EFFECTS OF PLASTIC POLLUTION ON ARCTIC ANIMALS

SUMMARY FOR POLICY-MAKERS

ARCTIC MONITORING AND ASSESSMENT PROGRAMME

ARCTIC COUNCIL

AMAP

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KEY FINDINGS

PLASTIC POLLUTION IS OMNIPRESENT IN THE ARCTIC, WITH A RANGE OF NEGATIVE IMPACTS ON ANIMALS AND ECOSYSTEMS.

- Impacts of plastic pollution include entanglement of animals in nets and lines as well as the risk of starvation, internal physical damage, and physiological impacts from ingesting microplastics or larger plastic items.
- Potentially harmful plastic additive chemicals can leach out into the environment and can affect animals that have swallowed plastic particles.

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IMPORTANT GAPS IN DATA AVAILABILITY AND QUALITY HAMPER EFFORTS TO ASSESS IMPACTS AND RISKS ACROSS THE ARCTIC.

- Data on impacts of plastics on Arctic animals are relatively sparse, available only for some regions and a limited number of species.
- Inconsistencies in data quality and other factors across studies hamper efforts to assess risks.
- AMAP's analysis aimed to identify gaps in data, knowledge, and resources and develop recommendations to address them. This Summary for Policy-makers includes key recommendations for actions that can help close those gaps.

Lauren Divine

ENTANGLEMENT, PHYSIOLOGICAL IMPACTS FROM INGESTION OF PLASTICS, AND EXPOSURE TO PLASTIC ADDITIVE CHEMICALS ARE PRIORITIES FOR RESEARCH AND INTERVENTIONS.

- Based on currently available data and studies, plastic pollution may affect multiple species and ecosystems in the Arctic.

Iuliia Bogomolova

ACTION IS NEEDED TO PROTECT ARCTIC ANIMALS AND PEOPLE FROM DETRIMENTAL EFFECTS OF PLASTICS.

- Many of the species studied in this analysis play important roles in Arctic ecosystems and food webs, and are an important food source for people. Plastics in animals that are consumed by people can therefore also lead to human exposure.
- Communities that subsist on fish and other affected animals face potential risks to food security and safety due to impacts of plastic pollution on species and ecosystems.
- Even if the worldwide production of plastics is reduced, the breakdown of existing plastics in the environment will continue to create microplastics, underscoring the need to understand impacts of microplastics on Arctic animals, ecosystems, and populations and develop strategies to protect them.

WHY LITTER AND MICROPLASTICS ARE OF CONCERN IN THE ARCTIC

The production of plastics has grown rapidly since the 1950s, and plastic pollution has become a global challenge. Plastic particles vary widely in size and chemical constituents. Microplastics are less than 5 mm in size and found in effectively every habitat on the planet.

In the Arctic, plastic litter and microplastics pose risks to the health and survival of animals, with the potential for impacts on Indigenous Peoples and other populations that rely on affected species. The exposure to plastics also interacts with other stressors, such as climate change and toxic chemicals in the environment.

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In 2016, AMAP identified marine plastics and microplastics as emerging issues of concern in the Arctic due to their growing presence and potential for broad impacts on Arctic ecosystems. AMAP subsequently established a monitoring plan to organize data collection on plastic pollution across Arctic ecosystems in a coordinated and harmonized way, with a view to assessments of sources, transportation, trends, and effects.

