforce and build on each other; and that industry partners become empowered to advocate for ambitious, economically driven policies.

To contextualize the global overviews shared by the previous speakers, Sandy Skolochenko walked participants through the state of plastics recycling in North Carolina, focusing on the key actions the state took before and after the 2018 China National Sword Policy, which sent shockwaves through global waste markets. As of 2020 (the latest available statewide data), 34% of the recycling in North Carolina remained in the state, with only 13% of its recycling being shipped internationally, signaling a great deal of investment in the state in domestic recycling. As evidence, the recycling industry counts 550 private businesses directly employing 15,700 North Carolinians, and contributing over $3.21 billion in economic activity.

Session 1: Source, Identification, and Fate

Speakers: Dr. Leah Johnson, Senior Director of Biomedical Technologies, RTI International; Dr. Taylor Maddalene, University of Georgia; Dr. Jack Kurki-Fox, Research Scholar at North Carolina State University

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Session 1: Key Themes and Recommendations

- **Dr. Leah Johnson** emphasized the urgent need for standardized testing and reference materials to improve detection and toxicity studies of micro- and nanoplastics, which often act as carriers of harmful chemicals.
- **Dr. Taylor Maddalene** showcased data-driven tools such as the Circularity Assessment Protocol and the Debris Tracker app, highlighting how local behavior mapping and artificial intelligence technologies are advancing circular waste solutions.
- **Dr. Jack Kurki-Fox** revealed that fine-mesh sampling detected 170 times more microplastics than a larger-mesh net in the Neuse River Basin, underscoring the pervasive nature of microplastics and the critical need for accurate environmental monitoring.

Dr. Leah Johnson highlighted the urgent need for improved detection methods. She emphasized that detecting microplastics and nanoplastics remains a significant challenge due to their wide variation in size, shape, and chemical composition. Although current analytical techniques can identify microplastics, the absence of standardized testing protocols makes it difficult to compare findings across studies. Dr. Johnson also distinguished nanoplastics from microplastics, noting nanoplastics' unique transport properties and capacity to penetrate biological membranes, which may lead to different toxicological outcomes. Her research addresses a critical gap by fabricating reference standards and generating well-characterized, monodispersed micro- and nanoplastic suspensions to support toxicological investigations. She further explored the role of microplastics as chemical carriers, or so-called "hitchhikers," which could transport toxins and heavy metals into ecosystems, potentially amplifying their environmental and health impacts. Dr. Johnson concluded by underscoring the need for standardized nomenclature as a foundational step toward advancing research, regulatory alignment, and mitigation strategies.

Dr. Taylor Maddalene presented on data-driven approaches to plastic waste management, emphasizing the role of digital tools and analytics in advancing circular-economy solutions. She highlighted the Circularity Assessment Protocol (CAP) as a key framework used to evaluate waste flows, plastic leakage, and community behaviors—insights that can inform local and regional strategies for circularity. She also showcased the Debris Tracker app, a citizen-science tool that enables individuals to contribute data on litter, helping to build a global database that supports both research and policy development. Emerging technologies are also playing a role: SpheriCity, a project supported by the National Science Foundation and led in part by the Circularity Informatics Lab at the University of Georgia, is leveraging artificial intelligence (AI) to help cities optimize material flows, reduce waste, and accelerate the transition to circular systems. Dr. Maddalene also referenced the development of an intervention library through the Circularity Informatics Lab—a collection of strategies being implemented in 51 cities that focus on reducing plastic production; improving waste management systems; and advancing the use of innovative, more sustainable materials.

