

Arctic Invasive Alien Species

Strategy and Action Plan 2017



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Executive summary

Arctic biodiversity is an irreplaceable cultural, aesthetic, scientific, ecological, economic, and spiritual asset. The envisioned goal of the Arctic as ecologically, culturally, and economically sustainable necessitates a focus on the factors that threaten the region's environment and human health. Invasive alien species represent a significant and rapidly emerging threat to Arctic ecosystems and inhabitants who depend upon these ecosystems for their livelihoods and well-being. At least three factors account for the Arctic's particular vulnerability to biological invasion: relatively low diversity of native species; warming climatic patterns; and increasing human activity in the region.

Invasive alien species enter and spread throughout the Arctic through "pathways." Pathways of particular concern in the Arctic include: shipping (ballast water, hull biofouling); horticulture; large-scale tree planting for aesthetics, fuel, windbreaks, and carbon sequestration; transport of material and equipment for energy development; mineral exploration; settlement expansion; (e.g. ports; roads; pipelines; aquaculture; and tourism, including hunting and fishing (e.g., through contaminated boats, equipment or gear). Examples of other pathways of invasion into Arctic ecosystems include: recreational boating and marine debris; translocated piers, docks, and pilings; and the release or escape of live animals.

Although changing climatic conditions and a growing interest in resource extraction, settlement, and tourism are making the Arctic region particularly vulnerable to biological invasion, there is an immediate opportunity—already largely lost in many other regions of the world—to proactively build resilience to the risks posed by invasive alien species to the Arctic's unique ecological, social, and economic systems. The Arctic Invasive Alien Species (ARIAS) Strategy and Action Plan sets forth the priority actions that the Arctic Council and its partners are encouraged to take to protect the Arctic region from a significant threat: the adverse impacts of invasive alien species. These priority actions span terrestrial, aquatic, and marine ecosystems. The actions take environmental, cultural, and economic perspectives into consideration, including drivers, impacts, and response measures.



Photo: Sigurður H. Magnússon/Nootka lupin, Iceland

The priority actions are divided into three categories:

1. Inspire urgent and effective action

Goal: Raise awareness of the unique opportunity that the Arctic Council and its partners have to inspire the urgent and effective action necessary to protect the Arctic from invasive alien species.

2. Improve the knowledge base for well-informed decision making

Goal: Improve the capacity of the Arctic Council and its partners to make well-informed decisions on the needs, priorities, and options for preventing, eradicating, and controlling invasive alien species in the Arctic by improving the knowledge base.

3. Undertake prevention and early detection/rapid response initiatives

Goal: Protect Arctic ecosystems and human well-being by instituting prevention and early detection/rapid response programs for invasive alien species as a matter of priority.

All those who value the Arctic are invited to consider the relevance of these priorities to their goals and to take action, as appropriate. Achieving these goals is dependent upon cooperation and urgent action. Some of the actions identified apply to the Arctic Council as a whole, while others are best addressed at the working group level or through national implementation. It is recommended that Arctic States, Permanent Participants, and their partners integrate the ARIAS Strategy and Action Plan into national commitments, as appropriate, and employ these priority actions as a means to advance decisions under other multi-lateral fora and instruments. These priority actions provide guidance on where to start, where to place priorities, and where to invest in the future of the Arctic.



Introduction

Globally, invasive alien species are among the most significant drivers of biodiversity loss (McNeely et al. 2001, Bellard et al. 2016) and, in some ecosystems, they are clearly the primary contributors to species endangerment and ecosystem degradation (esp. Islands, Reaser et al. 2007). While there are currently few invasive alien species in the Arctic, more are expected with climate change and increased human activity (CAFF 2013; al.; Bellard et al. 2016). Rapidly changing climatic conditions and a growing interest in resource extraction, settlement, and tourism make the Arctic region particularly vulnerable to biological invasion (Bennett et al. 2015, Hall et al. 2010, Walther et al. 2009, McNeely 2001). The arrival of invasive alien species will also impact people who depend upon Arctic ecosystems for their livelihoods and well-being (CAFF 2013).

We have a unique opportunity in the Arctic. We can act now—decisively—to prevent and mitigate the adverse impacts of invasive alien species that plague much of the rest of the world; loss of native flora and fauna, threats to cultural survival and human well-being, economic hardship, and reduced natural capital. In general, we know what needs to be done. What we need to do is join together and do it. The Arctic Invasive Alien Species (ARIAS) Strategy and Action Plan is a call to action. The priority actions contained herein show us where to start, where to place our priorities, and where to invest in the future of the Arctic.