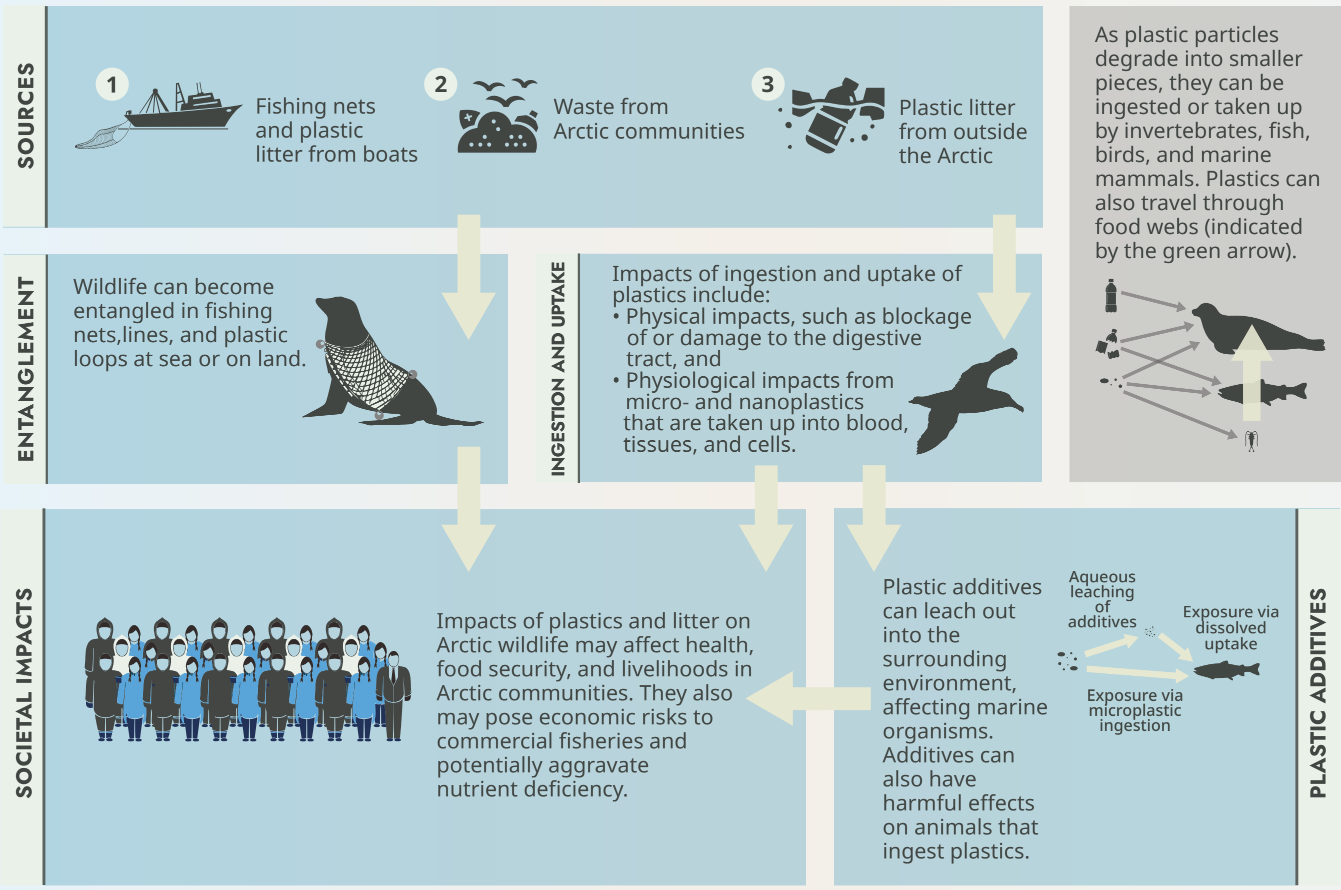
Plastic debris is present in most Arctic ecosystems, coming from local sources as well as through ocean transport from sources in lower latitudes. Small microplastic particles can also be transported through the atmosphere.

Although most Arctic animal species have not yet been examined for plastic ingestion, plastic particles have been found in many of the animals studied. Impacts of plastic pollution include entanglement, physical and physiological effects from ingested plastics, and potential toxic effects from plastic additive chemicals. The following sections of this Summary for Policy-makers discuss findings on these, along with identified gaps.

PREVIOUS AMAP AND ARCTIC COUNCIL RESOURCES ON LITTER AND MICROPLASTICS IN THE ARCTIC

- Overview of AMAP Initiatives for Monitoring and Assessment of Plastic Pollution in the Arctic (2021)
- AMAP Litter and Microplastics Monitoring Plan (2021)
- AMAP Litter and Microplastics Monitoring Guidelines, version 1.0 (2021)
- Review of Plastic Pollution Policies of Arctic Countries in Relation to Seabirds (2021)
- PAME Regional Action Plan on Marine Litter in the Arctic (2021)

IMPACTS OF LITTER AND MICROPLASTICS ON ARCTIC BIOTA

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ENTANGLEMENT

Plastic loops and lines present physical risks to animals in the Arctic. The entanglement of marine animals, including corals, crustaceans, and fish, in abandoned, lost, or otherwise discarded fishing gear is a major concern. Marine mammals and seabirds can also become entangled in floating plastic litter as well as in plastic debris that has washed ashore. Birds may incorporate plastic debris in their nests, which can lead to entanglement of adults as well as their young.

