INVASIVE PLANT INVENTORY AND BIRD CHERRY CONTROL TRIALS

Phase II: Bird Cherry distribution, demography and reproduction biology along the Chester and Campbell Creek trails, Anchorage, Alaska

Prepared by:
Flagstad, L.A., Cortés-Burns, H., and T.L. Roberts.
Alaska Natural Heritage Program
University of Alaska Anchorage
707 A Street
Anchorage, AK 99501

Prepared for:
The Municipality of Anchorage
& **Anchorage Parks Foundation**

February 3, 2010

Abstract

The Alaska Natural Heritage Program conducted surveys and control trials for the invasive tree species *Prunus padus* (European bird cherry) along the Chester and Campbell Creek trails for the Anchorage Parks Foundation and the Municipality of Anchorage during the 2008 and 2009 field seasons. The main goals of this work were to: 1) document the current extent and locations of *Prunus padus* infestations and 2) increase our understanding of *Prunus padus* population ecology and recruitment. Survey results show semi-continuous infestations of *Prunus padus* along both the Chester and Campbell Creek greenbelt trails. Within these stands, stem number decreases exponentially with age suggesting that populations of *Prunus padus* are either self-thinning or experiencing a dramatic population increase. Multi-year monitoring is necessary to confirm the cause of the pattern. Seed viability was high (79% viability for one-year old seeds) and seedling germination was vigorous following hand removal of the previous year's seedlings (seedlings regenerated at approximately 80% of their original abundance). We recommend that the Municipality discontinue their use of *Prunus padus* and its potentially invasive congeneric relative, *Prunus virginiana* as ornamental plantings in the Anchorage area. To control the existing *Prunus padus* infestations, we recommend management begin with the removal of mature, fruit-producing individuals along both trail systems and transition to the removal of sub-reproductive plants.

Acknowledgements

The Alaska Natural Heritage Program would like to thank the Municipality of Anchorage and the Anchorage Parks Foundation for their financial support of this and related projects. Michael Shepard, formerly with State and Private Forestry, was instrumental in the initial funding and development of this project.

We would also like to thank AKNHP staff members Trevor Roberts, Susan Klein, Kellee Hampy, Cassandra Wright, Tony Pirelli, Becky King and Tracey Leithauser for their assistance with field and laboratory work.

We were grateful to David Roon (UAF) to allow the use of his survey data to be used in this report.

Table of Contents

Table of Figures

Introduction

The establishment, growth, and persistence of non-native[1] plant species pose a serious threat to native ecosystems. Even though not all non-native species cause significant economic or ecological harm, invasive[2] plants (hereafter also referred to as weeds) are well known to alter community composition, successional pathways, nutrient cycling, hydrology, and fire regimes, as well as reduce or eliminate threatened and endangered native species populations (U.S. Congress 1993, Busch 1995, Myers 1997, Brooks 1999, Stein et al. 2000).

While invasive plants constitute a major problem in the Lower 48 states (cf. Randall 1996), Alaska has remained largely unaffected by non-native plants. However, over the last ten years, there has been a marked acceleration in the rate of introduction of non-native plants to the state, likely driven by increases in population, commerce, development, gardening, and outdoor recreation activities (Carlson and Shephard 2007). In some cases, invasive weeds have been documented moving off the human footprint into natural ecosystems (Cortés-Burns et al. 2007, 2008; Lapina et al. 2007; Villano and Mulder 2008).

The susceptibility of native plant communities to invasion is largely a function of the degree of natural or anthropogenic disturbance the community experiences (Hobbs and Huenneke 1992). In Alaska, non-native plant occurrence is most strongly correlated with frequently used and therefore highly disturbed areas such as urban centers, transportation routes and recreational sites. Within Alaska, Anchorage has the greatest concentration of human-altered landscapes and experiences the greatest volume of goods and services traffic. As a result, the number of non-native plant infestations and introductions is high. To its credit, the Municipality of Anchorage (MOA) maintains significant park lands that support largely native plant communities. However, non-native species have established in these areas and several of the more invasive non-natives now present a management problem. European bird cherry (*Prunus padus*) currently composes the greatest biomass of the non-native invasive species established in Anchorage. Although it is not as widely distributed as some non-native species in our state, this ornamental tree easily escapes cultivation and is able to invade native plant communities. *Prunus padus* appears to be the primary local non-native species spreading up the Chester and Campbell Creek riparian corridors and recruiting in remote areas adjacent to Chugach State Park.

In an effort to preserve the predominately native plant composition and natural ecosystem function of park lands in Anchorage, the MOA in cooperation with the Anchorage Parks Foundation (APF) has initiated a survey of and trial treatments on *Prunus padus* populations along select municipality trail systems. A more complete understanding of the locations and extents of *Prunus padus* infestations as well as the

---

[1] Non-native plants are plants whose presence in a given area is due to the accidental or intentional introduction by humans (AKEPIC 2005)

[2] Invasive plants are non-native plants that produce viable offspring in large numbers and have the potential to establish and spread in natural areas (AKEPIC 2005). Some invasive plants have strong negative impacts on native ecosystems, cause important economic losses, or can be detrimental to human health.

demographics and recruitment potential of *Prunus padus* populations will help determine the type, duration and frequency of control treatments necessary to manage this species within Municipal park lands.

Species biography:

Prunus padus (European bird cherry)
Invasiveness rank: 74, highly invasive (Carlson et. al. 2008)

This highly aggressive tree species has been historically planted as an ornamental in southcentral and southeast Alaska (Welsh 1974), where it easily escapes cultivation and establishes as a tall shrub layer in native habitats presumably at the expense of native shrubs and understory species (Figure 1, Cortés-Burns pers. obs.). Interestingly, *Prunus padus* appears more invasive in our northern climate than it does in the more temperate regions of its introduced range. To our knowledge, this behavior has not been addressed in the literature.

