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Commentary

Cleanups are an important part of the solution to global plastic pollution

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In addition to preventative solutions, cleanup of plastic pollution from the environment can mitigate further harm and inform upstream action. Following concerns regarding the potential negative impacts of cleanup, we provide recommendations to ensure that future cleanup efforts provide benefits to both people and the environment.

Urgent and coordinated action is required to tackle global plastic pollution. This is recognized through efforts to develop a Global Plastics Treaty, which have demonstrated that there is no one-size-fits-all solution. Within the portfolio of solutions are three broad strategies: plastic reduction, improving waste management, and cleanup of plastics from the environment. Plastic reduction and waste management are generally considered of highest priority.[1] Conversely, cleanup—particularly the use of cleanup technologies—has been framed as a distraction from upstream measures in scientific literature, policy documents, and the media (e.g., Helm and Richards,[2] Bergmann et al.,[3] Stuart,[4] and Stafford and Jones[5]). We agree that reduction and management are the priority. However, we believe that cleanup also plays a valuable role and should not be overlooked.

Plastic pollution is omnipresent across aquatic ecosystems and will continue to enter these environments, even with significant improvements in plastic reduction and waste management.[6] Cleanup is necessary to reduce the ecological, social, and economic impacts of plastic pollution.[7] Cleanup also facilitates data collection to inform upstream solutions, and community engagement to foster hope and empower positive change.

Here, we address the criticisms of cleanup and provide recommendations for a way forward. We aim to demonstrate that preventative solutions should happen *alongside* cleanup, not *instead of* cleanup. In tackling plastic pollution, the best results will be achieved when multiple strategies occur simultaneously, through widespread action with consideration for local needs and opportunities. We have no time to waste. Instead of a "No, but" approach, we need a "Yes, and" approach to reducing plastic pollution.

What is cleanup?

The two most common methods to remove plastics from the environment are manual and technological cleanups. Cleanup programs have various goals, including reducing risk for wildlife, data collection, community outreach, and improving aesthetics and safety. Manual cleanup, carried out by individuals, includes formal institutional programs and volunteer-powered events. Cleanup technologies capture and divert plastics from waterways, coastlines, or stormwater systems. They vary in sizes, materials, mechanics, carrying capacities, and cost. Examples include stormwater filters, booms, skimmers, remote-controlled or autonomous robots, bubble barriers, and vacuums. The variety in technologies facilitates a place-based approach customized to environment type, plastic accumulation, funding, and capacity for maintenance. Technologies can supplement manual cleanups in locations that are unsafe or challenging to access. Also, unlike humans, some technologies can function for 24 hours per day and via mechanical filtration and sieving can better capture microplastics from surface waters and sandy beaches that manual cleanups miss.

Do we need cleanup?

Plastic pollution has accumulated in the environment for decades. Every year, plastic waste leaks into the environment and approximately 9–23 million metric tons of plastic is predicted to enter global aquatic ecosystems[6] where it is ingested by wildlife, smothers habitats, entangles animals, spreads invasive species, leaches toxic chemicals and fragments into micro- and nanoplastics.[8] Plastic left in the environment continues to cause ecological harm. For example, a single abandoned fishing net is estimated to kill 556 marine invertebrates, 178 fish, and four seabirds on average before removal.[9] As such, we need cleanup. If we deprioritize cleanup, we are effectively agreeing to leave plastic pollution in the environment, knowing the harm it causes.

The co-benefits of cleanup

Cleanup has broader impacts beyond the physical removal of pollution (Figure 1). Data collection identifies local pollution sources, which can inform upstream solutions. Cleanup data can also inform risk assessments and monitor trends over time. For example, data on polystyrene foam waste collected by Mr. Trash Wheel informed a ban on disposable polystyrene foam products in the city of Baltimore in 2019. In the year following the ban, data from Mr. Trash Wheel revealed an >80% decrease in the number of foam containers collected from the harbor.[10] Success in one location can also