Vision and scope

The Arctic Council envisions a prosperous, safe, and peaceful Arctic region. Recognizing the connection between economic well-being, social stability, and environmental health, the Arctic Council supports its vision by working cooperatively, both within the Arctic and globally, to address the environmental changes facing the Arctic (Arctic Council 2013). It encourages an ecosystem-based approach, which balances conservation and sustainable use of the environment (Arctic Council 2011).

Impacts on the Arctic region have global implications. Arctic biodiversity is an irreplaceable cultural, aesthetic, scientific, ecological, economic, and spiritual asset (Meltøfte 2013). To envision the Arctic as ecologically, culturally, and economically sustainable necessitates a focus on the factors that threaten the region's environment and human well-being. The ARIAS Strategy and Action Plan sets forth the priority actions that the Arctic Council and its partners are encouraged to take to protect the Arctic region from one of the significant emerging stressors: the adverse impacts of invasive alien species. These priority actions span terrestrial, freshwater, and marine ecosystems. The actions take environmental, cultural, and economic factors into consideration, including drivers, impacts, and response measures.

The ARIAS Strategy and Action Plan identifies near-term priority actions that need to be taken in a cooperative manner. The Conservation of Arctic Flora and Fauna (CAFF) and Protection of the Arctic Marine Environment (PAME) working groups of the Arctic Council hope that each Arctic State, working collaboratively with its partners, will integrate the actions from the ARIAS Strategy and Action Plan into national plans, as appropriate, and employ the priority actions as a means to advance relevant decisions made under the auspices of other multi-lateral fora and instruments. As the Arctic Council and its partners develop strategies to increase the resilience of communities and ecosystems to a rapidly changing Arctic, the risks and potential impacts that invasive alien species pose will need to be considered.

Invasive alien species issues are inherently context-specific; they change through time and across ecosystems. Measures to address invasive alien species need to be tailored to particular pathways, populations of alien species, localities, type and scale of impact, and the available resources. Although it is important to have a comprehensive understanding of the multiple actions that need to be taken to effectively prevent, eradicate, and control invasive alien species within or beyond the Arctic region, resource limitations and the urgent need to initiate a collective approach necessitate priority setting. The ARIAS Strategy and Action Plan is a starting point; it sets forth the foundational, catalytic actions on which to build an effective regional initiative to minimize the impacts of invasive species.

Box 1: Definition of Invasive Alien Species

Invasive alien species are species that are not native to a given ecosystem (that is, when a species is present due to an intentional or unintentional escape, release, dissemination, or placement into that ecosystem as a result of human activity) and which may cause economic or environmental harm, including harm to subsistence species and activities, or harm to human health (CAFF 2016).

Invasive Alien Species

Throughout the world, invasive alien species have driven the endangerment and extinction of a wide range of plants and animals (Bellard et al. 2016, McNeely et al. 2001, Wilcove et al. 1998), contributed to the degradation of freshwater, marine, and terrestrial ecosystems (Pejchar & Mooney 2009, Rahel & Olden 2008, Reaser et al. 2007, Howard 1999), and hastened the alteration of ecological cycles (Chapin et al. 2000). Invasive alien species place constraints on a wide range of ecosystem services that underpin human well-being and economic growth, such as pollination, food and fiber production, disease prevention, climate resilience, and recreational opportunities (Simberloff 2011, Ehrenfeld 2010, McNeely et al. 2001, Mack et al. 2000, Mooney & Hobbs 2000). The impacts of invasive alien species can undermine national and regional security, placing constraints on water, food, health, cultural resources and identities, livelihoods, economies, and climate (Meyerson & Reaser 2002, 2003, McNeely et al. 2001, McNeely 2001).

Not all alien species are harmful; some of them play substantial roles in our economies, such as in agriculture, aquaculture, commercial and recreational fisheries, without causing adverse impacts. Nevertheless, the risks and impacts of biological invasion are growing. Changes in climate and land use are rendering some habitats, even the best protected and most remote natural areas, more susceptible to invasive alien species. At the same time, the globalization of trade, travel, and transport is greatly increasing the number and type of alien species moved around the world, as well as the rate of movement (Burgiel & Muir 2010, Reaser et al. 2003, McNeely et al. 2001).