Dr. Jack Kurki-Fox presented research on microplastic pollution in the Neuse River Basin. The study aims to measure plastic concentrations and understand how land use influences pollution levels. His team used two types of nets to collect samples and found that the finer mesh (64 μm, the width of a human hair) detected 170 times more microplastics than the larger one—highlighting how plastics degrade into tiny, nearly invisible particles. The study estimated that up to 230 billion microplastics flow into coastal waters annually, with urban areas and storm events contributing the most. The most common plastics were polyethylene, polypropylene, and polystyrene, all of which are widely used in packaging. Dr. Kurki-Fox emphasized that microplastics are everywhere, cannot be removed once they have entered the environment, and continue to accumulate. Given that half of all plastics were produced in the past 25 years, and that less than 10% of that amount has been recycled, the findings underscore the importance of effective sampling methods for accurate assessment.

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Session 2: Human Health Impacts and Environmental Justice

Speakers: Dr. Imari Walker-Franklin, Research Natural Scientist, RTI International; Hadley Hartwell, Laboratory and Research Project Manager, University of North Carolina at Chapel Hill; Chris Brown, Director of Research and Education, North Carolina Environmental Justice Network

Session 2: Key Themes and Recommendations

- **Dr. Imari Walker-Franklin** emphasized that a quarter of the 16,000 chemicals associated with plastics are potentially harmful. She called for standardized testing and long-term studies to better understand health risks from chemical mixtures.
- **Hadley Hartwell** presented evidence that polystyrene nanoplastics can disrupt placental gene expression and cell function, raising concerns about microplastic exposure during pregnancy.
- **Dr. Chris Brown** highlighted the disproportionate impact of plastic pollution on vulnerable communities, advocating for equitable, community-driven policies and practical solutions to reduce exposure and promote environmental justice.

Dr. Imari Walker-Franklin presented research on the potential health risks of microplastics and the thousands of chemicals they contain. Of the 16,000 chemicals associated with plastics, about 25% are considered chemicals of concern, including those that may disrupt hormones, cause cancer, or accumulate in the body. One example is 6PPD, a tire additive that transforms in stormwater into a toxic chemical linked to salmon mortality in the Pacific Northwest, thus underscoring ecological and human risks. Another is bisphenol A (BPA), a known endocrine disruptor which has been tied to reproductive and developmental issues, especially in children. In lab studies, aged plastic particles—particularly from tires—were shown to damage lung cells, increase inflammation, and release harmful chemicals. These effects varied by plastic type, color, and age. Dr. Walker-Franklin emphasized that chemical mixtures can behave unpredictably and that many of these substances have not been thoroughly studied. Her findings highlight an urgent need for standardized testing, long-term exposure studies, and increased scrutiny of chemical mixtures and transformation products affecting both humans and ecosystems.

Hadley Hartwell presented research on how microplastics—specifically, polystyrene nanoplastics, commonly derived from materials like styrofoam food containers—can affect the human placenta, with implications for maternal and fetal health. The placenta is vital for nutrient and waste exchange and may also transfer environmental toxins to the fetus. Recent studies have found microplastics in human placentas and newborns, prompting questions about their biological impact. In lab experiments, placental cells exposed to 50 nanometer (nm) polystyrene particles showed significant gene expression changes, even at low doses, particularly in genes linked to reproduction, hormones, and development. Higher doses also impaired cell migration, a key function in healthy placenta formation. Molecular analysis confirmed disruptions to pathways critical for cell growth and movement. These findings suggest that even low-level microplastic exposure during pregnancy could interfere with normal placental function, highlighting the need for further research into the health effects of microplastics on pregnancy and early development.

Dr. Chris Brown discussed how microplastic pollution moves through every stage of its life cycle, from manufacturing to disposal, impacting our land, air, water, and health. The presentation made the case for common-sense solutions that protect communities, especially those located near landfills, factories, and industrial sites. Drawing from historical examples such as Mossville, Louisiana, and neighborhoods in Durham, North Carolina, Dr. Brown showed how some areas have shouldered more of the pollution burden than others, without their residents having a voice in the decisions that affect them. Using the Environmental Kuznets Curve, Dr. Brown explained how economic growth and environmental responsibility can go hand in hand. The fact that there are *sacrifice zones*—areas with high pollution due to their location—underscores the need for fairer, more transparent policies that put

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communities first. The message was clear: We need to take responsibility for our environment, promote cleaner industry, and support practical solutions like reducing waste, recycling, and safeguarding health, especially for children and future generations.

