

Alaska Region

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Introduction

Alaska has fewer invasive species and is less impacted by invasive species than most places on Earth. Until recently, Alaska has been protected by its cold climate and by its comparative lack of roads and other development. However, these barriers are eroding. Warming climate trends and longer shoulder seasons have reduced the climate filter that so far may have prevented some invasive species from establishing in the State (Figs. A1.1 and A1.2; Carlson et al. 2015; Jarnevich et al. 2014; Sanderson et al. 2012; Wolken et al. 2011). More extensive wildland fire combined with increasing activity in mining, oil and gas extraction, and wilderness tourism are extending the network of travel corridors and altered landscapes that are vulnerable to the establishment and spread of invasive species (Cortes-Burns et al. 2008; Spellman et al. 2014). With 10,680 km of coastline and at least 2670 named islands, Alaska is also vulnerable to invaders in the nearshore marine environment.

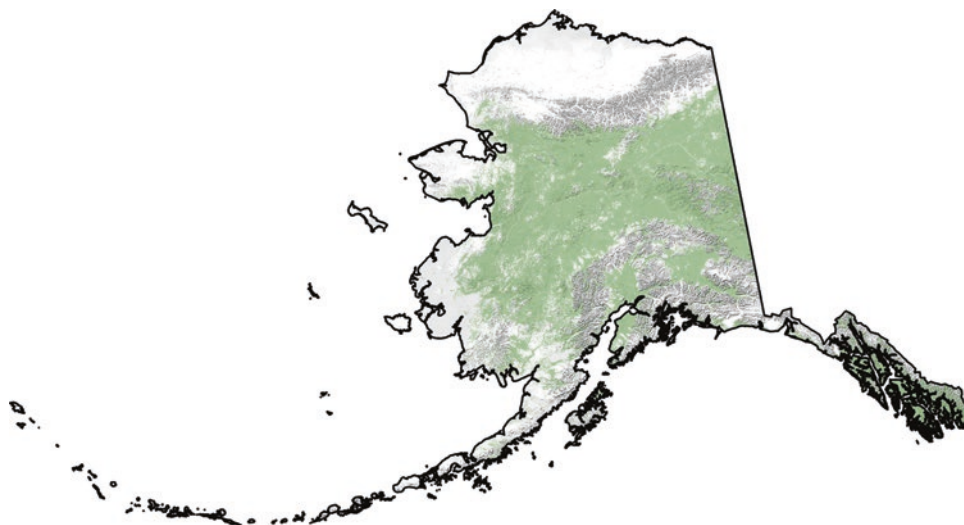
Invasive species have been introduced to Alaska via a variety of pathways. Plants have been intentionally introduced for agricultural and commercial purposes, and non-native animals have been introduced for subsistence and sport hunting. Many introductions of invasive species to Alaska, however, have been unintentional. Such pathways include contaminants in agricultural or forestry products; the movement of contaminated road vehicles, boats, and aircraft; and the disposal of live animals and plants from aquaria. Problem species span many taxa: both terrestrial and aquatic plants, mammals, birds, fish, insects, earthworms, and a marine tunicate.

Pathways

Animal Introductions Alaska has a long history of animal introductions, especially on its islands (Bailey 1993; Paul 2009). The first deliberate releases of Arctic foxes (*Vulpes lagopus*) for fox ranching on several Aleutian Islands occurred in 1750 (Black 1984); the first known accidental release of Norway rats (*Rattus norvegicus*) was prior to 1780 via a shipwreck (Brecht 1977). The rats spread so prolifically that the island where the shipwreck occurred later came to be known as Rat Island (Ebbert and Byrd 2002). It was the site of an intensive, successful rat eradication effort in 2008 for the purpose of restoring seabird nesting habitat (Croll et al. 2016; Dunham 2012; Fritts 2007; USFWS 2007). Cattle (*Bos taurus*), Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), and elk (*Cervus canadensis*) have all been released on islands in Alaska and have proven difficult to manage or remove when their populations thrived beyond intention or when management objectives changed (Ebbert and Byrd 2002).