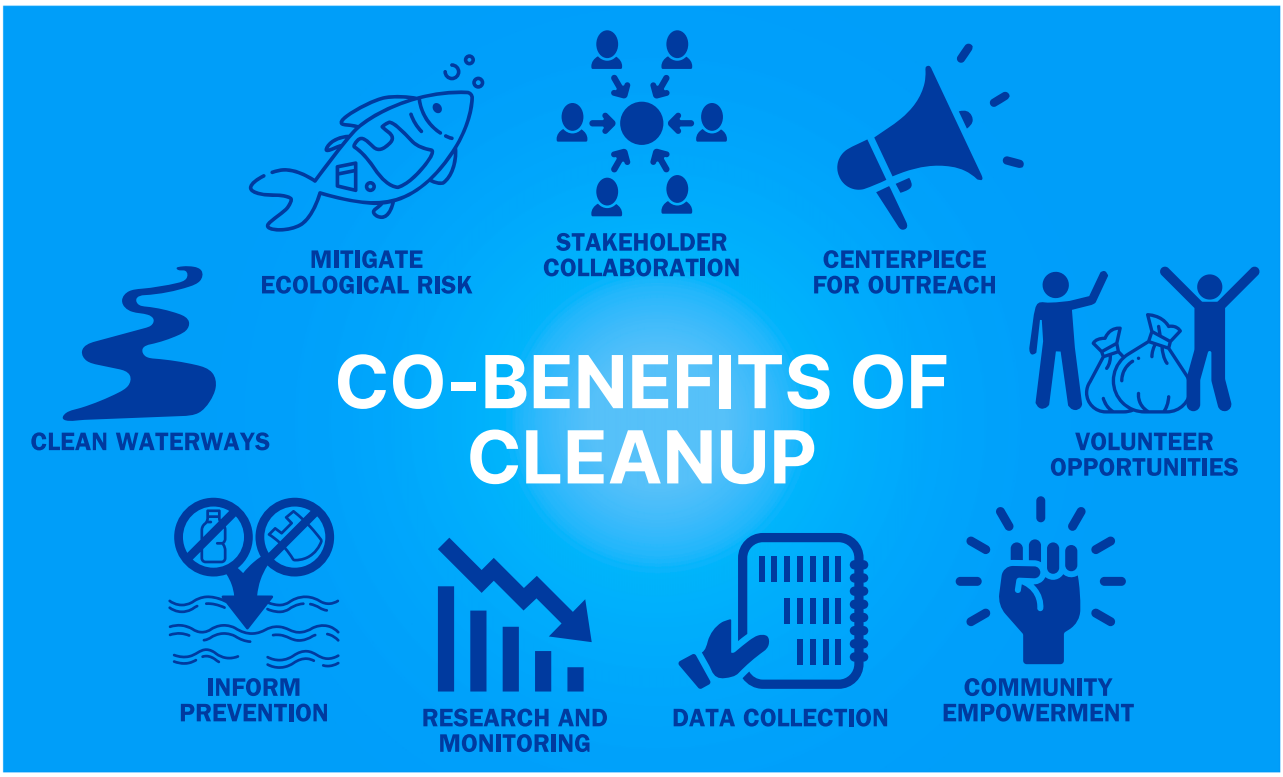

Figure 1. The co-benefits of cleanup

Removing plastic pollution from the environment not only mitigates ecological risk, it also provides opportunities for social benefits such as stakeholder collaboration, outreach, volunteer opportunities, and community empowerment. Data collection on the plastic removed through cleanup can support research and monitoring, inform prevention and policy, and document the efficacy of such interventions. All co-benefits contribute to cleaner waterways now and into the future.

catalyze progress elsewhere. In 2022, data collected during Ocean Conservancy's International Coastal Cleanup were used to highlight the presence of single-use plastics in the environment, informing successful plastic reduction legislation in California (Senate Bill 54).