DAY 2 – JANUARY 30, 2025

Session 3: Solutions—Technology, Regulatory, and Infrastructure

Fireside Chat: Microplastics Research Needs Within and Beyond North Carolina

A research-focused fireside chat with Dr. Barbara Doll (NC State University), Dr. Leah Johnson (RTI International), and Dr. Taylor Maddalene (University of Georgia) identified four key priorities to advance microplastics science, emphasizing interdisciplinary collaboration, emerging technologies, and the need for policy-relevant research within and beyond North Carolina.

1. Biological Pathways and Health Risks

There is limited understanding of how micro- and nanoplastics move through the human body—that is, how they cross membranes, accumulate in organs, and affect critical systems such as reproduction and digestion. To bridge this gap, researchers emphasized the need to leverage drug delivery research, adopt mass analysis techniques, and transition to in vivo models that reflect real-world exposure. Advancing this area would clarify the long-term health risks of microplastic exposure and support the development of more accurate toxicological assessments.

2. Standardized Methods and Detection Technologies

The lack of standardized sampling and testing protocols remains a major barrier to comparing results across studies. Tools like Fourier transform infrared spectroscopy (FTIR) and gas chromatography–mass spectrometry (GC-MS) have limitations in detecting smaller particles or identifying certain polymers. The panel called for clear, consistent protocols for particle-size measurement, filtration, and biological sample digestion. Innovations such as AI-driven detection tools could greatly improve the speed and accuracy of microplastic identification. Citizen-science initiatives offer promise, but they must be supported with clear standards to ensure usable data. Standardization would reduce contamination risks and improve the reliability of results across labs and regions.

3. Environmental Accumulation and Source Tracking

Microplastics accumulate in vulnerable ecosystems such as floodplains, estuaries, and urban streams, especially after storm events. Improved tools for tracking their movement, fingerprinting sources, and modeling environmental interactions are essential. The panel emphasized the need to design monitoring systems tailored to local environmental conditions, such as those found in North Carolina's coastal and riverine habitats. Scalable community-based monitoring programs, supported by researchers and agencies, could help fill data gaps and raise public awareness.

4. Regulatory and Policy Gaps

Despite growing evidence of harm, microplastics are not classified as regulated contaminants in stormwater or wastewater systems. Treatment facilities are not required to monitor or remove them, and industries face no mandates to limit emissions. The panel called for stronger policies that incorporate microplastics into existing water quality regulations—such as rules designed to control total suspended solids—and that create incentives for industry to adopt cleaner practices. Collaboration among academia, industry, and government is essential to ensure that research findings translate into actionable, enforceable regulations. International and interdisciplinary coordination will also be key, because plastic pollution transcends borders.

Turning the Tide: Industry Solutions to Reducing Plastic Waste

Dr. Jamie Pero Parker (Sustainability Lead, Innovation Advisors, RTI International) provided a nuanced analysis of the structural and operational challenges that industry faces in advancing a circular economy for plastics. Despite growing investment, progress is hindered by regulatory

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fragmentation, misaligned political and economic incentives, and limited geographic coordination. By presenting RTI's work with industry partners, she underscored the importance of multistakeholder collaboration to accelerate systems-level change. Key industry-led innovations include developing alternative materials (e.g., compostable plastics and paper-based substitutes), designing for recyclability through mono-material packaging and reduced use of additives, and expanding reuse-and-refill models that depend on consumer adoption and targeted behavioral incentives. She also pointed to the need for investment in recycling infrastructure, particularly in textiles and flexible films, noting that most plastics are not infinitely recyclable and may generate microplastics. Achieving a meaningful circular economy for plastics, she argued, requires integrated action across the value chain—uniting innovation, policy reform, and consumer engagement.