Figure 1: *Prunus padus*
© 2004 Ben Legler

In its native range, *Prunus padus* inhabits wet woodland, meadows, riverbanks and forest clear cuts (British Trees 2004, Gubanov et al. 1995). In Anchorage, *Prunus padus* forms dense monospecific stands along the Chester Creek Trail and is semi-continuous along the Campbell Creek Trail. Furthermore, this species is known to be spreading eastward up the Chester and Campbell Creeks to more remote areas of the Municipality of Anchorage and Chugach State Park. Although currently in lower numbers, this species has also been observed spreading along the Coastal Trail and in spring 2009 one flowering tree was observed on the Lekisch Trail in Kincaid Park (Cortés-Burns, pers. obs).

Prunus padus reproduces sexually by seed and vegetatively by clonal root and basal sprouts (Leather 1996). Flowers are bisexual and trees are able to self-pollinate and set fruit without a cross-pollinator (Grisez 1974). Seed abundance is high (USDA, NRCS 2006) and seeds remain viable in soil for up to two years (minimal [~10%] viability was shown after two winters in a Swedish boreal forest, Granström 1987) and require cold stratification for germination (USDA, NRCS 2010). Germination can be delayed by the passage of two winters and is capable of depleting the soil seed bank within three years (Granström 1987). Germination rates vary but an average value of 85% from fresh seed is given by Grisez (1974). The interval between large seed crop is two years (1-3 year range; Leather 1996). It is thought that delayed germination from the seed bank may help balance the inter-annual variation in seed production (Granström 1987).

Sprouting is a survival mechanism stimulated by damage to the parent tree by fire, browsing, cutting, windfall, disease etc. (Smith et al. 1997). In the case of *Prunus padus*, sprouts arise from adventitious buds along the roots and the stump. Root sprouts are more likely to develop into healthy trees as they are not clustered around the stump and are less susceptible to rot (Smith et al. 1997).

The fruits are very bitter-tasting to humans, but loved by birds (Snow and Snow 1988). In Anchorage, waxwings and rusty blackbirds have been observed (Cortes-Burns and Carlson pers. obs.) eating the cherries in the fall, thus assisting in the long distance dispersal of this species along the creek corridors and to other areas of the state. Seeds falling beneath the parent tree may be dispersed over shorter distances by small mammals (Leather 1996).

The impacts of *Prunus padus* on native ecosystems are largely unknown. However, its ability to form dense, monospecific stands in riparian habitats, with a consequent reduction in light and in the availability of high-quality willow forage, is expected to impact the moose population through reduction of their preferred foraging vegetation. Moose browsing marks have been observed on *Prunus padus* trees along the Chester and Campbell Creeks, but it is unknown whether this species' bark is as palatable as native forage shrubs.

The effects of this species on stream leaf litter processing and stream invertebrate community composition in relation to their predators, juvenile salmonids are currently being investigated by Dave Roon and Mark Wipfli at the University of Alaska Fairbanks (Roon et al. 2009).

Diagnostic traits of *Prunus padus*
(European bird cherry, Figure 2)

Shape:	rounded crown, branches ascending when tree is young
Bark:	dark grey brown
Leaves:	obovate to elliptic, finely serrate, dark green above, glabrous or with white hairs in tufts along lower side midrib
Petioles:	1-2 cm long, grooved, red, with two dark-red to brown extra floral nectaries
Inflorescence:	fragrant, white, pendulous 10-15 centimeters (cm) long; clusters (racemes) appear after the foliage emerges in spring
Calyx (sepals):	lobes 2-3 millimeters (mm) long, shallow rounded, obtuse; receptacle hairy within
Corolla (petals):	6-9 mm long, toothed
Fruit:	globose, shiny-black, bitter to taste
Hardy to:	USDA Zone 3
Native to:	Europe, northern Asia, to Korea and Japan; has spread from cultivation in Canada and the Northeast United States.

Figure 2: Growth habit, leaf morphology, flower structure and fruit character of the invasive tree species, *Prunus padus.*

Chokecherry (*Prunus virginiana*) is a closely related species to *Prunus padus* and has been recorded at locations along the Campbell Creek Trail (see Phase I of this project "Non-native plants recorded along four Anchorage Municipality trail systems" for detailed results). This non-native tree species, which much like *Prunus padus*, was introduced into Alaska as an ornamental and was originally thought to be less invasive, has already escaped cultivation and become naturalized along the city's greenbelts (although to a lesser extent than *P. padus*). There are two traits that help distinguish *Prunus virginiana* from *P. padus*:

- In early spring (May), when these species are in flower, the **hypanthium** (the cup-shaped structure on which the sepals and petals are born) of *Prunus virginiana* is **hairless** whereas the hypanthium of *Prunus padus* is **pubescent**
- Later in the summer, the **foliage** of *Prunus virginiana* turns **dark red**, whereas the leaves of *Prunus padus* **remain green** throughout the growing season

Diagnostic traits of *Prunus virginiana*
(chokecherry, Figure 3)

Shape:	irregular, thicket forming shrub, oval-rounded crown
Bark:	red-brown and smooth in young trees, and grayish-brown later, not peeling readily
Leaves:	ovate to elliptic, finely serrate, dark green above and gray-green beneath, minute glands on petiole
Petioles:	2.5 cm long, with 1-2 glands at base
Inflorescence:	elongated clusters to 10 cm long bloom in mid-spring
Calyx (sepals):	lobes 1-1.5 mm long, blunt, glandular and ragged-edged, generally wider than long
Corolla (petals):	petals 4-6mm long, nearly circular
Fruit:	dark red to purple-black drupe, maturing in late summer
Hardy to:	USDA Zone 2
Native to:	much of eastern North America, from Newfoundland to Saskatchewan, south to Kansas and North Carolina.