AFFECTED SPECIES

Studies have reported entanglements of at least 12 marine mammal species, three terrestrial mammal species, and 24 seabird species in the Arctic. Some records also report entangled corals, crustaceans, and fish at the bottom of the ocean.

IMPACTS

Entanglement effects vary by type of species. In seals and other marine mammals, entanglement in marine debris may lead to lacerations, which can result in infection and loss of limbs. Entanglement often causes reduced mobility, higher energy requirements (due to the increased effort involved in moving), and reduced foraging capacity. Both entangled mammals and birds are more vulnerable to predators and are at risk of drowning, and entangled organisms on the sea floor such as groundfish, crabs, and lobsters face higher risks of starvation. It is difficult to assess the number of animals that have drowned due to entanglement and subsequently decomposed before their mortality can be observed and documented.

Lauren Divine

GAPS

Data on entanglement are based mostly on opportunistic observations (mainly of marine mammals) by researchers and community members, so the frequency of entanglement, the number of species affected, and the locations in which entanglements occur in the Arctic cannot yet be characterized. No common or standardized databases are yet available to collect information on entanglement of Arctic animals. The datasets that do exist are generally at local or regional scales, and the lack of standardized methods for sampling and reporting prevents quantitative analyses.

The lack of harmonized circumpolar entanglement data and the difficulty of accessing entanglement data across many databases are the main gaps that must be addressed before researchers can understand the extent, frequency and impact of entanglement in the Arctic.

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Jakob Strand

INGESTION/UPTAKE

Ingesting plastic can have harmful and sometimes fatal effects on animals. The potential impacts of ingestion/uptake can be divided into two main categories: physical impacts (e.g., blockage of or damage to the digestive tract) and physiological impacts (from microplastic particles or chemicals in plastics, which can also be taken up through respiration, gills and other avenues).

Physical damage from ingesting plastic has been studied in only some species and geographic areas.

Physiological effects from ingesting plastics (or by uptake through respiration, gills, and other avenues) include impacts on survival, growth, reproduction, metabolism, intestinal microbiomes, behavior, and oxidative stress, among other impacts.

AFFECTED SPECIES

In the Arctic marine environment, plastic items have been detected in mammals, birds, fish, and invertebrates. On land, polar bears, Arctic foxes, and wolves have been observed to consume plastics. However, as of 2023, most Arctic animal species have still not been examined for plastic ingestion.

Although plastics were found in many of the species examined, only a few studies reported indications of physical damage from ingested plastic (in birds). Some physiological impacts have been detected in fish and invertebrate species native to the Arctic in laboratory studies, and other field and laboratory studies have reported physiological impacts in birds.