Fireside Chat: Industries' Efforts to Address Microplastics

An industry-focused panel featuring leaders from Procter & Gamble (Mark Agerton), Sonoco Products Company (Dr. Glenn Jordan), Becton Dickinson & Company (Amit Limaye), and Plastic Ingenuity (Zach Muscato) surfaced four core themes that define both the challenges and opportunities in tackling plastic pollution and advancing a circular economy.

1. Persistent Gaps in Microplastics and Nanoplastics Research

Across sectors, the panelists acknowledged significant gaps in understanding the behavior and impacts of micro and nanoplastics. Zach Muscato noted the challenge of identifying the sources and environmental pathways of microplastics, emphasizing that current tracking and fingerprinting methods remain underdeveloped. The group agreed that standardized testing protocols for detecting micro- and nanoplastics in food, water, and biological tissues are lacking, complicating both scientific assessments and regulatory responses. There was also concern that existing recycling processes may unintentionally generate microplastics, raising questions about the long-term efficacy of these processes. These gaps point to a critical need for interdisciplinary research—including toxicology, environmental science, and material engineering—to inform both risk assessment and innovation. Recommendations included increased investment in interdisciplinary research that draws from toxicology, environmental science, and materials engineering; the development of harmonized detection protocols across labs; and the creation of public–private partnerships to accelerate scientific innovation and cross-sector learning.

2. Systemic Barriers to Achieving a Circular Economy for Plastics

The panel highlighted a range of structural and logistical challenges preventing the transition to a circular economy. Mark Agerton of Procter & Gamble emphasized that while the company is targeting a 50% reduction in plastic use through redesign, geographic constraints (e.g., infrastructure disparities, climate, and consumer habits) limit the transferability of solutions across markets. He stressed that product reformulation, especially in personal care, must also consider regional water conditions, product stability, and safety, making the transition more complex than it may appear.

Amit Limaye from Becton Dickenson discussed the barriers within health care, including the fragmented regulatory environment around medical and biohazard waste, which varies by state and county, making it difficult to implement a uniform recycling strategy. Hospitals manage up to 10 different waste streams, and many staff are not trained to distinguish plastics that are recyclable from those that are not, resulting in significant volumes of recyclable materials being landfilled. Recommendations included advocating for EPR legislation to create accountability; supporting the development of localized circular-economy strategies; and investing in policy harmonization to enable smoother implementation of sustainable practices across jurisdictions.

3. Industry-Specific Challenges and Practical Constraints

The panelists agreed that each sector faces unique hurdles in tackling plastic waste. In health care, Amit Limaye noted that 80%–85% of plastic packaging used to maintain sterility never touches a patient—

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yet most of it ends up in landfills due to inadequate infrastructure and uncertainty about recyclability. The Healthcare Plastics Recycling Council, which Becton Dickinson supports, is working to build awareness, educate designers, and promote circular practices within the sector. Still, implementation is challenged by lack of investment in recycling infrastructure, the complexity of mixed-material packaging, and regulatory constraints tied to safety and efficacy.

In consumer goods, Mark Agerton highlighted the trade-offs in selecting alternative materials such as paper or biodegradable plastics. These alternatives often carry higher production and transport costs and may not be compatible with existing recycling systems. He also emphasized that material innovation must be guided by toxicological safety, particularly for products that come into contact with skin or water. Recommendations included investing in site-specific recycling infrastructure, training staff in proper waste sorting, and supporting material innovation that meets both environmental and performance requirements. Public–private partnerships were also encouraged to align industry needs with environmental goals.

4. Design Innovation and Supply-Chain Solutions

Glenn Jordan, Director of Technology at Sonoco Products Company, shared how packaging design decisions can significantly impact recyclability. He cited the example of black plastic food containers, which were once popular for their visual appeal but are undetectable by most sorting equipment, leading to high landfill rates. In response, Sonoco and its customers have shifted to alternative colors and begun removing problematic additives to improve recyclability.