Figure 3: Growth habit, leaf morphology and flower structure of the invasive tree species, *Prunus virginiana.*

Methods

To characterize the current locations and extents of *Prunus padus* infestations, the Alaska Natural Heritage Program (AKNHP) conducted general vegetation surveys along several municipal trail systems (see Phase I of this project "Non-native plants recorded along four Anchorage Municipality trail systems" for detailed results). Phase II (this report) focuses on stand demographics, recruitment patterns and regeneration potential of *Prunus padus* along the Chester and Campbell Creek trail systems. Plot locations were recorded using a Garmin Map 76CSx handheld GPS unit; site attributes and species information were recorded on a version of the datasheet included as Appendix I.

Plot naming, location and set up:

Plots are labeled BCT, in reference to Bird Cherry Tree; plots BCT001-BCT010 are located on the Chester Creek Trail, plots BCT011-BCT020 are located on the Campbell Creek Trail (Figure 4). Plots were located approximately every 250 meters (m) along the Chester Creek Trail and every 750 m along the Campbell Creek Trail; where the plot frequency interval is proportional to the overall trail length. Plot locations were adjusted within 50 m (Chester Creek) or 100 m (Campbell Creek) of their predetermined location to capture stands with greater than 25% (Chester Creek) or ten percent (Campbell Creek) *Prunus padus* cover. Stand threshold covers were scaled to account for the greater presence of *Prunus padus* along the Chester Creek trail system relative to the Campbell Creek trail system. If at a given location the required canopy covers were met on both sides of the trail, the plot was located on the creek side of the trail. If a sufficient stand of *Prunus padus* could not be found within the above distances from the predetermined plot location, field crews moved to the next plot location and repeated the site assessment process.

The *Prunus padus* infestation class of each plot was characterized based on the following criteria:

0: **Completely native** (tree vegetation). No *Prunus padus* present
1: **Native dominant**. *Prunus padus* is absent from or is present in trace amounts in the creeping, low, medium and/or high canopy; *Prunus padus* seedlings and/or woody seedlings with diameter less than 2.5 cm are present at less than 10% in the understory
2: **Native dominant**. *Prunus padus* trees with diameter of 2.5 or greater are present at 10% or more in the medium and high canopy. Some (10-25%) *Prunus padus* seedlings and/or woody seedlings with diameter less than 2.5 cm are present in the understory and/or the creeping or low canopy.
3: **Mixed native-non-native**. Some (10-25%) *Prunus padus* trees with diameter greater than 2.5 cm are present in the canopy (at any canopy level). Many (25-50%) *Prunus padus* seedlings and saplings are present in the understory.
4: ***Prunus padus* dominant**. Many (25-50%) *Prunus padus* trees with diameter greater than 2.5 cm are present in the canopy (at any canopy

level). The understory is dominated (25-75%) by *Prunus padus* seedlings, saplings and suckers.

5: ***Prunus padus* near-monoculture**. *Prunus padus* trees with diameter greater than 2.5 cm dominate (>50%) the canopy (at any canopy level). The understory is strongly dominated (>75%) by *Prunus padus* seedlings, saplings and suckers.