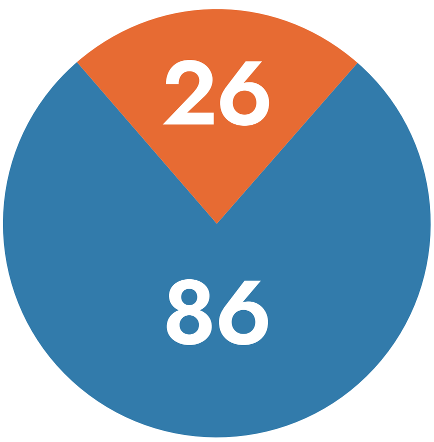
PHYSICAL IMPACTS

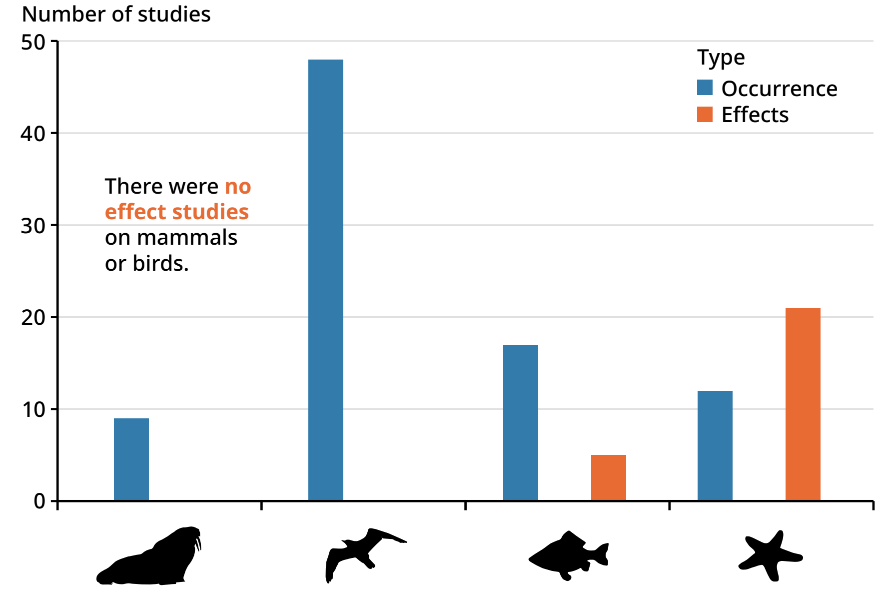
Outside of the Arctic, marine animals such as birds, whales, and turtles have been observed with lower food intake or starvation due to full or partial blockage of the digestive tract by plastics, and in some cases researchers suggested it may have caused mortality.

Some animal species have also been found with lesions in their digestive systems (e.g., turtles, birds, marine mammals) but internal damage to tissue is not necessarily common, even in locations with high levels of plastic ingestion. “Plasticosis,” in which seabirds that consume considerable amounts of plastic develop scar tissue in their digestive tract, has been reported only in laboratory studies and in one species of wild seabird in the Southern Ocean.

In the Arctic, given the limited evidence to date, physical damages from ingesting plastic seems to be uncommon. This may change in the future with increased shipping or development in Arctic regions.

23% OF IDENTIFIED STUDIES ON MICROPLASTIC IN ARCTIC-RELEVANT BIOTA ASSESSED PHYSIOLOGICAL EFFECTS.





OBSERVED EFFECTS IN ARCTIC SPECIES WERE ON:

- REPRODUCTION
- METABOLISM
- TISSUE CHANGES
- MOVEMENT
- MOLTING

PHYSIOLOGICAL IMPACTS

Ingestion and uptake of plastics can affect survival, growth, reproduction, metabolism, intestinal microbiomes, behavior, and oxidative stress, among other impacts. In species native to the Arctic, these effects have been observed in invertebrates, fish, birds, and mice; outside of the Arctic they have also been reported in other mammals and birds.

Emerging evidence suggests that smaller microplastic particles (e.g., less than 10 µm) may cause more negative effects than larger ones. Smaller particles can enter a wider range of organs compared with larger particles.

Microplastics can transfer across the food web as prey species are consumed by predators, and movement of ingested microplastics to other tissues has been documented in laboratory studies of fish and crabs, as well in wild-caught Arctic fish. Humans can be exposed to microplastics by eating seafood, and microplastics have been observed outside the Arctic in human breastmilk, blood, lung tissue, feces, and the endometrium. Microplastics were found in whale blubber, which could pose risks to Arctic Indigenous Peoples who rely on whale blubber as part of their traditional diet.

Human exposure to microplastics could lead to oxidative stress, inflammatory response, altered metabolism, disturbance of the gut microbiome, transfer of pollutants, neurotoxicity, reproductive toxicity, carcinogenicity, and effects on immune response. Adverse impacts of microplastic ingestion on fish populations may also affect human food security and safety, especially in Arctic communities with subsistence fisheries.