Zach Muscato discussed how Plastic Ingenuity is investing in mono-material packaging, colorant-free plastics, and design-for-recyclability guidelines, while also collaborating with customers to build transparency across the supply chain. The panel also emphasized the need for digital tools to monitor plastic usage and promote material traceability from production to end of life.

On a broader level, the panelists supported policies such as EPR, noting that policy incentives, improved infrastructure, and behavioral interventions (such as consumer education and reuse incentives) are all needed to scale sustainable packaging and recycling solutions. Recommendations included embedding design-for-recyclability methods into product development, scaling traceability technologies, supporting infrastructure upgrades, and launching consumer awareness campaigns that could leverage influencers to shift behavior.

From Global to Local (NC): Policies to Address Plastic and Microplastic Pollution

Michelle Nowlin underscored the critical role of policy and governance in addressing microplastic pollution and its disproportionate impacts on marginalized communities. While existing laws like the Clean Water Act and Toxic Substances Control Act provide a regulatory foundation, they do not yet classify microplastics as pollutants, leaving stormwater and wastewater discharges unchecked. She highlighted the Save Our Seas Act as a positive but limited step, focused on cleanup rather than upstream prevention. Ms. Nowlin advocated for more comprehensive approaches, including EPR and adherence to international agreements like the Basel Convention (a treaty on the movement of hazardous and other wastes). She connected plastic waste to broader environmental justice concerns, noting that areas of waste accumulation, such as high-litter zones in Durham, often overlap with formerly redlined neighborhoods. She called for phasing out single-use plastics; improving product design; and ensuring that circular-economy policies promote transparency, accountability, and equity. Ultimately, she argued that governance must move beyond downstream solutions and support a circular-economy approach that integrates transparency, corporate accountability, and environmental justice.

Fireside Chat: Government's Role in Addressing Microplastics

During this fireside chat, panelists Michelle Nowlin (Duke University), Madison Haley (Haw River Assembly), Scott Cassel (Product Stewardship Institute), and Nina Butler (Stina Inc.) explored the barriers and opportunities for advancing microplastics policy in North Carolina and beyond.

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Four key themes emerged, each highlighting core challenges and actionable recommendations.

1. Strengthen Regulatory and Policy Frameworks

Michelle Nowlin emphasized the pressing need to modernize US environmental laws to reflect the realities of plastic pollution. As pointed out in other sessions, currently, microplastics are not classified as regulated contaminants under the Clean Water Act or Toxic Substances Control Act, leaving stormwater and wastewater systems unaccountable. In North Carolina, state preemption laws prevent local governments from implementing plastic reduction measures, thereby undermining community-driven efforts. The panel called for repealing these preemption laws, adopting EPR policies, and developing a coordinated national strategy that focuses on prevention, not just cleanup.

2. Build Public Awareness and Grassroots Advocacy

Madison Haley highlighted the invisibility of microplastics as a major barrier to public engagement. To build momentum for policy change, she stressed the importance of making the issue tangible—through storytelling, visuals, and hands-on community events. She encouraged local groups to host town halls and workshops and to facilitate direct communication between residents and elected officials. Personal stories, local data, and visible community concern could turn abstract environmental issues into political priorities.

3. Align Economic Incentives with Environmental Goals

Scott Cassel brought attention to the economic toll of plastic pollution on local governments. For example, the North Carolina Department of Transportation spends approximately $25 million annually on litter cleanup—a cost borne by taxpayers. Panelists recommended quantifying these costs to inform more compelling policy arguments. They also called for economic incentives for producers that reduce plastic use and that promote the adoption of sustainable packaging. By linking pollution reduction to cost savings and public benefit, governments could better align environmental objectives with economic realities.