Pathways are the means by which an organism is moved into a new ecosystem. The pathways by which invasive alien species are translocated vary across space and through time. Some organisms are intentionally translocated for commercial and recreational purposes, for example, for live food, horticulture plants, pets, or sport fishing, while other organisms become “hitchhikers” when goods, equipment, or people relocate (such as marine organisms in ballast water and on ships’ hulls, seeds in a tourist’s shoe, or insects in soils of imported plants) (Ruiz & Carlton 2003). Recent decisions under the Convention on Biological Diversity (CBD) have called on governments to prioritize pathways of concern and to take the necessary action to minimize their capacity to transport harmful organisms.



Photo: Shutterstock/Tourist boat

Box 2: Taking collective action

The ARIAS Strategy and Action Plan is a response to findings and recommendations coming from previous Arctic Council documents, in particular the Arctic Biodiversity Assessment: Summary for Policy makers (CAFF 2013), the Arctic Marine Shipping Assessment (Arctic Council, 2009), the Arctic Ocean Review (PAME 2013), and the Arctic Marine Strategic Plan 2015-2025 (Arctic Council 2015).

The Arctic Biodiversity Assessment: Summary for Policy makers (CAFF 2013) found that there are currently few invasive alien species in the Arctic, but more are expected with climate change and increased human activity. It recommended:

- *Reducing the threat of invasive alien/non-native species to the Arctic by developing and implementing common measures for early detection and reporting, identifying and blocking pathways of introduction, and sharing best practices and techniques for monitoring, eradication and control. This includes supporting international efforts currently underway, for example those of the International Maritime Organization to effectively treat ballast water to clean and treat ship hulls and drilling rigs. (Recommendation 9)*

Actions for Arctic Biodiversity: Implementing the Actions of the Arctic Biodiversity Assessment 2013-2021 (CAFF 2015) sets forth two actions to address Arctic invasive alien species:

- *Action 9.1 (2015-2017): Develop a strategy for the prevention and management of invasive species across the Arctic, including the identification and mitigation of pathways of introduction of invasions. Include involvement of indigenous observing networks, which include invasive and new species reporting, to assist with early detection; and*
- *Action 9.2 (2017-2019): Incorporate common protocols for early detection and reporting of non-native invasive species in the Arctic into CAFF's Circumpolar Biodiversity Monitoring Program (CBMP).*

Relevant actions from the Arctic Marine Strategic Plan (Arctic Council 2015) include:

- *Action 7.1.3: Improve the understanding of cumulative impacts on marine ecosystems from multiple human activity-induced stressors such as climate change, ocean acidification, local and long range transported pollution (land and sea-based), marine litter, noise, eutrophication, biomass overharvesting, invasive alien species and other threats;*
- *Action 7.1.9: Strengthen, where feasible, the collection, observation, monitoring and dissemination of relevant data on the Arctic marine environment. This could include hydrographic and bathymetric data; oceanographic data (including tides and currents) and meteorological information for numerical modelling and forecasting; pollutants; climate change-related impacts (especially ocean acidification); and ecosystem and biodiversity status and trends (including invasive alien species and other metrics of environmental change); and*
- *Action 7.2.5: Develop and encourage the Arctic states to implement common measures and support research into technology and techniques for early detection and reporting of marine invasive alien species in the Arctic marine environment.*



Photo: Michel Royon Wikimedia Commons / *Elodea canadensis*

Case study: Effects of deliberate release: the red king crab in the Barents Sea

Although many invasive alien species in the marine environment arrive as unintended consequences of human activity, Russian scientists and managers intentionally released the red king crab (*Paralithodes camtschaticus*), native to the northern Pacific/Bering Sea, into the Barents Sea in the 1960s in order to establish a valuable fishery. From 1961 to 1969, 1.5 million larvae, 10,000 juveniles, and more than 3,000 adult red king crabs were introduced into the Kola Bay area. The red king crab is among the largest crabs in the world, growing to 10 kilograms and measuring 1.5 meters across. The red king crab is an omnivore which mainly feeds on polychaetes, mollusks, and echinoderms. Through this predation, the red king crab has significant adverse effects on native biodiversity. It can also reduce fisheries' takes by feeding on fish captured in nets. Because it's a cold-adapted species, it has the potential to establish and become harmful throughout most of the North Atlantic.