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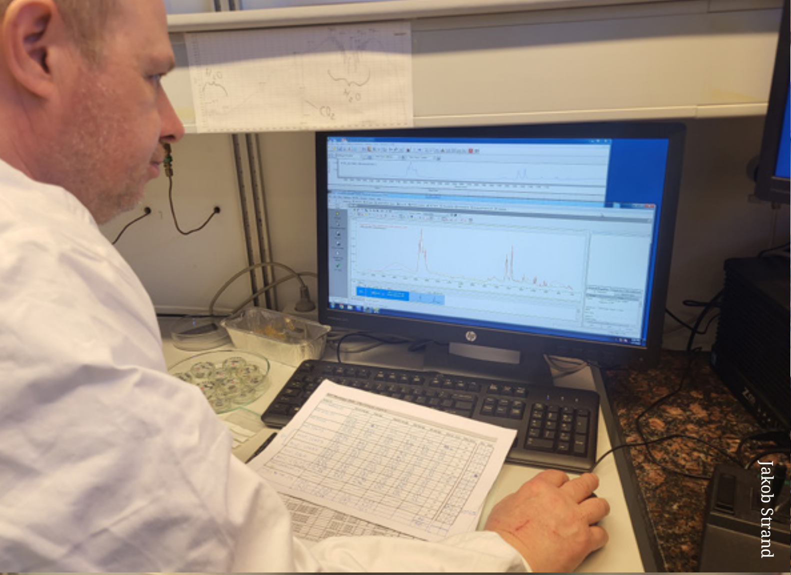

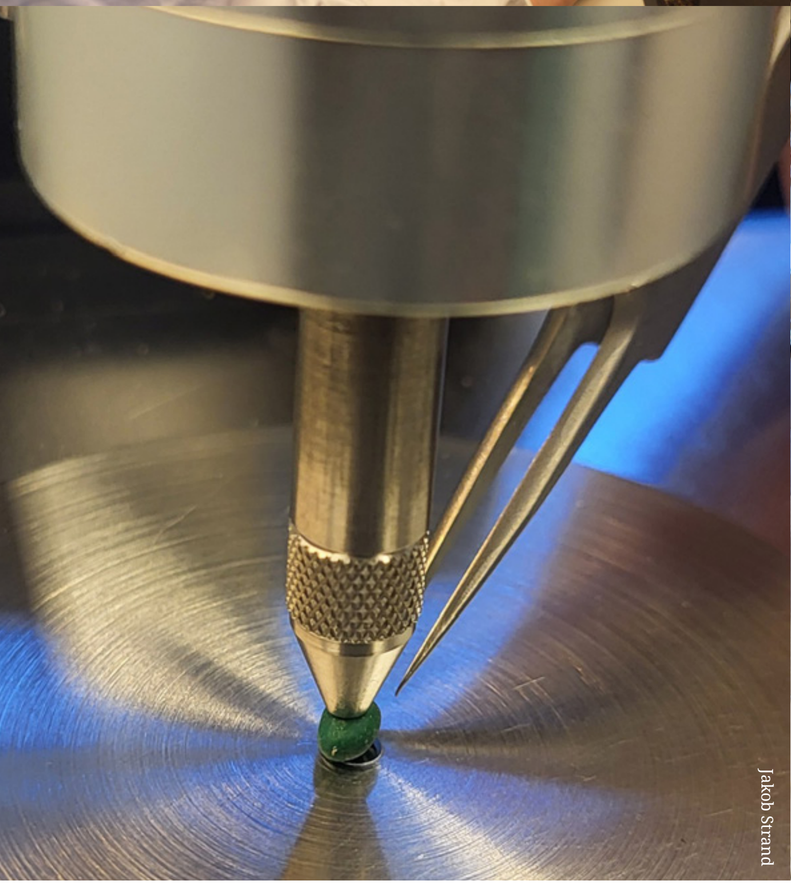

GAPS

In general, data on the effects of plastic ingestion in Arctic species are limited. Very little data are available from the Arctic, which has only been sampled in certain areas or opportunistically. Data on impacts of plastic ingestion are also very sparse for terrestrial species, except for laboratory studies on mice and rats. Currently, no common database exists for the collection of data on microplastic effects in animals.