Alaska encompasses a very large geographic area, and species that occur naturally in one part of the State may behave invasively and problematically when introduced to another. Two prime examples are northern pike (*Esox lucius*) and Alaska blackfish (*Dallia pectoralis*), both of which are native to parts of Alaska north or west of the Alaska Range. Both have been illegally transplanted to Southcentral Alaska, starting in the 1950s, resulting in a number of established populations. The diets of introduced blackfish are similar in composition to the diets of native juvenile salmonids (*Oncorhynchus* spp.) and stickleback (*Gasterosteus aculeatus* and *Pungitius pungitius*), pointing to the potential for competition for prey between blackfish and native fish species (Eidam et al. 2016). Northern pike are highly predatory; where introduced, they have greatly reduced the

Fig. A1.1 The Alaska region



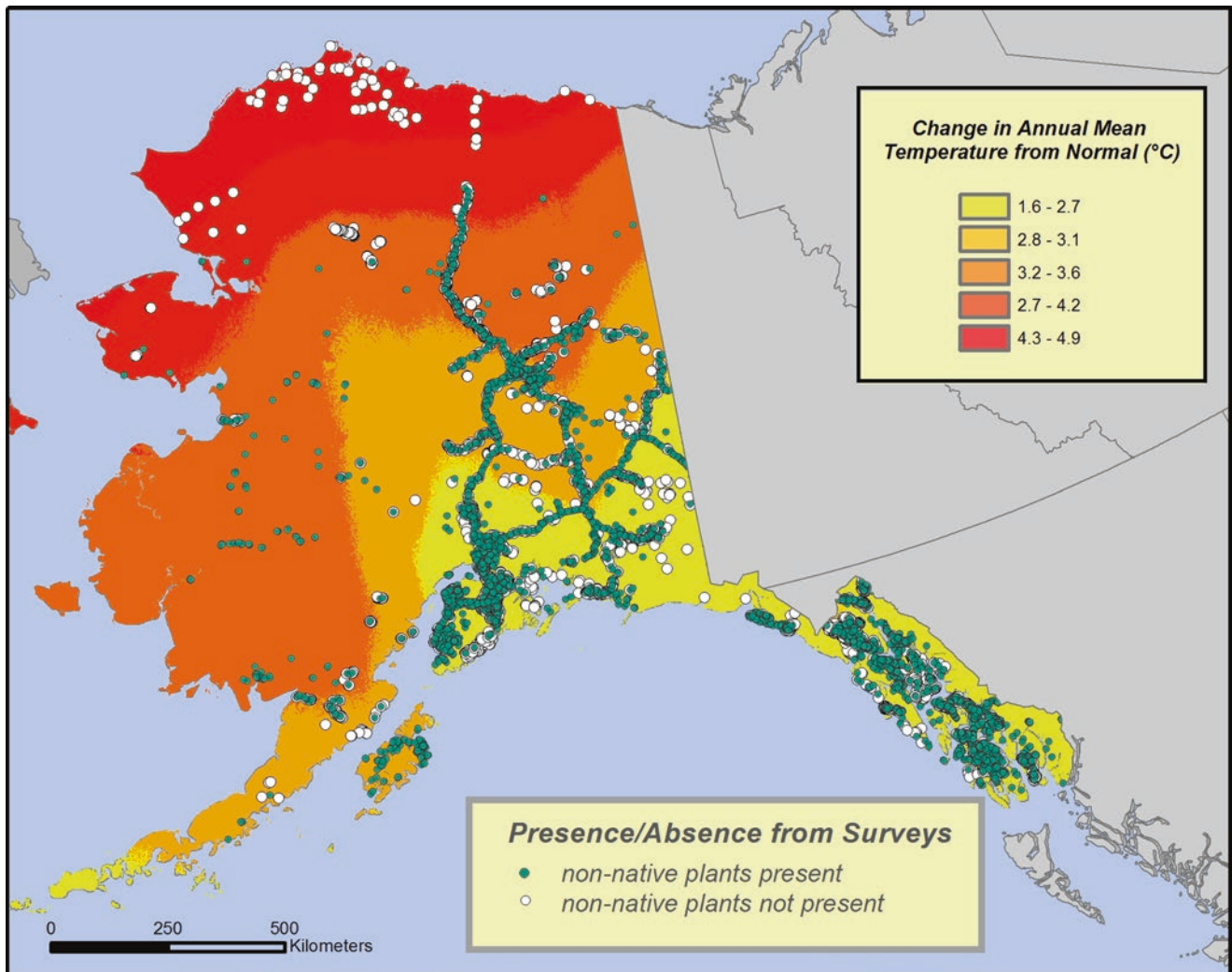


Fig. A1.2 Current known distribution of non-native plant species in Alaska, shown with the projected change in annual mean temperature from the reference period 1970–1999 to the future period 2030–2059. The projected climate is the average of five climate model projections (CMIP5) for a higher emissions scenario (RCP 8.5). Plant data are from

the Alaska Exotic Plant Information Clearinghouse database (<https://accs.uaa.alaska.edu/invasive-species/non-native-plants/>); climate projections are from the US Department of the Interior Alaska Climate Science Center. (Data courtesy of Scenarios Network for Alaska and Arctic Planning (SNAP 2016))

presence of native fish species. Rutz (1999) identified five species of Pacific salmon juveniles in the stomachs of harvested pike in the Susitna River drainage, with coho salmon (*O. kisutch*) juveniles in 59% of non-empty stomachs. The Alaska Department of Fish and Game considers northern pike to be the highest-priority invasive threat in Southcentral Alaska (ADFG 2002).

Agriculture and Horticulture Several of Alaska's most aggressive invasive plant species were initially introduced through agriculture, either for forage (e.g., reed canary grass (*Phalaris arundinacea*), bird vetch (*Vicia cracca*)) or to improve soils (e.g., white sweetclover (*Melilotus albus*)), or accidentally through seed mix impurities (e.g., creeping thistle (*Cirsium arvense*)). Some of these agricul-