Photo: L. Haddock USFW/Red king crab

Invasive Alien Species in the Arctic

Many species and habitats are found only in the Arctic and nowhere else on Earth. More than 21,000 species of mammals, birds, fish, amphibians, reptiles, invertebrates, plants, and fungi are native and uniquely adapted to the region. These include species such as polar bear (*Ursus maritimus*), narwhal (*Monodon monoceros*), caribou/reindeer (*Rangifer tarandus*), and snowy owl (*Bubo scandiaca*). The Arctic is also characterized by extreme seasonality; many species migrate long distances, some by the millions, in order to track resource productivity. Although Arctic ecosystems are characterized by low species richness, species abundance is often high (for example sea birds). The lack of overall species diversity may, however, make Arctic ecosystems particularly vulnerable to environmental change, including the impacts of invasive alien species (Fernandez et al. 2014).

Arctic flora and fauna support local livelihoods as well as commercial industries. Approximately four million people live in the Arctic today, including indigenous peoples who depend upon subsistence gathering and harvesting of native species from the land and sea as a major source of their daily food intake and as a vital element of their culture. Commercial fisheries annually harvest millions of tons of marine organisms valued in the billions of U.S. dollars (Christiansen & Reist 2013, Sundet 2014). In addition, several extractive industries, such as oil, gas, and minerals, are well-established and show a growing interest in the region as melting ice makes access to natural resources more feasible for extraction (Emerson & Lahn 2012, Clement et al. 2013, Loe et al. 2014, Gavrilchuk & Lesage 2014). Also, as sea ice melts (see Box 4), new shipping routes through the northernmost latitudes are emerging and existing routes are becoming more navigable, thus increasing opportunities for shipping activity (Arctic Council 2009). This trend is expected to continue in the future (Smith & Stephenson 2013, Miller & Ruiz 2014, Eguíluz et al. 2016).

Pathways of particular concern in the Arctic include: shipping (ballast water, hull biofouling); horticulture; large-scale tree planting for aesthetics, fuel, windbreaks, and carbon sequestration; and transport of material and equipment for energy development; mineral exploration; settlement expansion; ports; roads; pipelines; aquaculture; and tourism, including hunting and fishing (e.g. through contaminated boats, equipment, and gear). Examples of other pathways of invasion into Arctic ecosystems include: recreational boating and marine debris; translocated piers, docks, and pilings; and the release or escape of live animals.

The sources of introduction for the Arctic's most harmful invaders to date include: escapes from fur farms e.g. American mink (*Mustela vison*), a highly effective predator to Iceland and Scandinavia (Birnbaum 2013); introduction through gardening and land reclamation e.g. Nootka lupine (*Lupinus nootkatensis*) which has outcompeted native plants and changed the ecological structure and function in Iceland (Magnusson 2010); intentional releases into the natural environment e.g. red king crab (*Paralithodes camtschaticus*), an effective predator of a wide range of marine species in some Norwegian fjords), into the Barents Sea (Oug et al. 2011) and the Raccoon dog (*Nyctereutes procyonoides*), a predator of ground-nesting birds and amphibians and a vector of rabies and other pathogens and parasites in northern Scandinavia (Sutor et al. 2010, Kowalczyk 2014, Dahl & Åhlén 2016). There is an urgent need for Arctic States and their partners to manage and monitor invasion pathways, including by coordinating transboundary strategies (Lassuy & Lewis 2013, Miller & Ruiz 2014).

Invasive alien species have not been an issue of substantial concern for the Arctic until recently. Thus, relatively little baseline data on species presence and impacts is available. There is a need to evaluate the current status and trends of invasive alien species according to country, species, and pathway specific parameters (Hendrichsen et al. 2014). Strategic, comprehensive invasive alien species assessments are necessary to enable governments to set priorities for addressing specific species,

susceptible sites, and pathways (McGeoch et al. 2016), as well as to protect particularly vulnerable ecosystems. The data generated through these assessments can be coupled with data on changes in human activity patterns and climate to generate projections of potential future conditions and thus strengthen and expand the programs of work necessary to minimize the risk of impact to Arctic ecosystems and human well-being.

Invasive alien species do not respect jurisdictional boundaries. Thus, effective communication and collaboration with neighboring countries and trading partners is of paramount importance in the prevention, eradication, and control of invasive alien species in the Arctic. Governments at all levels need to work together to reduce the risks of biological invasion through commerce and other pathways by cooperating in on-the-ground prevention and management efforts across shared ecosystems and by addressing the various factors that make ecosystems particularly vulnerable to the adverse impacts of invasive alien species.

Box 3: The Arctic Regions

There are varying approaches to defining the Arctic, for example, geophysical, ecological, or political. For the purposes of this document, the CAFF delineation of the Arctic is used (Figure 1). Recognizing that invasive alien species move across these boundaries, different delineations of the Arctic may be more appropriate when undertaking certain activities.