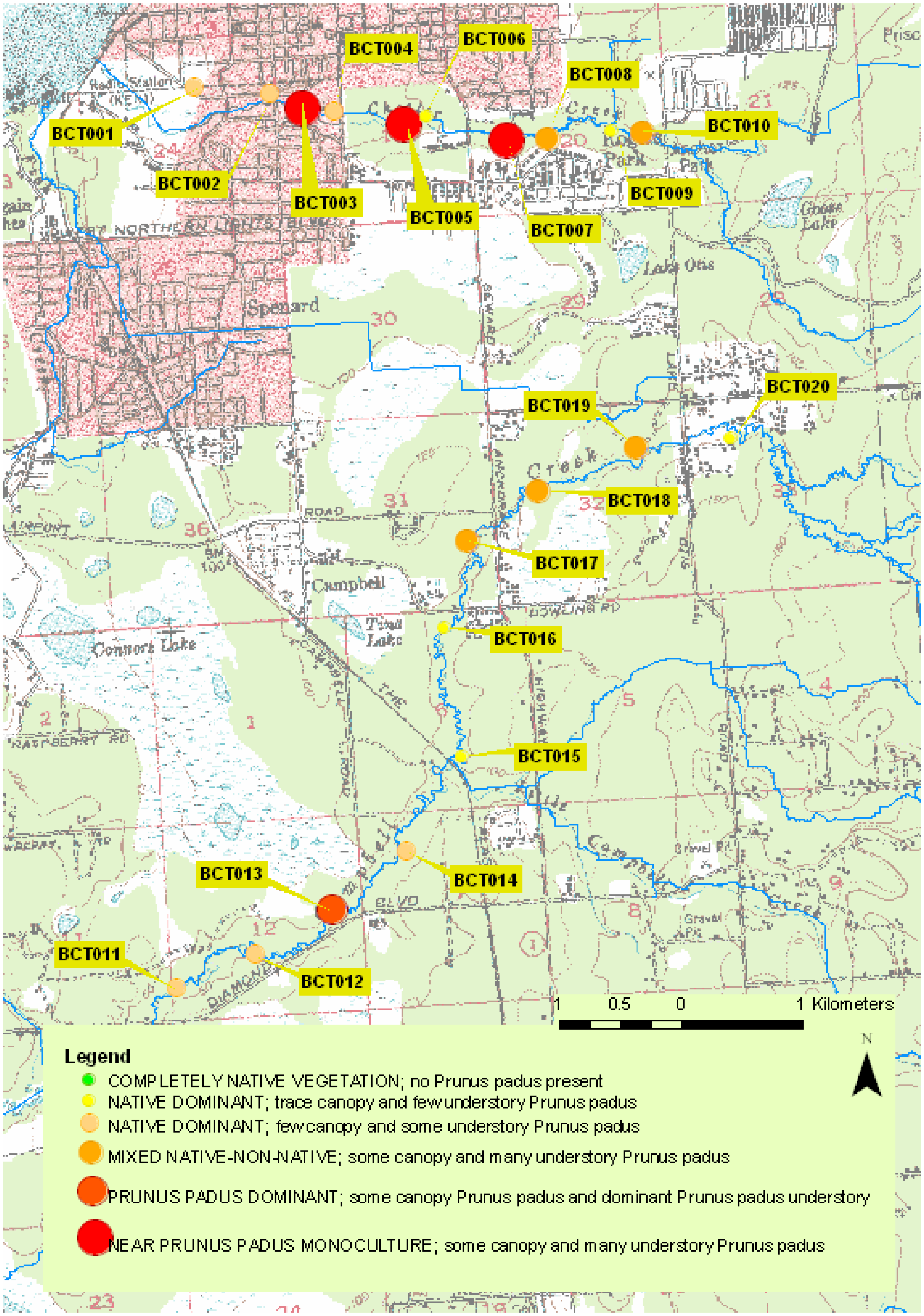

Figure 4: Study area, plot locations and *Prunus padus* infestation class, Anchorage, Alaska. Plots BCT001-BCT010 are located on Chester Creek; plots BCT011-BCT020 are located on Campbell Creek.

Each plot is composed of two 12-meter transects (Figure 5) that are designated by a ".1" or ".2" suffix. For example, Plot 1, Transect 1 would be designated as BCT001.1; whereas the second transect in the same plot would be designated as BCT001.2. Transects were oriented perpendicular to the trail and originated two meters away from the trail edge so that they would not interfere with trail traffic. Transect 2 was offset four meters to the right (facing away from the trail) from Transect 1; both transects were marked with orange survey line.

To aid in future relocation, yellow-capped rebar was planted at the beginning and end of each transect and an azimuth paralleling the transects was recorded. The origin and terminus of Transect 1 are denoted as R1.0 and R1.1, respectively and as R2.0 and R2.1, respectively for Transect 2.

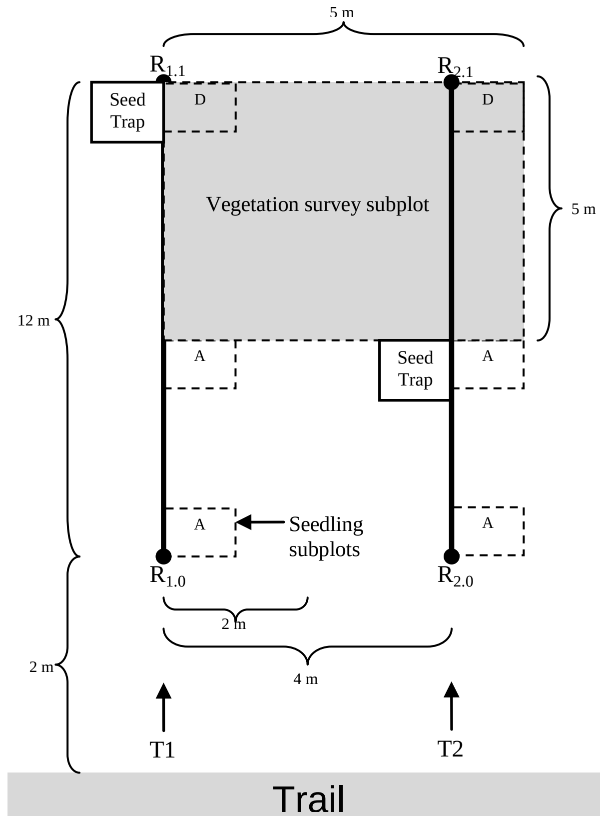

Figure 5: Schematic of plot, transect and seed trap, seedling subplot and vegetation subplot organization.

In addition, an "observer tree" was marked with an aluminum tag inscribed with the project name, date, plot name and azimuth readings. Azimuths from this point to the beginning of each transect (R1.0 and R2.0) were recorded. Photographs were taken to record the condition of the plot and to aid in relocation. Photo points were typically located at 1) of the plot from the trail in line with transect 1, 2) down the trail, 3) up the trail 4) of the opposite side of the trail from R1.0, 5) of transect 1 from R1.0 to R1.1 and from R1.1 back towards R1.0, and 6) of transect 2 from R2.0 to R2.1 and from R2.1 back towards R2.0, however photos were not taken at all of these locations for each plot. Plot photographs and azimuths are included as Appendix VIII.

Vegetation surveys:

A vegetation survey was performed at each plot to compare the relative abundances of *Prunus padus* to other (typically native) vegetation. Vegetation sub-plots measured 5 x 5 m and were located with one corner at the end of transect 1 (R1.1) and extending 5 m towards the beginning of transect 1 (R1.0) and 5 m perpendicular to T1 through R2.1 (Figure 5). Vegetation sub-plot perimeters were marked along the transect survey line. Within this sub-plot, canopy cover was estimated for *Prunus padus* and other landcover classes including needleleaf trees, birch trees, cottonwood trees, alder shrubs, willow shrubs, other shrubs, forbs, graminoids, and unvegetated ground.

