Comparing the Costs and Benefits of Different Strategies to Reduce Microplastic Pollution

Microplastics are a ubiquitous environmental contaminant

Microplastics are small plastic particles <5mm in size and include a diverse range of polymers, shapes, colors, and chemical additives. Microplastics may be intentionally produced as pre-production pellets (e.g., nurdles) to manufacture other plastic products. More often, particles are generated when larger plastic items breakdown and fragment. Microplastics may be generated from virtually any plastic material or product, but major sources include single-use food ware packaging, clothing, plastic bags, and car tires. Microplastics are routinely found in surface waters, sediments, and air. While particle counts are often greatest near areas with large amounts of anthropogenic activity, plastic particles have also been found in deep ocean trenches and remote arctic regions. Thus, microplastics are considered a ubiquitous global contaminant.

Microplastics cause adverse health effects in aquatic organisms

Aquatic organisms are continuously exposed to microplastics. Many organisms may inadvertently ingest microplastics or mistake them for food items. Though most particles are thought to be egested within a few days, extremely small particles may translocate from the gut to other organs such as the liver or muscle tissue. Microplastic exposure has been shown to cause adverse effects as plastic particles may take up space in the gut, leaving limited room for nutritional food items, possibly leading to abnormal development, reductions in growth, or impaired reproduction. Alternatively, microplastic translocation may initiate inflammatory responses or the overproduction of free radicals, both of which can lead to cell and tissue damage.

What are the costs and benefits associated with different strategies to reduce microplastic concentrations in the aquatic environment?

Given the ubiquitous nature of microplastics and their potential impacts on aquatic organisms, the state of California is motivated to address microplastic pollution by reducing microplastic concentrations in coastal habitats. However, given the complexity and diversity of the production, use, and disposal of plastic, there are no clear, thoroughly investigated solutions known to lower microplastic concentrations. Thus, there is a need to determine the efficacy and potential costs associated with various approaches that have been recommended to reduce microplastic environmental loads*:

- Removal of microplastics from coastal habitats
- Increase plastic recycling in existing waste management streams
- Ban and/or replacement of select single-use plastic products with alternative materials
    - e.g., paper straws instead of plastic
- Capture of microplastics before release into the environment
    - e.g., installation of dryer filters to capture microplastic fibers

A comparative cost benefit analysis of strategies to reduce microplastic concentrations will empower environmental managers to make economically viable decisions while protecting coastal ecosystems

Understanding the costs and benefits of different strategies to reduce microplastic contamination will allow environmental managers to select approaches most appropriate with regard available funding, level of management action required, and the specific scenario at hand. This approach will allow microplastic pollution to be addressed efficiently with consideration to both cost and sustainability.

**This list is not an exhaustive list of proposed microplastic solutions.*