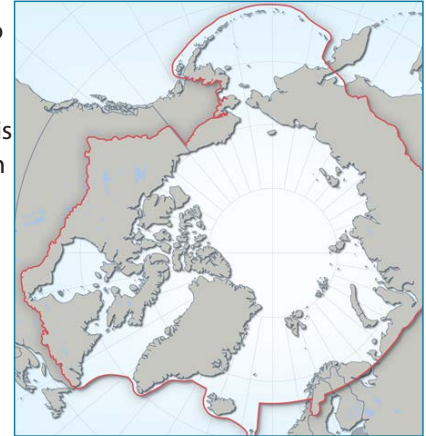


Figure 1: Delineation of the Arctic as defined by CAFF (32 million km²).

Strategy

Biological invasion is a context-specific phenomenon that changes through time and across landscapes; therefore, measures to address invasive alien species need to be timely and fit for purpose. Four general approaches are used to minimize the impact of invasive alien species, each associated with a different stage in the invasion process:

1. Prevention (keeping invasive alien species from entering a new ecosystem);
2. Early Detection and Rapid Response (EDRR) (detecting and responding to an alien species before it becomes established and causes harm);
3. Eradication (removing the entire population of an alien or invasive alien species); and
4. Control (containing or otherwise managing the population of an invasive alien species so as to minimize spread and impacts).

Case study: Rat eradication in the Aleutian Islands

Hawadax Island's story is a story of recovery—the recovery of an Alaskan island ecosystem and a cultural identity. Spanning 2,704 hectares, Hawadax (pronounced “how AH thaa”) is a rugged volcanic island located about 1,300 miles west of Anchorage in the Aleutian Archipelago. Since 1827, Hawadax had been known as Rat Island, a name that reflected the abundance of invasive brown rats (*Rattus norvegicus*) and the havoc they had wrought on the island's ecosystem for approximately 200 years. The rats had arrived on ships as “stowaways,” established a large population, and proceeded to devour seabird eggs and young chicks as well as the vegetation that provided habitat for numerous native island species.

In September 2008, after several years of data collection and planning, the U.S. Fish and Wildlife Service partnered with two non-governmental organizations, Island Conservation and the Nature Conservancy, to eradicate the invasive rats. Their bait drops were successful. Within five years, the detection of terrestrial birds, shorebirds, and seabirds increased significantly. Nesting tufted puffins (*Fratercula cirrhata*) and Leach's storm petrel (*Oceanodroma leucorhoa*) re-colonized the island, and black oystercatchers (*Haematopus bachmani*) nesting success increased substantially. The Aleutian endemic giant song sparrow (*Melospiza melodia maxima*), which had likely been extirpated from Hawadax, was confirmed breeding on the island. In May 2012, the U.S. Board on Geographic Names celebrated the island's recovery by approving a proposal to change the name of Rat Island back to Hawadax Island—Hawadax being the original Aleut name meaning “entry” and “welcome”. The project partners continue to work together to prevent the reintroduction of invasive rats to the island.

Preventing the introduction of potentially harmful organisms is not only the first line of defense for minimizing the spread and impact of invasive alien species, but also the most cost-effective strategy (McNeely et al. 2001, Kellert et al. 2007). Prevention may include border surveillance and controls, as well as the management of invasion pathways (means of intentional or unintentional transport) through regulatory and non-regulatory measures (Shine et al. 2000, Reaser 2011). Risk analyses based on science and Traditional and Local Knowledge (TLK), as well as horizon scanning, can be used to inform regulations that either permit or prohibit the entry of certain alien species at jurisdictional borders (Ruiz & Carlton 2003, Kolar & Lodge 2002, Leung et al. 2002, National Research Council 2002, Shine et al. 2010, Gederaas et al. 2012, Gordon et al. 2012, Koop et al. 2012, Roy et al. 2014). The Arctic Council also places an importance on integrating Traditional and Local Knowledge into risk-based decision making.

When potentially harmful alien species breach prevention systems, it is imperative to quickly detect and respond to these organisms before they have the opportunity to establish in a new location and cause harm. This process is generally referred to as EDRR (U.S. Department of the Interior 2016). Failure to enact EDRR for a single incursion of a potentially harmful alien species can, over time, result in billions of dollars in damages and control costs (Pimentel et al. 2000, Pimentel et al. 2005, Pimentel 2011).

Eradication is the ideal response to the introduction of potentially harmful invasive alien species and to spreading populations of invasive alien species that are already established. Eradication is accomplished through removing or destroying the entire population of organisms of concern.

