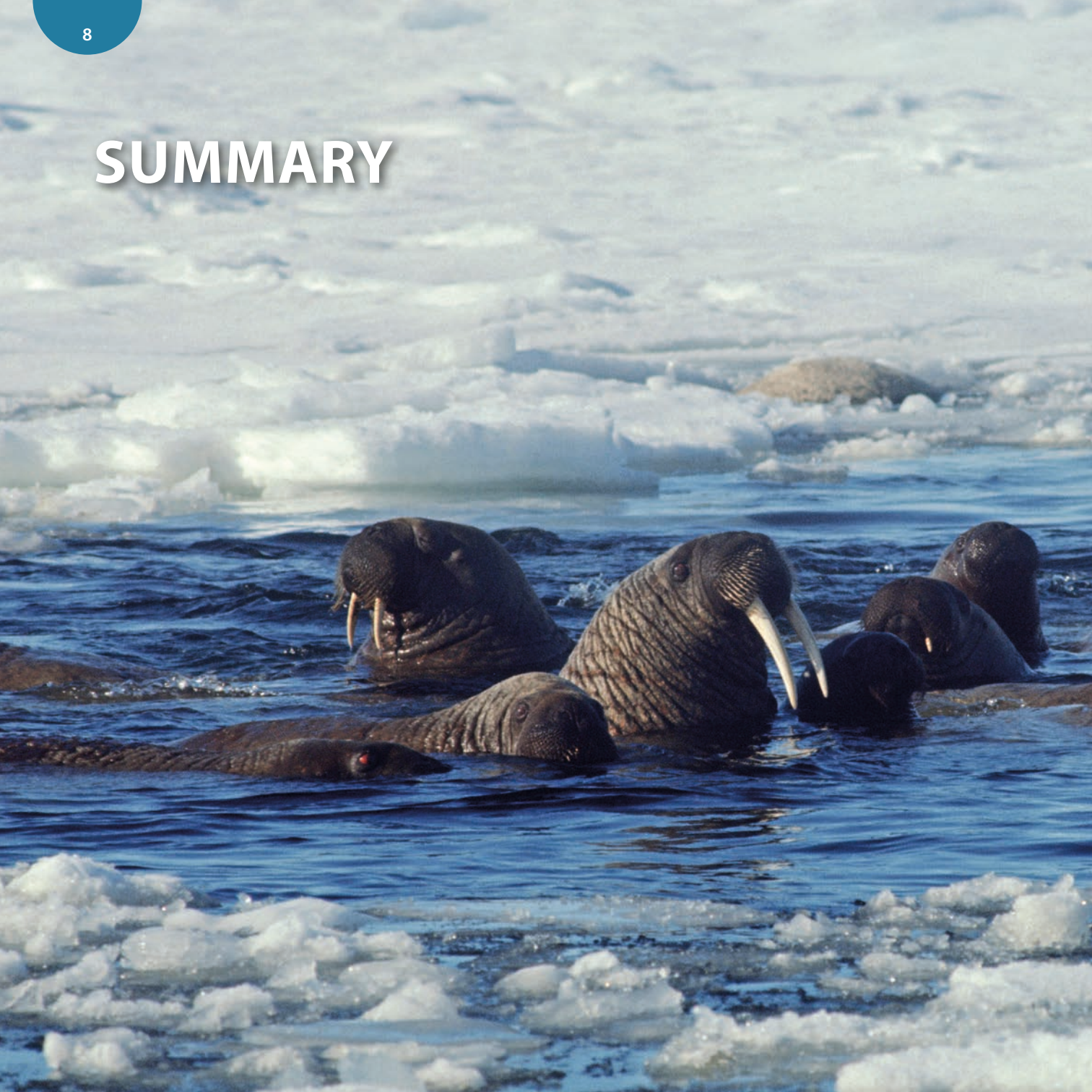
SUMMARY



Arctic biodiversity – the multitude of species and ecosystems in the land north of the tree line together with the Arctic Ocean and adjacent seas – is an irreplaceable cultural, aesthetic, scientific, ecological, economic and spiritual asset. For Arctic peoples, biodiversity has been the very basis for their ways of life through millennia, and is still a vital part of their material and spiritual existence. Arctic fisheries and tourism are also of particularly high value for the rest of the world, and so are the millions of Arctic birds and mammals migrating to virtually all parts of the globe during winter.

The Arctic is home to more than 21,000 species of often highly cold-adapted mammals, birds, fish, invertebrates, plants and fungi (including lichens) – together with large numbers of undescribed endoparasites and microbes. These include charismatic and iconic species such as polar bears *Ursus maritimus*, narwhals *Monodon monoceros*, walrus *Odobenus rosmarus*, caribou/reindeer *Rangifer tarandus*, muskoxen *Ovibos moschatus*, Arctic fox *Vulpes lagopus*, ivory gull *Pagophila eburnea* and snowy owls *Bubo scandiaca* together with marine and terrestrial ecosystems such as vast areas of lowland tundra, wetlands, mountains, extensive shallow ocean shelves, millennia-old ice shelves and huge seabird cliffs.

The functional significance of different groups of organisms in maintaining the integrity, structure,

Perennial as well as seasonal sea ice make up an important habitat for Arctic marine ecosystems, where polynyas and leads make room for diverse species assemblages of birds and marine mammals. Walruses in a lead in the summer sea ice in Baffin Bay. Photo: B&C Alexander/ArcticPhoto.com

services and health of Arctic ecosystems, however, is generally greatest among those we understand least. Microorganisms are key elements of Arctic ecosystems, yet they have been little studied.