4. Foster Cross-Sector Collaboration and Community Partnerships

Nina Butler emphasized the urgent need for standardized data and systems-level thinking to address plastic pollution. She highlighted how Stina Inc. tracks plastic flows and develops tools such as CircularityInAction.com, but warned that data and policy lag far behind plastic production. Butler also criticized the structural incentives that drive overproduction and underrecovery, calling for a "North Star" approach—a clear, overarching principle to guide all decisions, actions, and strategies toward a long-term vision rooted in transparency, accountability, and the rights of nature. By anchoring policy development to these values, Butler emphasized the need to shift plastic policy from waste management to ecological preservation.

Concurrent Facilitated Breakout Sessions: Exploring Solutions

During these interactive breakout sessions, participants used a creative matrix to explore how three different sectors—academia, industry, and government—can apply innovative technologies, policy and regulation, and funding mechanisms to address microplastic pollution. Cary Strickland, Dr. Edgard Ngaboyamahina, and Verone Bernard co-moderated the sessions, guiding participants through a structured discussion that highlighted both sector-specific strengths and shared priorities, thus laying the groundwork for the Actionable Strategies session.

Academia

Innovative Technologies

- Academic researchers can advance scientific methods to detect, track, and assess the risks associated with microplastics.
- Biologists and other scientists can develop and deploy innovative methods to track microplastics in the human body as well as in environmental pathways such as air, water, and food systems.
- Environmental scientists can research and establish reliable biomarkers to determine the origin and movement of plastics, thereby supporting data-driven regulatory decision making. Investigators

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can prioritize and investigate which microplastics are the most toxic or prevalent, ensuring that limited research resources address the most critical issues.

Policy / Regulation

- University-based specialists can produce high-quality research that directly informs environmental policies and guides future legislative frameworks.
- Policy experts can systematically evaluate existing environmental policies (e.g., the Clean Water Act, stormwater regulations) to identify and document gaps related to microplastics management.
- Investigators can communicate their research findings directly to legislators and policy advocates to bridge the divide between science and policy.
- Evaluation specialists can conduct systematic reviews of policy effectiveness, measuring outcomes to recommend data-driven changes that strengthen environmental laws.

Funding Mechanisms

- Colleges, universities, and aligned nongovernmental organizations can actively seek targeted, sustained funding opportunities to support ongoing research on microplastic pollution, and ensure that results are shared openly with the public.
- Academic institutions and affiliated consortia can leverage opportunities for multidisciplinary grants that connect health, waste management, and technology to broaden research impact.
- College and university faculty can establish partnerships with government agencies and private funders to turn laboratory discoveries into scalable, community-level solutions.
- Academicians can develop and disseminate clear, accessible summaries of research outcomes to educate and inform the community about both the challenges and the practical implications of the findings.

Industry

Innovative Technologies

- The private sector has both the capital and the operational reach to scale solutions across supply chains.
- Businesses can invest in filtration and detection technologies that prevent microplastics from entering water systems during manufacturing or post-consumer use.
- Businesses can develop and adopt nonplastic alternatives and reuse-and-refill models that reduce dependency on single-use packaging.
- Companies can also support transparency initiatives by making product chemical compositions public, contributing to safer design and innovation.

Policy / Regulation

- Industry can play a major role in both shaping and complying with policy.
- Companies can support EPR laws, which hold producers financially accountable for the end-of-life management of their products.
- Industry can incentivize reuse initiatives, offering discounts or rewards for consumers who participate in circular models.
- Forward-thinking businesses can move beyond compliance by voluntarily adopting higher environmental standards, setting industry benchmarks for others to follow.

Funding Mechanisms

- Industry can direct resources to where innovation is most needed.
- Corporations can fund start-ups, nonprofits, and academic laboratories developing microplastic solutions.
- Through grant competitions or innovation challenges, commercial firms can foster creative partnerships around waste reduction, filtration, and behavior change.
- Investments in consumer education campaigns can also shift purchasing behaviors and brand loyalty toward sustainable products.

Government

Innovative Technologies

- Government has the authority to fund, standardize, and scale new technologies.
- Agencies can prioritize nature-based solutions, such as wetlands restoration, which help capture microplastics before they reach critical ecosystems.