Control programs, including containment measures, may be necessary when populations of invasive alien species become so well-established that eradication is no longer logistically feasible. They are, however, costly in terms of time, money, and often socio-political will. Integrated pest management—a combination of mechanical control (such as pulling plants or trapping animals), chemical control (e.g. biocides or toxicants), and/or biological control (the use of other living organisms to suppress invasive alien species)—has proven particularly effective when invasive alien species have infested large areas (Wittenberg & Cock 2001).

Where possible, awareness raising, education, human and institutional capacity building, regulatory and legal frameworks, information management, surveillance and monitoring, scientific research, human dimension, economic assessment, technological innovation, and multi-stakeholder cooperation need to be integrated into a comprehensive strategy to address invasive alien species (McNeely et al. 2001, Shine et al. 2000). From the Arctic Council's perspective, it is also imperative to include Traditional and Local Knowledge when taking a collaborative approach to implementing the ARIAS Strategy and Action Plan.

Action Plan

We have a unique opportunity in the Arctic. Unlike much of the world, Arctic ecosystems and economies have not yet suffered the devastation that invasive alien species have wrought on other regions. The Arctic Council and its partners need to work together to take the steps necessary to protect the Arctic by preventing the introduction of potentially harmful alien species, as well as by quickly eradicating those organisms which bypass prevention systems.

Preventing the spread and impact of invasive alien species in the Arctic will have cascading benefits. If Arctic ecosystems are protected from invasive alien species, they may have a greater ability to resist and be resilient to other potential stressors—most notably, climate change. The third recommendation in the Arctic Biodiversity Assessment: Summary for Policy-makers is to “incorporate resilience and adaptation of biodiversity to climate change into plans for development in the Arctic” (CAFF 2013).

The ARIAS Strategy and Action Plan sets forth the most urgent and important steps needed in order to prevent the spread and impact of invasive alien species in the Arctic. Some of the priority actions apply to the Arctic Council as a whole, while others are best addressed at the working group level or through national implementation. The effective conservation of Arctic biodiversity also depends upon actions by non-Arctic States (including Arctic Council Observer States), regional and local authorities, industry, and all who live, work, and travel in the Arctic. States, organizations, and other stakeholders outside of the Arctic Council are invited to consider the relevance of these priorities to their goals and to take action, as appropriate. Participation is welcomed and needed by everyone who values and depends on Arctic ecosystems. Guidance on implementation of these priority actions is provided in Annex I.

1. Inspire Urgent and Effective action

Goal: Raise awareness of the unique opportunity that the Arctic Council and its partners have to inspire the urgent and effective action necessary to protect the Arctic from invasive alien species.

Priority Actions:

- 1.1 Promote and, as needed, develop targeted communications and outreach initiatives to raise awareness of the urgent need and unique opportunity to protect the Arctic region from the adverse impacts of invasive alien species;
- 1.2 Encourage Arctic States and non-Arctic States (including Arctic Council Observer States), working collaboratively with Permanent Participants, to implement effective programs for preventing the introduction and controlling the spread of invasive alien species through domestic actions and/or international agreements and relevant guidelines, such as the International Convention for the Control and Management of Ships' Ballast Water and Sediments, and the IMO Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (Biofouling Guidelines);
- 1.3 Promote and coordinate the Arctic Council's work on invasive alien species with relevant scientific, technical, and policy-making bodies and instruments; and
- 1.4 Encourage the integration of the outputs of the Arctic Council's work on invasive alien species into international efforts and legal and institutional frameworks, especially planning and coordination mechanisms, including at the national and sub-national levels, where appropriate.

2. Improve the Knowledge Base for Well-Informed Decision Making

Goal: Improve the capacity of the Arctic Council and its partners to make well-informed decisions on the needs, priorities, and options for preventing, eradicating, and controlling invasive alien species in the Arctic by improving the knowledge base.

Priority Actions:

- 2.1 Identify and assess: a) the invasive alien species and pathways that pose the greatest risk of biological invasion into, within, and out of Arctic ecosystems; b) the Arctic ecosystems, livelihoods, and cultural resources most vulnerable to biological invasion; and c) the current and projected patterns and trends of introduction and impacts of invasive alien species in the Arctic;
- 2.2 Produce a series of topic-specific assessments of invasive alien species issues in the Arctic considering scientific, TLK, technical, environmental, economic, socio-cultural, legal, and institutional perspectives;
- 2.3 Improve the collection of information on the occurrence and impacts of Arctic invasive alien species, taking advantage of new technologies for early detection, and integrate this information into circumpolar, regional, and community-based observing networks, monitoring programs, (in particular the Circumpolar Biodiversity Monitoring Programme), and associated information systems such as (the Arctic Biodiversity Data Service); and
- 2.4 Facilitate full, timely, and open sharing of data and other information relevant to Arctic invasive alien species prevention and management through the Arctic Biodiversity Data Service and the CAFF Web portal.