Anthropogenically driven climate change is by far the most serious threat to biodiversity in the Arctic, and there is an immediate need to implement actions to reduce this stressor. Due to a range of feedback mechanisms, the 2 °C upper limit of human-induced warming, chosen by world leaders, is projected to result in an air temperature increase of between 2.8 and 7.8 °C in the Arctic, likely resulting in severe disruptions to Arctic biodiversity.

Climate change is the most likely explanation for shifts already visible in several parts of the Arctic, as documented by both scientists and Arctic residents. These include northward range expansions of many species and changes in ecosystems likely resulting from habitat warming and/or drying of the substrate associated with warming and earlier snow melt, together with development of new oceanic current patterns.

Future global warming will result in further northward shifts in the distribution of a great many species. This will include boreal species and ecosystems encroaching on areas currently characterized as the low Arctic, and low Arctic species and ecosystems encroaching on areas currently characterized as the high Arctic.

Northward movement of boreal species may increase the number of species found in the Arctic, but this does not represent a net gain in global biodiversity. The additions will primarily be species that are already common in southern habitats, some of which may outcompete or displace unique assemblages of Arctic species with the risk of severe range reductions and possible extinctions.

Terrestrial habitats in the Arctic are bounded to the north by marine ecosystems. Therefore, northward ecosystem shifts are expected to reduce the overall geographic extent of terrestrial Arctic habitats – in particular for high Arctic habitats. Arctic terrestrial ecosystems may disappear in many places, or only survive in alpine or island 'refugia'.

Arctic freshwater ecosystems are undergoing rapid change in response to the influence of both environmental and anthropogenic stressors. The distribution and number of lakes, ponds, wetlands and riverine networks are being altered with significant implications to the structure, function and diversity of associated biological communities.

Also in the marine Arctic, climate-induced effects on species and ecosystems, associated with a decrease in sea ice extent and duration, are already being observed. Of key concern is the rapid loss of multi-year ice in the central Arctic basins and changes in sea ice dynamics on the extensive Arctic shelves, which affect the biodiversity and productivity of marine ecosystems.

A secondary effect of increased CO_2 in the atmosphere is ocean acidification resulting from increased dissolved CO_2. Since the solubility of CO_2 is higher in cold than warm waters, Arctic marine ecosystems are especially prone to acidification, and there are already signs of such changes in the Arctic Ocean. This is an important threat to calcareous organisms, and thereby may have cascading impacts on marine ecosystems including potential impacts on biodiversity and fisheries.

Until the second half of the 20th century, overharvest was the primary threat to a number of Arctic mammals, birds and fishes. A wide variety of conservation and management actions have helped alleviate this

pressure in many areas to such an extent that many populations are recovering, although pressures on others persist.

Since the middle of the 20th century, a variety of contaminants have bioaccumulated in several Arctic predator species to levels that threaten the health and fecundity of both animals and humans. However, due to concerted global action to reduce the release of contaminants, there are, as yet, few demonstrated effects on Arctic species at the population level. Lack of data may mask such impacts, however. New contaminants, and changing fluxes of others, continue to be introduced to Arctic ecosystems and related food webs with unknown ecosystem effects.

Arctic habitats are among the least anthropologically disturbed on Earth, and huge tracts of almost pristine tundra, mountain, freshwater and marine habitats still exist. While climate change is the most geographically extensive and potentially harmful anthropogenic impacts at present, regionally ocean bottom trawling, non-renewable resource development and other intensive forms of land use pose serious challenges to Arctic biodiversity.

Pollution from oil spills at sites of oil and gas development and from oil transport is a serious local level threat particularly in coastal and marine ecosystems. A major oil spill in ice-filled waters would be disastrous to marine mammals, birds and other biota, because containing and cleaning up oil spills in broken ice is very difficult, particularly under problematic weather, light and ice conditions.

Many Arctic species spend much of the year outside the Arctic; e.g. Arctic waterbirds are highly dependent on a network of staging and wintering areas in wetlands in many parts of the world. These habitats are experiencing severe development pressure and in some cases overharvest, particularly in East Asia, but also in other parts of the world.

At present, few human-introduced alien species, including pathogens and disease vectors, are spreading unchecked and putting Arctic species under pressure. However, the pathways by which invasive species spread, such as shipping and resource development corridors are rapidly expanding and may dramatically increase the rate of introduction. Many potentially disruptive alien species are also found in sub-Arctic regions and will probably spread northwards along with other species in a warming climate.

There is an enormous deficit in our knowledge of species richness in many groups of organisms, and monitoring in the Arctic is lagging far behind that in other regions of the world. Even for the better-studied Arctic species and ecosystems we have insufficient data on trends in distribution, abundance and phenology and too few natural history specimens for retrospective and baseline analyses. Also the functioning of Arctic ecosystems is insufficiently understood making it difficult to implement ecosystem-based monitoring and management. Hence, there is a critical lack of essential data and scientific understanding necessary to improve the planning and implementation of biodiversity conservation or monitoring strategies in the Arctic.

The multitude of changes in Arctic biodiversity – driven by climate and other anthropogenic stressors – will have profound effects on the living conditions of peoples in the Arctic, including the diversity of indigenous languages, cultures and the range of services that humans derive from Arctic biodiversity. While the ecosystem changes may provide new opportunities, they will also require considerable adaptation and adjustment.