Access to suitable Arctic sample types and sizes to study physical and/or physiological impacts of ingestion is a fundamental challenge. Further knowledge gaps exist with respect to plastic occurrence in different species, information on whether microplastics bioaccumulate, and which species are best suited as indicators of ecosystem pollution. Gaps also exist in our knowledge of the effects of concentrations and combinations of microplastics that have been measured in the environment on the physiology of organisms and ecosystems, as well as any interacting effects of multiple stressors.

It is crucial to ensure consistency between studies of occurrence of plastic ingestion and studies of the effects of plastic ingestion, in terms of matching the types of plastic, size, and composition. To enable these comparisons, occurrence data should be published with more details including metadata, and effect studies need to employ realistic concentrations, compositions, and long-term exposures.

PLASTIC ADDITIVE CHEMICALS

Plastic additive chemicals (hereinafter referred to as plastic additives) are intentionally added to plastics to achieve a desired effect during processing or to impart specific properties to the final products (e.g., flexibility, durability, and color). Plastic additives can affect Arctic animals that have ingested plastic particles. Furthermore, Arctic animals can be affected by exposure to chemicals that have leached out from plastics in the marine environment, or through consumption of other species that have been exposed to these chemicals.

A recent study identifying more than 16,000 chemicals used or present in plastic products noted that only 6 percent of these chemicals are subject to international regulation, and it found more than 4,200 plastic chemicals of concern due to their persistent, bioaccumulative, mobile, and/or toxic qualities. In some plastic products, plastic additives may account for nearly 60 percent of the total mass of the material. Toxic and non-toxic chemicals in the environment can also attach to plastic particles.

Common plastic additives include phthalates and bisphenol A, which studies have found to be associated with endocrine disruption and subsequent reproductive and developmental abnormalities in marine organisms such as fish and invertebrates. Antioxidants and UV stabilizers, which are used to prolong the life of plastic products, can also leach out and accumulate in marine environments. Preliminary studies suggest exposure to these chemicals could lead to endocrine disruption and oxidative stress in aquatic organisms.

Although studies have documented the presence of current-use plastic additives in Arctic animals, very few have examined the effects of exposure to these chemicals in the Arctic environment. In addition, it can be difficult to relate the occurrence of chemicals directly to plastic particles as their source. The studies addressing the physical effects of plastic on organisms, have not usually considered the impacts of plastic additives.

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AFFECTED SPECIES

Studies have documented the presence of plastic additives in a variety of mammals, birds, fish, and invertebrates. However, most studies do not identify the sources of these chemicals, so it is unknown whether exposure occurs through leaching from plastics to the environment, from ingestion/uptake by the organism, or through diet (i.e., through consuming other organisms that contain these chemicals).

IMPACTS

Studies on plastic additives in Arctic animals are few, and most only document their presence in Arctic species, not their impacts. Effects can be assumed, but to date there is little scientifically documented evidence for them. A higher presence of certain additives in some Arctic species and not in others suggests differences in exposure, uptake, and metabolization across species, probably linked to the individual chemical properties. One study on walrus and ringed seals found that the concentration of UV absorbents and industrial antioxidants known to occur in some plastics varied across tissue types, such as blubber, muscle, and liver tissue.

GAPS

One of the major gaps identified in this report related to plastic additives is that the effects on Arctic animals are still largely unknown, both for single compounds and mixtures. A related gap is the lack of data on local, regional, and pan-Arctic exposure of animals and human populations to plastic additives.

There is also a need to better understand the sources of plastic additives, including identifying chemicals from local sources versus those transported to the Arctic from elsewhere. The chemical properties and quantities of plastic additives in different plastic polymers remain poorly understood, and the leaching behavior of plastic additives requires more study. Data are also lacking on species-specific bioaccumulation vs. transformation of plastic additives.

PLASTIC ADDITIVE CHEMICALS CONSIDERED IN THIS ASSESSMENT

In the technical report on which this Summary for Policy-makers is based, AMAP assessed the state of knowledge on effects of plastic additive chemicals in Arctic animals. “Plastic additive chemicals” refers to chemicals intentionally added to plastic polymers during manufacturing. Although there are other chemicals associated with plastics (e.g., monomers, non-intentionally added substances, sorbed environmental contaminants), these compounds are not covered in this report.