3. Undertake Prevention and Early Detection/Rapid Response Initiatives

Goal: Protect Arctic ecosystems and human well-being by instituting prevention and early detection/rapid response programs for invasive alien species as a matter of priority.

Priority Actions:

- 3.1 Collaborate with industries, such as, tourism, energy, fisheries, mining, and shipping, and other stakeholders, as relevant, to develop and implement a wide range of biosecurity measures for points of entry and along priority pathways to reduce the initial transfer of species;

- 3.2 Encourage the establishment of new, or strengthen existing, surveillance, monitoring, reporting, and rapid response programs necessary to ensure EDRR at points of entry. Consideration of TLK and community-based monitoring programs should be encouraged;
- 3.3 Encourage the development and sharing of tools to enable EDRR for invasive alien species that may pose a substantial threat to the Arctic;
- 3.4 Actively facilitate the eradication of invasive alien species from island ecosystems throughout the Arctic as well as the recovery of native island species and habitats that have been impacted by those invasive alien species;
- 3.5 Develop guidance for the use and transfer of native and alien species to and throughout the Arctic environment, and identify opportunities to foster ecological resistance and resilience to environmental change;
- 3.6 Collect information on best practices and assess whether there is a need for International Maritime Organization to develop Arctic specific guidance for minimizing the threat posed by ballast water and biofouling as vectors for the transfer of aquatic invasive alien species from shipping; and
- 3.7 Foster development of the innovative research, tools, and technologies needed to advance invasive alien species prevention and EDRR capacities in the Arctic region, including through support from funding programs.

Implementation

The effective implementation of these priority actions will depend upon:

- Securing the resources necessary to implement them as a matter of urgency;
- Collaboration with Permanent Participants, r non-Arctic States (including Arctic Council Observers), regional and local authorities, industry, and all others who live, work, and travel in the Arctic; and
- Recognition by States, authorities, and organizations outside of the Arctic Council that these priorities are relevant to their goals and that collaborating with the Arctic Council provides a collective and highly desirable benefit.

The ARIAS Strategy and Action Plan addresses both short-term and long-term challenges and opportunities. Achieving its goals is dependent upon cooperation. The Arctic Council working groups will coordinate and cooperate closely, and the Arctic Council will need to look to government agencies and industries for support and participation. Its implementation may also necessitate that the Arctic States cooperate to promote the goals in relevant international and regional fora.

CAFF and PAME, under the overall direction of the Senior Arctic Officials, will coordinate implementation and draw on other working groups and partners as needed. They will incorporate those actions that relate to their mandates into their work plans, as appropriate. Reports on progress of the implementation of the ARIAS Strategy and Action Plan will be submitted by CAFF and PAME to the Senior Arctic Officials and Arctic Council Ministers every two years.

Case study: Precautionary measures for pine wood nematode

Native to North America, the pine wood nematode (*Bursaphelenchus xylophilus*) is now a major threat to conifers (e.g. pine, spruce, fir, larch) in other parts of the world. The organisms are translocated long distances in timber and solid wood packaging material. In the early 20th Century, the pine wood nematode was inadvertently introduced to Japan on infected timbers. It spread to China and Korea and then to Europe where it was detected in Portugal in 1999. The nematode causes pine wilt, a disease capable of killing trees within just a few months. Once established in the environment it is very difficult and expensive to eradicate; it readily spreads from tree to tree through an insect vector. Preventative measures are thus the most cost-effective means of minimizing the impacts of the pine wood nematode. Precautionary approaches have been taken in different parts of Europe, including Arctic regions. In Finland, for example, the 2011 Contingency Plan for the Pinewood Nematode published by the Finnish Food Safety Authority includes measures to be taken if pine wood nematode is found in a Finnish forest or transported materials such as timber or packaging material. The plan also contains estimates of the resources required for the planned measures, the consequent costs, and the compensation to be paid to forest owners.

Annex 1: Implementation Guidance

The following information is provided to support implementation of the priority actions set forth in this document. The ecosystem approach, science, and TLK need to be considered in all actions.