To characterize *Prunus padus* stand demographics at each plot, the total *Prunus padus* cover was parsed into eight classes based on tree development (seedling, sapling, and mature tree) and size (height and diameter at breast height [DBH]). The eight demographic classed used were:

0:	non-woody seedlings
W0:	woody saplings <2.5 cm DBH
W01:	woody saplings <2.5 cm DBH and ≥ 1 m tall
3:	trees with DBH 2.5-7.5 cm
5:	trees with DBH 7.5-12.5 cm
7:	trees with DBH 12.5-17.5 cm
7+:	trees with DBH >17.5 cm
S:	root or basal sprouts

Seedling counts:
To quantify annual recruitment, seedlings were counted and removed within six 1 x 1 m sub-plots at each plot in 2008 and 2009. Seedling sub-plots were positioned from 1-2, 4-5, and 11-12 m along the right side of both transects at each plot (Figure 5). If no seedlings were found within the sub-plot, nothing was pulled; however any saplings that could be confused for the previous year's growth at the next annual sampling event were pulled.

Seed traps:
Seed traps were set at each plot to collect first year seeds for viability testing. Two traps were set in each plot; one seed trap was set adjacent to the left of one transect between meters 4-5 and the other trap was adjacent to left of the other transect between meters 11-12 (Figure 5). If tree trunks, water filled depressions etc. precluded the placement of traps at the specified meter interval along the transect, the trap would be moved farther to the left of the transect line or if this movement exceeded 20 cm, the order of trap placement would be switched.

Figure 6: Typical installation of a burlap seed trap.

Seed traps were made of one square meter of burlap secured to the ground surface with biodegradable stakes at each corner and more severely in the middle to create a slightly concave surface that would prevent material loss over the sides of the trap (Figure 6). The burlap was placed in 2008 and seeds were collected in 2009. To collect the seeds, the burlap was removed and placed on a larger mesh screen to prevent material loss. Litter and duff were carefully sorted from *Prunus padus* seeds (either fruits or stones). *Prunus padus* fruits and stones were counted and recorded; then approximately 10-15 percent of the total seed count per trap was removed for viability testing. The burlap traps were re-placed in their original position and litter and fruits and stones that were not selected for viability testing were returned to the trap. A second square meter burlap trap was placed over the original square and staked creating a sandwich-type seed trap. Separation of the 2008 and 2009 seed fall will help record inter-annual variance. Additional funding would allow AKNHP botanists to harvest a second crop of seeds and determine their longer-term viability. We are specifically interested in comparing the viability of *Prunus padus* seeds produced by the local populations to the two year period cited in literature (minimal viability was shown after two winters in a Swedish boreal forest, Granström 1987). Twelve seedling subplots could not be relocated/reused for the 2009 sampling (plots BCT015 and BCT016).

Seed viability testing

Figure 7: Example of tetrazolium seed viability test results.
This test differentiates live, respiring seeds (red) from dead, non-respiring seeds (white) based on color.

Seeds were tested for viability using a tetrazolium biochemical test that differentiates live from dead seeds based on the activity of respiration enzymes in the seeds. Viabile seeds treated with tetrazolium stain red (Figure 7). The viability of *Prunus padus* seeds collected in this study was tested following the protocol for the Rosaceae family, *Prunus* genus as described in the Tetrazolium Testing Handbook (Association of Official Seed Analysts 2000). In summary, hydrated seeds were treated with tetrazolium and evaluated for viability using a dissecting scope and picture references from the Tetrazolium Handbook. Four seed traps were missing or damaged and could not be reused in 2009 (BCT004, BCT015, BCT019 and BCT020).

Tree age determinations:

Tree cores were extracted from the most mature *Prunus padus* individuals within a plot to build an age-to-diameter growth model. Plots where mature trees did not occur were not sampled. In one case, core samples were collected from outside the boundaries of plot BCT002 to capture the ages of two large-diameter trees. Cores were extracted using an increment borer driven at breast height (3.5 feet above the ground surface) into the trunks of individuals with a minimum DBH of one inch. Samples that could not be accurately assessed in the field were stored in plastic drinking straws for laboratory analysis. In the lab, dried cores were mounted to wooden trays and sanded with increasingly fine grades of sandpaper. Annual growth rings were then counted with the naked eye or under magnification. Early- and late-wood were easily distinguishable and provided confident age.

Results and Discussion

The 20 plots completed for this study are primarily located in forested riverine habitats. European bird cherry was the third most common species by foliar cover (*Prunus padus*: 14%)[3], behind birch (*Betula papyrifera*: 23% average foliar cover) and cottonwood (*Populus balsamifera*: 20%) and followed by needleleaf species (predominately *Picea* spp.: 8%). The shrub genera alder (*Alnus* spp.) and willow (*Salix* spp.) were present at 11 and three percent cover, respectively. This forest composition compares well with the paper birch/Sitka alder and black cottonwood/Sitka alder plant community types described by DeVelice et al. (1999) for the Chugach National Forest. Due to the similarity between plant communities recorded here to those documented in nearby and pristine habitats, it does not appear that forest composition *per se* facilitates the introduction of *Prunus padus*.