tural species were later repurposed for erosion control during road construction, mineral exploration, and mine reclamation. This enlarged the area occupied by the introduced species, providing a greater source for further spread. Horticultural activities have greatly increased the variety of species being introduced, again both intentionally—such as Japanese knotweed (*Fallopia japonica*), Siberian peashrub (*Caragana arborescens*), European bird cherry (*Prunus padus*), Maltese cross (*Silene chalcadonica*), and orange hawkweed (*Hieracium aurantiacum*)—and inadvertently such as perennial sowthistle (*Sonchus arvensis*) in the soil of containerized imported ornamental plants (Conn et al. 2008a). Imported hay and straw have been shown to carry a variety of viable weed seeds (Conn et al. 2010).

Shipping In recent years, introductions have increased in frequency and opportunity through trade (Carlson and Shephard 2007). Shrink-wrapped bundles of firewood originating in Washington State and sold in Fairbanks were found to harbor five species of living insects, including two exotic bark beetles (FS-R10-FHP 2012). European and Asian gypsy moths (*Lymantria dispar*) have been detected in Alaska (either captured in insect traps or intercepted in ports) seven times since 1985 (FS-R10-FHP 2012). The European gypsy moth egg masses were likely carried north from the lower 48 States on recreational vehicles; the Asian egg masses were found on cargo ships from Asia.

Recreational Activities Several taxa are known to have been introduced or spread through recreational activities. Non-native plants are common along most of the hiking trails in the Kenai Mountains, but are rare within natural vegetation communities of the area, suggesting that the plants were introduced by trail users or trail maintenance activities (Bella 2011; Develice 2003; Ware et al. 2012). Three species of non-native earthworms (Lumbricidae) have been introduced on Alaska's Kenai Peninsula, with at least one of them arriving via bait abandonment by anglers (Saltmarsh et al. 2016).

Transport of Aquaculture Gear A marine tunicate invader, "D-vex" (*Didemnum vexillum*), was discovered in Sitka's Whiting Harbor in 2010. D-vex is known to foul shellfish aquaculture gear, hamper scallop movement, and overgrow extensive areas of benthic habitat. This find represented a

1000-km northward extension of the range of this species along the West Coast of North America (Cohen et al. 2011). The attention it garnered has led to a multi-organization effort to test control options (McCann et al. 2013).