Action 1.1: Employ innovative approaches for awareness raising, including the use of multi-media platforms and collaboration with relevant industries (such as tourism, energy, fisheries, mining, and shipping) and local communities. Use the outputs of priority Actions 2.1 and 2.2 to identify key messages, prioritize target audiences, and determine effective communications approaches.

Action 1.2: In particular, consider the International Convention for the Control and Management of Ships' Ballast Water and Sediments, and the IMO Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (Biofouling Guidelines);

Action 1.3: Integrate invasive alien species issues, as appropriate, into all Arctic Council working groups and other subsidiary bodies. Use priority Actions 2.1 and 2.2 to establish linkages and priorities.

Action 1.4: Examples of international efforts and legal and institutional frameworks where the outputs of the Arctic Council's work on invasive alien species could be integrated include: Convention on Biological Diversity; International Maritime Organization; World Organization for Animal Health; Ramsar Convention; Convention on Migratory Species; Convention on the Law of Non-Navigational Uses of International Watercourses; and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Action 2.1: Use tools such as risk analysis, horizon scanning, and site-based prioritization in identifying and assessing pathways that pose the greatest risk of biological invasions.

Action 2.2: Priorities for topic-specific assessments of invasive alien species include assessments of: the current status, projected trends, and impacts of alien species in the Arctic region; pathways of biological invasion; legal and institutional frameworks for addressing invasive alien species in the Arctic (including for border controls and importation); regional prevention and EDRR capacities; and the relationship between invasive alien species and indigenous peoples/local communities in the Arctic. These assessments should utilize both TLK and science, as appropriate, including the outputs of priority Action 2.1.

Action 2.5: The portal for information relevant to Arctic invasive alien species would include example scientific and technical information, best practices and tools, institutional and legal frameworks, and education/outreach materials. Utilize the Arctic Biodiversity Data Service (ABDS) and the CAFF website.

Action 3.1: When collaborating with industries to develop and implement biosecurity measures, these measures may be voluntary (e.g. social marketing initiatives, local eradication programs, and codes of conduct) and/or legally binding (for example, national-level implementation of international standards). A Hazards Analysis Critical Control Points approach may be of particular value. Take the outputs of priority Actions 2.1 and 2.2 into consideration.

Action 3.2: In order to facilitate early detection and rapid response, place emphasis on airports, sea ports, and their surrounding areas, take community based monitoring programs into consideration.

Action 3.3: In order to facilitate early detection and rapid response, include decision support frameworks, cooperative agreements, flexible funding mechanisms, and technical tools such as watch lists, identification applications, and guides.

Annex 2: Glossary of Terms

Alien species: a species, subspecies, or lower taxon introduced outside its natural past or present distribution due to an intentional or unintentional escape, release, dissemination, or placement into that ecosystem as a result of human activity; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce (synonymous with non-native species).

Biological invasion: the process by which alien species breach biogeographical barriers and extend their range.

Control: containing or otherwise managing the population of an invasive alien species so as to minimize spread and impacts.

Early Detection: a process of surveying for, reporting, and verifying the presence of an alien species before the population becomes established or spreads so widely that eradication is no longer feasible.

Ecosystem restoration: recovering species and ecosystems post removal of invasive alien species.

Eradication: removing the entire population of an alien or invasive alien species.

Horizon scanning: the systematic examination of future potential threats and opportunities that can contribute to the prioritization of invasive alien species of concern and the means to address their introduction and spread.

Introduction: the movement by human agency, indirect or direct, of an alien species outside of its natural range (past or present). This movement can be either within a country or between countries or areas beyond national jurisdiction.

Invasive alien species: species that are not native to a given ecosystem (i.e. when a species is present due to an intentional or unintentional escape, release, dissemination, or placement into that ecosystem as a result of human activity) and which may cause economic or environmental harm (including harm to subsistence species and activities) or harm to human health (in the U.S., the term invasive alien species is synonymous with invasive species).

Native species: with respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.

Non-native species: see Alien species.

Pathway: any human-mediated means of facilitating the introduction or spread of an alien species.

Prevention: keeping invasive alien species and potentially harmful alien species from entering a new ecosystem.

Rapid Response: a process that is employed to eradicate a population of an alien species from a specific location.

Risk analysis: (1) the assessment of the consequences of the introduction and likelihood of establishment of an alien species using science-based information (i.e. risk assessment); and (2) the identification of measures that can be implemented to reduce or manage these risks (i.e. risk management), taking into account socio-economic and cultural considerations.

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