Distribution

Infestations of *Prunus padus* are semi-continuous along Chester Creek from the outlet at Westchester Lagoon upstream to the tank trail; along Campbell Creek infestations are semi-continuous from the outlet at Little Campbell Lake upstream to the Campbell Tract (Figure 8). Stands tend to be denser along the Chester Creek Trail and likely reflect a longer history of infestation. The average age of trees cored in Chester Creek plots was 15 years, whereas the average age in Campbell Creek plots was 10 years (see Demographics section for further discussion). Along both corridors *Prunus padus* has dispersed into pristine ecosystems adjacent to Chugach State Park.

Within its natural range, *Prunus padus* is thought to prefer riparian habitats (Leather 1996). However, occurrences of this invasive tree species documented in conjunction with this and other invasive species surveys in the Anchorage area has lead to reconsideration of *Prunus padus* as exclusively a riparian threat. *Prunus padus* individuals have been observed growing on a variety of substrates and in non-riparian locations. For example, dune habitats in Kincaid Park (Cortés-Burns, pers. obs.), margins of black-spruce wetlands in the Anchorage Bowl, wetlands at the mouth of Ship Creek and upland habitat on Fort Richardson (Roon, pers. obs.). Dave Roon reported a woody *Prunus padus* sapling in a subalpine mountain hemlock at the top of the wooden staircase leading up from the Glenn Alps parking lot; however, we were not able to relocate this plant. A single individual of *Prunus virginiana* (chokecherry) was observed on a gravel bar of the Matanuska River near the old Glenn Highway Bridge (Duffy, pers. obs.).

[3] Average *Prunus padus* cover does not include seedling, saplings or suckers (demographic classes 0-3 are not included). Please note that plots were located to capture high densities of *Prunus padus*, thus the average cover values reported here are likely higher than the average values for *Prunus padus* cover along the entire trail systems.

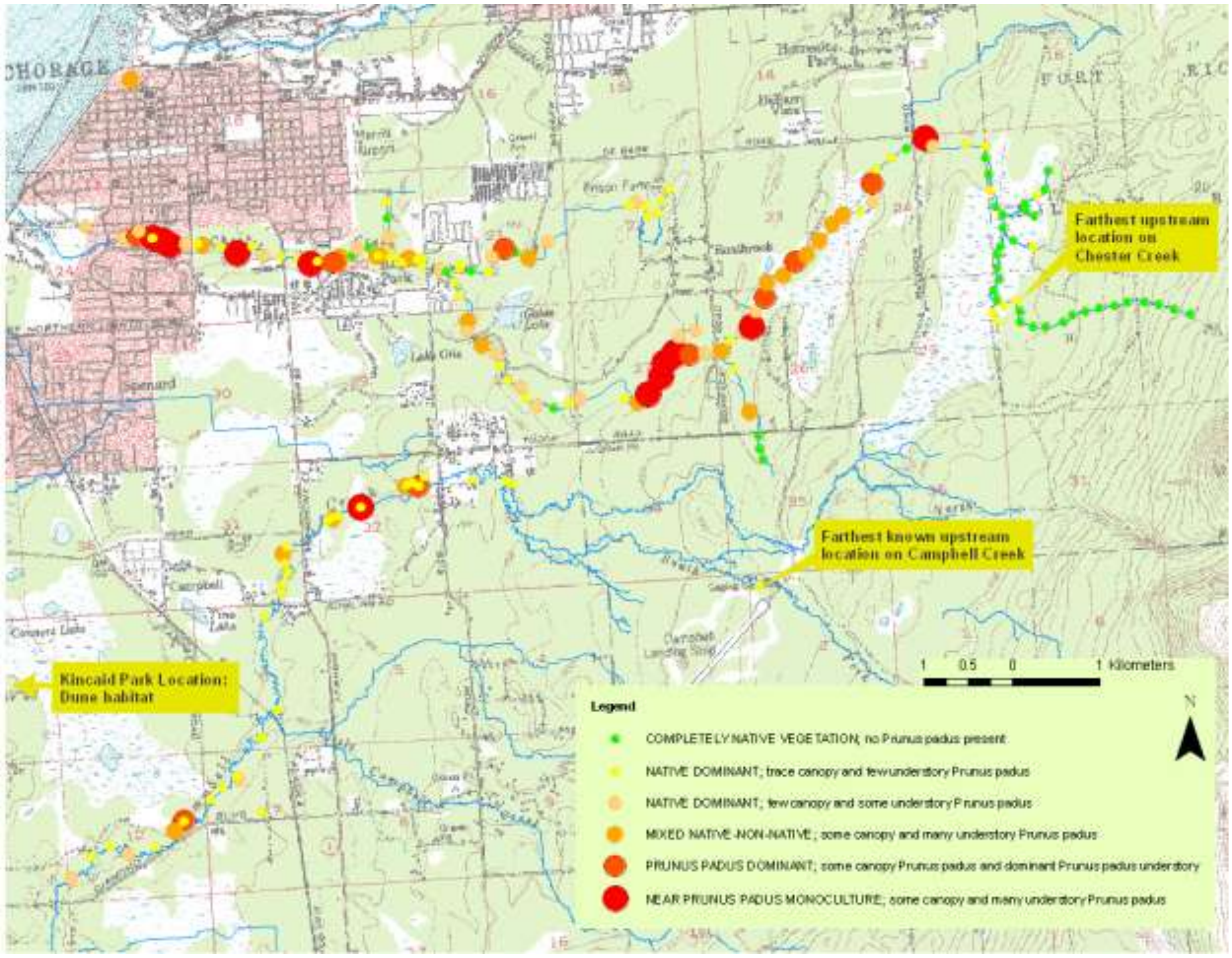

Figure 8: Locations and classes of *Prunus padus* infestations along the Chester and Campbell Creeks, Anchorage, Alaska.
Data were compiled from phases I and II of this project, the AKEPIC database (http://akweeds.uaa.alaska.edu/), and data collected by University of Alaska Fairbanks graduate student Dave Roon (Roon et al. 2009). At the time of this report Dave Roon had completed an intensive survey on Chester Creek only; survey of Campbell Creek will be completed in the summer of 2010. Thus, the distribution along Campbell Creek may be underrepresented in this figure. Additional locations recorded for Elmendorf Air Force Base are not shown in this figure; see the AKEPIC database for these records.