Due to the large volume of plastic associated chemicals, AMAP assessed a pre-defined narrow scope of plastic additive chemicals that have not been commonly assessed by AMAP. This will provide a baseline understanding of the state of the science on effects of plastic additive chemicals in Arctic animals.

Additives considered in the technical report include phthalates, bisphenol A, organophosphate esters, UV filters and stabilizers, and substituted diphenylamine antioxidants (SPDAs). Formerly used additive chemicals that are banned today, such as certain flame retardants, were extensively evaluated in previous AMAP assessments and therefore are not included here.

RECOMMENDATIONS

Considering the need for urgent action to reduce Arctic pollution from plastic litter and microplastics, as well as to address the important knowledge gaps identified in this update, AMAP makes the following recommendations:

POLICY RECOMMENDATIONS

These recommendations are addressed to governments of Arctic States and observer countries.

SUPPORT EFFORTS TO REDUCE PLASTIC LITTER.

In March 2022, the fifth session of the United Nations Environment Assembly adopted a resolution to develop an international legally binding instrument on plastic pollution, including in the marine environment, to be based on a comprehensive approach that addresses the full life cycle of plastic, including its production, design, and disposal. In light of the impacts of litter and microplastics on Arctic ecosystems and people, Arctic Council Member States and Observers should support this and other international, national, regional, and local efforts to reduce plastic litter and to prevent the issue from becoming worse.

Chemical additives in plastics are not sufficiently regulated in any global, legally binding treaty. A provision on chemical additives as part of a comprehensive legally binding treaty on plastic pollution will be needed to ensure that these chemicals can be regulated effectively and efficiently.

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SCIENCE RECOMMENDATIONS

These recommendations are addressed to governments of Arctic States and observer countries, along with international and national research funding agencies.

ADDRESS GAPS RELATED TO ENTANGLEMENT.

- Increase efforts to systematically record observed entanglement events, capturing the date observed, species involved, location, entanglement material, and other key information.
- Focus efforts to harmonize and analyze data from existing databases to identify population-based effects.

ADDRESS GAPS RELATED TO INGESTION AND UPTAKE.

- Establish or enhance sampling programs in Arctic countries to acquire digestive tracts.
- Support Indigenous-led community-based monitoring including studies on effects of plastics.
- Encourage collaboration of different research environments, including collaboration with Indigenous-led community-based monitoring and industry (e.g. fisheries) to increase efforts for plastic identification. Develop or adopt standards for reporting plastic ingestion damage in animals that are aligned with existing global programs.
- Identify animals at high risk of exposure to microplastic pollution, as well as those that are human food sources and crucial parts of the traditional diet of Indigenous Peoples or are important for other reasons, and determine which species are more affected or sensitive than others.
- Analyze relevant tissues of animals at potentially high risk of microplastic pollution in relation to biomagnification, bioaccumulation, and human consumption.
- Begin monitoring efforts for plastics and related effects in Arctic animals to analyze trends.
- Conduct long-term exposure studies of Arctic animals to environmentally relevant microplastic levels and compositions, including studies of occurrence and physiological markers of microplastic exposure in the wild.
- Analyze impacts of multiple stressors, such as impacts of exposure to microplastics in the context of stressors from climate change, or the combined impacts of exposure to microplastics and chemicals.

ADDRESS GAPS RELATED TO PLASTIC ADDITIVE CHEMICALS.

- Clarify the definitions and categories of plastic additives.
- Expand ongoing monitoring efforts to include screening and/or monitoring for plastic additive chemicals.
- Include Indigenous-led community-based approaches in monitoring efforts for plastics in animals to ensure that food security and food safety perspectives are considered.
- Focus research on better understanding the environmental fate of plastic additive chemicals, including sources (near and distant) and long-range transport.
- Expand analytical approaches, methods, and tools related to plastic additive chemicals, including intercomparisons across laboratories.

AMAP, established in 1991 under the eight-country Arctic Environmental Protection Strategy, monitors and assesses the status of the Arctic region with respect to pollution and climate change. AMAP produces science-based policy-relevant assessments and public outreach products to inform policy and decision-making processes. Since 1996, AMAP has served as one of the Arctic Council's six working groups.

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