Cleanup serves as a powerful platform for public communication about plastic pollution. Information sharing during cleanup events can clarify the broader context of cleanup in mitigating plastic pollution. The visually captivating appearance of some cleanup technologies captures public interest, including audiences with limited awareness of the issue. Furthermore, cleanup facilitates volunteer opportunities through assistance with waste and data collection. In some cases, cleanup technology maintenance and waste processing creates jobs for local community members, generating direct local benefits, for example the work of organizations such as Plastic Fischer.[11] Involvement in cleanup creates community, inspires hope, and empowers people to call for upstream solutions. For example, community organization Fight Dirty Tybee were so distraught by cigarette butt litter on beaches in Tybee Island, Georgia (USA) that they lined the walkway to their city hall with buckets full of cigarette butts collected during manual cleanups. This spectacle, combined with local cleanup data, helped push for a smoking ban on the island's public beaches, which passed in June 2022.[12]

Ensuring a net benefit

To end plastic pollution, we must use all tools available, including cleanup. However, there are concerns regarding potential negative aspects of cleanup,[2,3] including distraction from upstream solutions, greenwashing, the amount of plastic cleaned up versus the scale of plastic pollution, and wildlife and habitat disturbance. Below, we describe each concern and the type of cleanup it applies to, respond with our perspectives, and provide recommendations to ensure that future cleanups have a net benefit where the environmental, social and economic benefits outweigh potential costs.

Cleanup as part of a strategy, not a distraction

As cleanup is a downstream solution, it has been described as a distraction from the root cause of plastic pollution, addressing the symptoms of plastic pollution but doing little to prevent the root cause. Of course, we should prioritize plastic reduction and waste management[3]; however, when run in parallel, both manual and technological cleanup have co-benefits that support these strategies including identification of pollution sources, monitoring trends, informing policy, community engagement, and increasing public awareness.

Cleanups can be vulnerable to greenwashing when funded by plastic-polluting industries.[2,3] Publicized actions from plastic producers to mitigate their environmental impacts can improve brand perception, such as brand-sponsored

cleanup technologies that gain media attention. However, many companies' financial reward from continued plastic production outweighs their concern over the impacts of plastic waste and willingness to change practices, often meaning these projects are short term and lacking strategy. Within the draft Global Plastics Treaty and in jurisdictions worldwide, there is support for cleanup as part of extended producer responsibility (EPR). EPR and related financial mechanisms must ensure that polluter-funded cleanup efforts are meaningful and accurately reported, avoiding unfounded self-promotion. For example, plastic-producing companies could contribute to a fund that independently administers support to remediate past harms from across the plastic life cycle, prioritize communities and environments impacted the most by plastics, and support local data collection and education alongside cleanup to promote co-benefits. Plastic producers should also commit to meaningful changes in their business practices and contribute to upstream solutions, reducing the need for cleanup over time.

Target cleanup to achieve the greatest impact

The increasing amount of plastic entering the environment can make cleanup efforts seem like a losing battle. While small-scale cleanup efforts can still provide social co-benefits through education and community empowerment, cleanups can also be strategized to achieve the greatest impact. For example, cleanups should prioritize near-source, coastal or inland areas with large plastic inputs and/or accumulations that can be intercepted before traveling to the open ocean where cleanup is more logistically and financially demanding.[13] Visual audits, remote sensing methods, and data modeling (e.g., Ypma et al.[14]) can assist the identification of these high priority locations. Cleanup can also target specific items that are particularly harmful to wildlife (e.g., abandoned, lost or otherwise discarded fishing gear), be planned at times when plastic pollution is high (e.g., following rainfall) and prioritized where the greatest societal and ecological benefits can be achieved, including improved community health, local job creation, increased tourism, influence on policy action, and protection for ecologically important species.

Monitor and mitigate environmental impacts

Cleanup activities can negatively interact with wildlife through disturbance of habitats and accidental capture. Specifically, some cleanup technologies cannot discriminate between plastics, wildlife, and organic matter and can capture these simultaneously.[15] To mitigate this issue, cleanup technologies should be designed to prevent wildlife capture and used in scenarios with high plastic density but low opportunity for ecological harm.[16] The likelihood, extent, and impacts of wildlife interactions will differ for each scenario. Consultation with stakeholders, including communities with knowledge of the local ecosystem, can ensure that relevant organisms and habitats are considered when planning a cleanup activity and inform decisions on local thresholds for negative impacts. For example, Seabins installed along the Toronto harborfront, monitored by the University of Toronto Trash Team, capture mostly floating macrophytes by weight. Consultation with local conservation organizations concluded that these were invasive species, and the macrophytes entering the Seabins had previously become detached from the original plant structure. Thus, the local port authority welcomed removal of the decaying organic matter to minimize damage to boat propellors. Post-installation, cleanup technology users should report wildlife interactions including species, count, and mortality status to understand the implications and to facilitate evidence-based adjustments. In lieu of regulations such as bycatch limits, wildlife and organic matter deemed beneficial to ecosystem health should be returned to the environment following plastic removal. Most importantly, cleanup efforts using technologies that are negatively impacting wildlife should be relocated, use an alternative method (e.g., manual skimming with nets), or cease altogether.