Demographics

Prunus padus stand demographics follow a reverse J-shape diameter distribution (Figure 9, Appendix IV) typical of balanced, uneven-aged stands (Oliver and Larson 1996). This pattern is indicative of continuous as opposed to episodic recruitment and suggests some level of equilibrium between recruitment and mortality. The high density of non-woody seedlings relative to woody seedlings suggests that stands either self-thin quite dramatically by the second year or that populations are currently experiencing a dramatic increase in size. In our opinion, self-thinning appears to be the primary mechanism underlying the exponential decrease in density with increasing diameter because seedling densities are far too high for the majority of these individuals to reach maturity. Also, high density seedlings tend to be concentrated in areas with well-established *Prunus padus* stands, rather than new sites. Multi-year monitoring is required to confirm that these populations are indeed self-thinning opposed to experiencing exponential growth.

The frequency of trees declines with increasing size classes and only a small fraction of the total trees are reproductive. However, single mature reproductive individuals are capable of producing hundreds of seedlings. Due to prolific production of seed (USDA, NRCS 2006) and the presumed ability of stands to self-thin, we believe that the removal of mature trees will be substantially more effective than seedling control. Secondary management should focus on larger, yet sub-reproductive individuals.

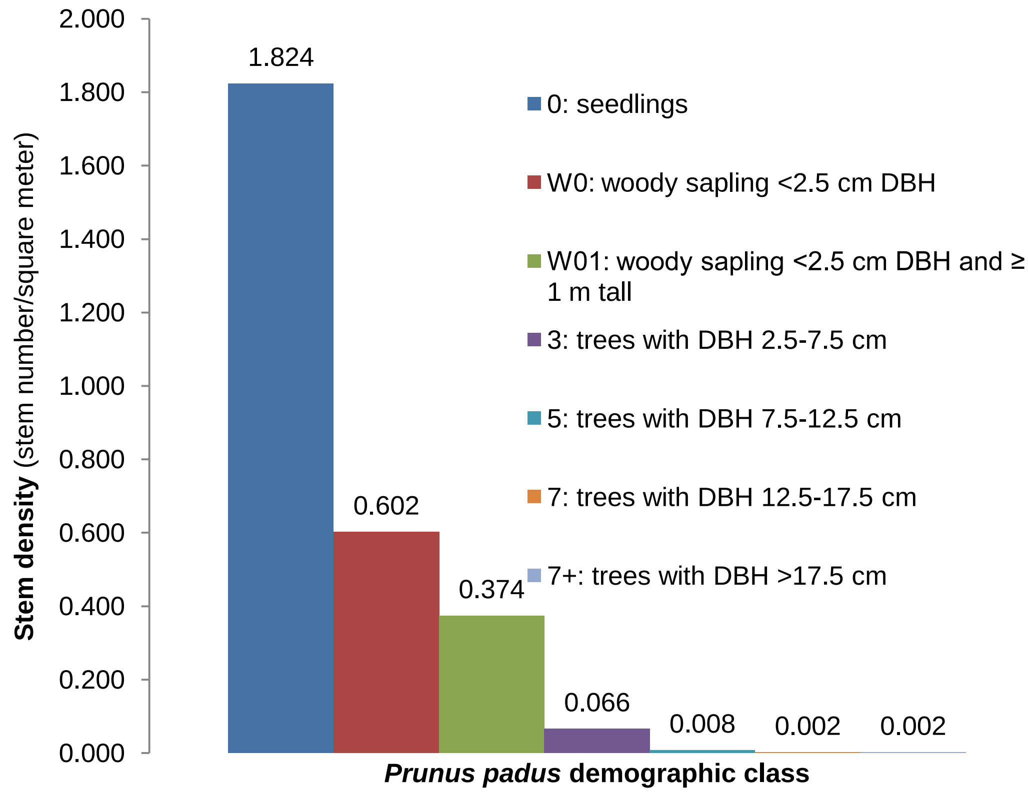

Figure 9: Density of *Prunus padus* stems (average stem number per square meter) by demographic class along the Chester and Campbell Creeks, Anchorage, Alaska.
DBH = diameter at breast height, 3.5 feet above the ground surface.

Age data were collected from *Prunus padus* trees at 15 plots and one random sample location to capture data from two large-diameter trees (Appendix VII.). The correlation between tree age and diameter at breast height is strong (Figure 10, R^2=0.84; n = 25). Mean annual increases in tree diameter has been shown to vary considerably in accordance with site condition and especially for young (less than 15-years old) *Prunus padus* trees in their native range (United Kingdom, Leather 1996.) Thus, the strong relationship observed in this study suggests consistent growth conditions (either favorable or unfavorable) and even competition for resources (Warring and Running 1998).