Aquarium Release Aquatic plants of the genus *Elodea* are native to much of North America but are not native to Alaska. The genus is widely used in aquaria, and in fact elodea was likely first introduced to Alaska's wild waterways by aquarium dumping. Since the initial find of a small amount of elodea in Eyak Lake in 1982, it has been found in more than 20 locations around the State, with several infestations occurring in urban lakes and waterways in Anchorage and Fairbanks (FS-R10-FHP 2016). It was released from aquaria (one infestation is immediately behind an elementary school) and has spread via boats, floatplanes, and downstream water flow (FS-R10-FHP 2016). Once established in a lake or slow-moving waterway, elodea grows aggressively (Figs. A1.3 and A1.4), with the potential to degrade fish habitat, displace native flora and fauna, impede boat travel and safe floatplane operation, decrease water flow rates, and increase sedimentation rates (Luizza et al. 2016). The amount of suitable habitat for this species in Alaska is projected to increase with the warming climate (Luizza et al. 2016). If elodea continues to spread in Alaska, it may pose direct negative impacts on subsistence practices related to Chinook salmon (*O. tshawytscha*) and whitefish (*Coregonus nelsonii*), thereby posing a major challenge to Alaska Native communities (Luizza et al. 2016). Elodea is already challenging Alaska's natural resource managers. Small infestations on the Kenai

Fig. A1.3 Dense stands of the invasive aquatic plant elodea in a waterway near Fairbanks, AK, and close-up view of elodea (*inset*). (USDA Forest Service photos)



Fig. A1.4 Elodea washed up on the shore of Eyak Lake, in spring 2016. (USDA Forest Service photo)



Peninsula and the Anchorage Bowl have been successfully treated with aquatic herbicides (Morton et al. 2014), but getting control of the State's larger and more challenging infestations (some in remote locations, some in flowing water) will take significant funding and cross-agency cooperation.

In 1982, a school teacher on Chichagof Island in Southeast Alaska purchased frog eggs from a biological supply company for a classroom project and later released about two dozen newly metamorphosed juvenile red-legged frogs (*Rana aurora*) into a small pond there. Red-legged frogs are not native to Alaska. By 2006, the frogs had spread to occupy over 6000 ha of wetland and forested habitats, completely displacing the native amphibian species (Lerum and Piehl 2007; Rozell 2009).

Ecological Effects

Information on the ecological effects of invasive species in Alaska is scant, partly because, beyond the historical mammal releases on islands, invaders are only beginning to move into natural ecosystems from areas disturbed by humans (Oswalt et al. 2015; Rose and Hermanutz 2004). Between 1999 and 2004, an outbreak of larch sawfly (*Pristiphora*

erichsonii), an insect native to Europe, impacted an estimated 240,000 ha of interior Alaska, killing roughly 80% of the larch trees (*Larix laricina*) in the affected area (Burnside et al. 2010). In 2010, the green alder sawfly (*Monsoma pulveratum*), an insect native to Europe and North Africa, was found to be widespread in Southcentral Alaska; in some areas it completely defoliated large patches of alder (*Alnus* spp.) (FS-R10-FHP 2011; Kruse et al. 2010). How this sawfly was originally introduced to Alaska is unknown. The European bird cherry, a popular landscape tree, produces fruits that are readily consumed and spread by wild birds. Near monocultures of European bird cherry have formed in some forested urban parklands of Anchorage, including along two urban streams that support runs of wild salmon. Roon (2011) studied the invertebrates present on bird cherry foliage, the biomass of insects falling to the stream below, and the consumption of those insects by juvenile salmon. Riparian bird cherry trees had significantly less invertebrate biomass on their foliage and lower stream input of insects compared to native deciduous trees (Roon et al. 2016). Reduced terrestrial prey subsidies to streams are likely to have negative consequences for salmon as European bird cherry continues to spread (Roon et al. 2016).