Ensure the benefits outweigh the costs

The environmental, economic, and social costs of leaving plastic in the environment should be weighed against the cost of cleanup to ensure a net benefit,[3] particularly for technological cleanup programs that are larger in scale and long-term. To be environmentally and socially just, consultation among local stakeholders (device manufacturers, scientists, environmental and community groups, waterway users, affected communities, local governments) can ensure that feedback is heard and needs are prioritized. Together, stakeholders must consider the severity of local plastic pollution, patterns of plastic accumulation, ecosystem sensitivity, technology suitability, stakeholder involvement, short and long-term maintenance needs, education and outreach opportunities, data collection, and progress toward upstream solutions. Different aspects of the program can be led by different stakeholders, depending on their interests or areas of expertise. As an example of these considerations, the International Trash Trap Network (ITTN) has developed a checklist for guidance.[17] Public access to tools such as decision frameworks and cost-benefit analyses can also assist in the identification of appropriate cleanup technologies for different scenarios.[18] To support this, the efficacy of cleanup technologies should be independently verified, providing clear information about technology capabilities in specific scenarios (e.g., mass and count of plastics removed per unit effort and size capture limits).

Technological cleanup activities are currently unregulated (i.e., formal impact assessments are not legally required prior to or following cleanup). Moving forward, cleanup using technologies should demonstrate that the benefits outweigh the potential costs, from installation through to waste management. For example, Environmental/Sustainability Impact Assessments and Management Plans can be used. However, these processes should not impede the urgent need for cleanup or create barriers for community contribution to solutions. Exclusions may apply where the cost of an impact assessment exceeds the potential for risk, e.g., small-scale cleanups. Assessment frameworks should be developed through consultation with experts in the field, however formal assessment would require an independent body to define guidelines, methods and accreditation systems. Questions remain as to how this could be funded and managed.

There is no one-size-fits-all solution

Plastic pollution is a complex problem. As such, we should consider all strategies available to tackle it. While technological solutions should be viewed critically to

prevent unintentional harm, we must not let perfection become the enemy of the good. Concerns regarding cleanup should not devalue its use, but instead motivate improvements to current practices, elevating the benefits and mitigating the risks.

Cleanup is a long-standing practice in many communities, and technology provides a way to supplement manual efforts. To positively impact both people and the environment, cleanup of all forms should be prioritized in areas of the greatest need, locally focused, community led, and collaborative. To achieve a net benefit, we need an integrated approach toward cleanup that includes data collection, community education, and circular waste management. With this approach, the impact of cleanup is amplified and directed toward upstream solutions to prevent plastic pollution.

To solve our plastic pollution crisis, a coordinated global approach is needed that targets every phase of the plastic cycle. Alongside reducing production and improving waste management, cleanups are one of the tools in our toolbox to holistically address this problem. We must both turn off the plastic emissions tap and clean up our mess to prevent further harm.

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Conceptualization: H.D., C.M.R. Writing – original draft: H.D., C.M.R. Writing – review & editing: H.D., C.M.R., B.R.B., S.D., Z.T.D., R.F., R.F.G., G.H.L., N.J.M., C.S., S.W.

DECLARATION OF INTERESTS

S.D., R.F.G., C.M.R., C.S., H.D., S.W. and N.J.M. work and/or worked to run the International Trash Trap Network as part of Ocean Conservancy's International Coastal Cleanup. N.J.M. and S.W. work to run Ocean Conservancy's International Coastal Cleanup. B.R.B., R.F., and G.H.L. work for Ocean Conservancy, advising and/or communicating the work of the International Trash Trap Network and/or the International Coastal Cleanup.

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