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- Agencies can fund research and development for biological remediation, such as studying plastic-eating microbes, while regulating any unintended consequences (e.g., methane release).
- Governments can enable the use of satellite data and AI to identify hotspots of plastic leakage and direct targeted interventions.

Policy / Regulation

- Public institutions have the power to set and enforce the rules of the game.
- Governments can implement bans on single-use plastics, improve stormwater and wastewater treatment regulations, and create eco-tax structures that disincentivize unsustainable production.
- Policy makers can pass ecocide laws and legally recognize the rights of nature, establishing accountability for environmental destruction.
- At the local level, municipalities can be empowered to pilot and fast-track remediation projects, while national policy sets broad standards.

Funding Mechanisms

- Governments manage public funds and can create financial conditions that either enable or block progress.
- By streamlining access to public funding, governments can ensure that communities, particularly under-resourced ones, have access to testing and cleanup technologies.
- Governments can invest in publicly available microplastic detection tools, leveling the playing field for municipalities, nongovernmental organizations, and researchers.
- Governments can fund public education campaigns, grant programs, and cross-sector partnerships that focus on awareness, behavior change, and environmental justice.

Concurrent Facilitated Breakout Sessions: Turning Ideas into Actionable Strategies

In these concurrent brainstorming sessions, participants evaluated the interventions developed during the previous solutioning discussions. Each idea was assessed using a two-dimensional framework. First, participants individually rated the relative impact of each intervention, focusing solely on its potential environmental or systemic benefit, while ignoring feasibility. Next, they assessed the relative difficulty of implementing each idea, considering factors such as cost, time, effort, technical complexity, and political barriers ignoring impact. This approach empowered participants to disentangle the desirability of an intervention from its practicality and collectively map ideas into four categories:

1. Best Bets – Relatively high impact and high feasibility: effective interventions that are practical to implement in the near term.
2. Moonshots – Relatively high impact but low feasibility: transformative ideas that face significant implementation barriers.
3. Low-Hanging Fruit – Relatively low impact but high feasibility: easier-to-implement strategies that offer incremental progress.
4. Low Priority – Relatively low impact and low feasibility: interventions that are unlikely to be effective or practical without further development.

Academia

Best Bets (High Impact and Feasible)

Priority actions include developing open-access tools and data-sharing platforms to promote transparency and collaboration, and improving marketing strategies based on behavioral science to influence consumer habits. Academic institutions can also help design and evaluate deposit-return systems and provide scientific backing for EPR frameworks.

Moonshots (High Impact but Less Feasible)

Forward-looking interventions could be developing biological remediation methods (e.g., plastic-degrading microbes), expanding EPR into more resistant political and commercial settings, and scaling nature-based solutions. The adoption of legal innovations such as ecocide laws or assigning rights to natural entities was also viewed as potentially transformative, though requiring substantial advocacy and legal reform.

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Low-Hanging Fruit (Lower Impact but Feasible)

Academia can contribute through evaluating existing policies and environmental regulations for gaps and effectiveness. Supporting public communication efforts and increasing public understanding of scientific findings were also seen as relatively easy-to-implement but modest-impact strategies.

Low Priority (Low Impact and Low Feasibility)

Ideas considered difficult and less impactful included tracking plastic exposure using biomarkers and deploying microplastic detection tools without clear application pathways. Traditional educational efforts without strong behavioral components were also viewed as having limited effectiveness.

Industry

Best Bets (High Impact and Feasible)

The private sector can scale practical, high-impact interventions, such as encouraging cross-sector collaboration, funding innovation challenges, and shifting consumer behavior through positive marketing and incentives. Supporting pilot programs and sharing best practices within and across industries were also considered high-potential strategies.

Moonshots (High Impact but Less Feasible)

Expanding EPR across all product lines and markets, promoting nonplastic alternatives, and mainstreaming reuse-and-refill systems were seen as transformational but currently hindered by infrastructure, supply-chain dynamics, or regulatory complexity.