White sweetclover was originally introduced to Alaska to increase nitrogen and organic matter content in agricultural soils. Later, sweetclover was planted for roadside stabilization and for reclamation projects associated with oil and gas exploration, pipeline construction, and mining. Alaskan beekeepers have sown it to enhance foraging opportunity for honeybees. From roadsides and reclamation project sites, sweetclover has spread onto the floodplains of at least four major rivers, where its seeds are easily carried downstream. Sweetclover spread from the town of Telegraph Creek in British Columbia down the Stikine River to the Stikine-LeConte Wilderness Area in Southeast Alaska (Conn et al. 2008b, 2011). On early successional floodplain sites, dense stands of sweetclover create novel shade environments; such areas had 50% greater mortality of native seedlings than areas without, suggesting that sweetclover infestations have the potential to change plant community composition (Spellman and Wurtz 2011). A study of reproductive interactions between sweetclover and native cranberry (*Vaccinium vitis-idaea*), blueberry (*V. uliginosum*), and Labrador tea (*Rhododendron groenlandicum*) found a complex relationship, with negative, neutral, and positive effects on pollination and fruit set of native species (Spellman et al. 2013, 2015). Habitat suitability models have projected increasing white sweetclover habitat in Alaska as a consequence of climate change (Jarnevich et al. 2014).

Regulation

Few regulatory measures related to invasive species have been enacted in Alaska (Environmental Law Institute 2002). A Prohibited and Restricted Noxious Weed List was established in 1987, initially focused on species that are likely to be introduced as contaminants in crop seed. Because of this focus, the list fails to include many of Alaska's most aggressive invasive plants. State laws prohibit stocking any fish into waters of Alaska without a permit and releasing unwanted pets into the wild. In 2012, the State banned the use of felt-soled waders to reduce the risk of introducing non-native aquatic pests and in 2014 enacted a quarantine that prohibits the importation, sale, and distribution of five aquatic plant species, including elodea. Although these laws and regulations have been enacted, the State's ability to enforce them is very limited. The State has also initiated voluntary weed-free gravel and forage certification programs.

The Alaska Committee for Noxious and Invasive Plant Management (CNIPM), established in 2000, is an effective network with more than 40 Federal, State, local, and private member organizations. Its strategic plan includes objectives in coordination, education and outreach, prevention, inventory and monitoring, control and management, and research (Alaska CNIPM 2016). Its members use a weed-ranking system (Carlson et al. 2008) and a statewide database of known infestations of non-native plants (Alaska Center for Conservation Science 2016). CNIPM identifies research

opportunities to address existing knowledge gaps, determine potential impacts of a changing climate, and improve methods for managing invasive pests (Alaska CNIPM 2016). Monthly conference calls and an annual workshop bring people together to exchange information. CNIPM facilitates communications between regulatory agencies to remove roadblocks to timely treatments and between funding sources and small community organizations that support activities such as local weed surveys, weed pulls, and a vehicle-washing station at the ferry terminal of one island community. In 2016, the focus of this organization broadened from plants to all taxa of invasive species, becoming the Alaska Committee for Noxious and Invasive Pests Management (CNIPM). In 2017 CNIPM changed its name to Committee for Noxious and Invasive Pests Management to reflect the ongoing collaboration across taxa. In 2018 CNIPM changed its name once again to the Alaska Invasive Species Partnership (AISP).

The likelihood of invasive species reaching new parts of Alaska is increasing with resource development and climate change, as demonstrated in modeling exercises (Bella 2011; Carlson et al. 2015; Jarnevich et al. 2014). New gas lines and mines are being developed; new and far-ranging roads are proposed or are under construction. The increasing extent and severity of wildfire means that more land area will be disturbed, much of it vulnerable to the introduction and spread of invasive plants (Cortes-Burns et al. 2008; Spellman et al. 2014). Fortunately, many Alaskans are observant and tuned in to their environment; they're natural citizen scientists (Sigman et al. 2015). In several well-documented cases, initial reports of new invaders have been made by citizens. In 2010, the village environmental officer in the tiny Southeast Alaska community of Kake reported the State's first (and so far, only) infestation of giant hogweed (*Heracleum mantegazzianum*); she recognized the species, Alaska's only known infestation of a Federally listed noxious weed, from a photo included in an outreach booklet. Citizens are monitoring for European green crabs (*Carcinus maenas*) and invasive tunicates in Ketchikan, Sitka, Juneau, Seward, Kodiak, Tatitlek, and Cordova (ADFG 2016). Outreach to both urban and rural communities is an ongoing effort and has led to greater awareness by land managers and the public. Alaskans are taking the lessons learned in other parts of the country to heart and putting those lessons into action.

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