Low-Hanging Fruit (Lower Impact but Feasible)

Feasible but incremental strategies include offering consumer incentives for refill and reuse (e.g., reward programs), and investing in improved detection technologies. These interventions could help lay the groundwork for broader change, especially when paired with other systemic efforts.

Low Priority (Low Impact and Low Feasibility)

Technical solutions such as cost-effectively tracking plastic particles and monitoring chemical additives were recognized as scientifically useful but viewed as low priority due to high development costs and unclear pathways to immediate environmental impact.

Government

Best Bets (High Impact and Feasible)

Government agencies can focus on implementing incentive-based policies (e.g., deposit-return schemes), supporting collaborative innovation platforms, and deploying effective marketing strategies to change public behavior without blame. These actions would be feasible with political will and could yield substantial returns in the short to medium term.

Moonshots (High Impact but Less Feasible)

Policy innovations such as ecocide laws, comprehensive bans on single-use plastics, and scaling of nonplastic alternatives were seen as having transformative potential but also as being politically and administratively complex. These steps would require broad stakeholder engagement and long-term commitment.

Low-Hanging Fruit (Lower Impact but Feasible)

Governments can lead in conducting feasibility studies, streamlining public funding mechanisms, and implementing awareness campaigns tailored to diverse communities. These activities could build institutional capacity and public trust, even if their direct impact was limited.

Low Priority (Low Impact and Low Feasibility)

Investments in experimental remediation methods (e.g., microbes), or in high-cost detection technologies without clear integration into enforcement or public health strategies, were seen as less viable in the near term.

Conclusions and Cross-Cutting Insights

The prioritization of microplastic interventions across academia, industry, and government reveals both distinct roles and shared priorities among these stakeholder groups. While their tools, incentives, and time horizons may differ, several converging themes emerged that suggest clear opportunities for coordinated action.

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1. Shared Emphasis on Behavior Change and Reuse Models

All three groups identified interventions that influence consumer behavior—particularly through marketing, education, and incentive systems—as both high impact and feasible. The growing interest in reuse-and-refill models signals a collective recognition that shifting away from single-use plastics is both necessary and increasingly achievable with the right infrastructure, messaging, and policy support.

2. Support for EPR

EPR frameworks surfaced repeatedly across all stakeholder groups as a promising but complex tool. Academicians saw EPR as a policy mechanism deserving further study and refinement; industry representatives viewed it as a necessary though sometimes politically sensitive shift in accountability; and government officials acknowledged its potential for systemic change, particularly when embedded within broader regulatory and funding strategies. This alignment underscores the need for multisector dialogues to refine and expand EPR in ways that are equitable and enforceable.

3. Innovation is a Shared Priority with Distinct Pathways

Each group highlighted the importance of innovative technologies, but approached this concept from different angles:

- Academia focused on upstream research, including detection methods and biomarker development.
- Industry prioritized scalable technologies and pilot-ready solutions.
- Government emphasized funding access and equitable deployment, especially in underserved communities.

This divergence suggests the need for collaborative innovation platforms that link basic research, market testing, and public funding to accelerate adoption.

4. Feasibility as a Strategic Filter

Across all sectors, participants demonstrated a clear understanding of the gap between ambition and implementation. Many high-impact ideas such as ecocide laws, biological remediation, and comprehensive bans were consistently categorized as moonshots, reflecting shared awareness of the technical, political, and social barriers to large-scale transformation. These ideas were not abandoned but rather deferred, contingent on further research, policy reform, and public support.

5. The Role of Foundational, Low-Risk Actions

So-called low-hanging fruit interventions such as pilot programs, communication strategies, and policy reviews were not seen as transformational, but were widely acknowledged as necessary stepping stones. These actions can build the public approval, institutional readiness, and data foundations required for scaling more ambitious interventions.

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