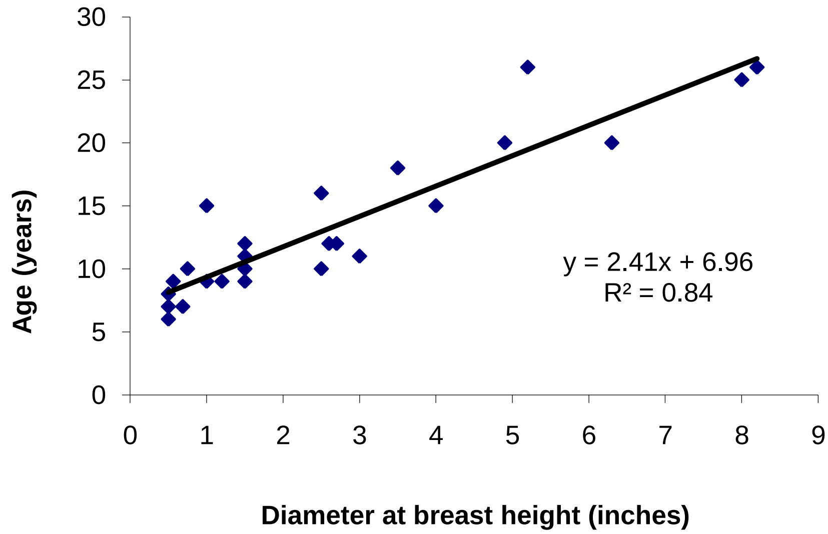

Figure 10: Age of *Prunus padus* individuals compared to trunk diameter at breast height along the Chester and Campbell Creeks, Anchorage, Alaska.

The average age of trees cored in Chester Creek plots was 15 years (n=16), whereas the average age in Campbell Creek plots was 10 years (n=9). The oldest *Prunus padus* individuals were found along the Chester Creek Trail. Two individuals (aged 25 and 26 years) were located near plot BCT002, which is largely surrounded by urban development; the third individual (aged 26 years) was located at plot BCT008 on a relatively unimpacted section of trail between the Seward Highway and Lake Otis Boulevard. This maximum age indicates that *Prunus padus* has been present in Anchorage since at least 1984 and suggests that the species has spread from a point of introduction near the city center.

Recruitment

Relative to Campbell Creek, seedling density was much higher in Chester Creek subplots with averages of 13 and nine seedlings per square meter in 2008 and 2009, respectively (Appendix V). The average seedling density in Campbell Creek subplots ranged from one to four seedlings per square meter in the 2008 and 2009 sampling, respectively. The variations in these average densities also show that seedling number was relatively higher along Chester Creek in 2008 whereas 2009 was a relatively more prolific year for seedlings along Campbell Creek. *Prunus padus* is known to produce fruit episodically with a one to three year interval between large seed sets. The annual fluctuations in seedling number shown for our local creek systems may reflect this episodic production. The temporal offset in annual seedling number recorded between Chester (high in 2008) and Campbell (high in 2009) Creeks may relate to asynchronicity in timing of large seed sets between separate *Prunus padus* metapopulations. However the intervals between large seed sets are short enough that we do not expect several, discrete cohorts to be discernable in the diameter distributions presented above (Figure 9).

On average, the seedling density in 2009 (6.5 seedlings per square meter) was less than the density in 2008 (8 seedlings per square meter). This 24 percent decrease is likely due to the hand-removal of all seedlings conducted after the 2008 seedling count but before the 2009 count, but could also relate to inter-annual variation in seed rain and/or germination or even the delayed germination of seed retained in the soil bank. No discernable relationships were found between seed rain (quantified as the number of seeds produced in 2008 yet collected from seed traps early in the 2009 growing season) and seedling germination (quantified as the number of seedlings in seedling subplots counted and germinated in 2009). The lack of relationship between the seed rain and seedling germination likely relates to the timing and spatial distribution of our sampling efforts. Assuming the germination of *Prunus padus* seed is delayed by passage of two winters (Granström 1987) it would be necessary to count seedlings in 2010 to determine what percent of the plants germinated from the seed produced during the 2008 growing season. However, seed traps and seedling subplots are not co-located; to best capture the percent germination from seed, we would need to count seedlings growing within the boundaries of the seed traps. The AKNHP is interested in collecting this type of seedling data during the 2010 field season with permission and funding from MOA and APF.

For all years and both creek systems, seedling numbers were highest in subplots located closest to the trail (Appendix V). There was no consistent pattern between the number of seedlings and distance from the trail at distances greater than six meters from the trail edge. High *Prunus padus* seedling number proximal to the trail likely relates to the greater frequency of large reproductive parent trees, more sunlight and possibly greater soil disturbance close to the trail edge.

The average annual seedling density was not related to any measure of native ground cover. No significant trends were found between seedling regeneration and upstream/downstream position along the stream corridor for either Chester or Campbell Creeks. For example, seedlings were not found in greater or lesser abundance at downstream (typically more disturbed) or upstream (typically more pristine) plots. Lack of relationship between native cover and level of site disturbance to presence of *Prunus padus* may reflect a wide ecological tolerance and/or high competitive ability of this species in Anchorage.

Regeneration

Seed viability testing found 79% of the seeds tested (n=119) were viable after one year (Appendix VI). This percent viability is within range for similar studies [74% viability after one year (Gordon and Rowe 1982); 85% average germination after one year (Grisez et al. 1974)]. In a Swedish boreal forest, *Prunus padus* seeds maintained minimal germination (~10%) after two winters and the seed bank was depleted by germination within three years (Granström 1987). With permission and funding, the AKNHP would like to conduct further testing on the viability of the seeds produced in 2008 that remain in the traps. Determination of the longer-term viability of *Prunus padus* seed in the Alaskan boreal transition zone has important management implications. If seed banks are depleted within a similar time span as that cited by Granström (1987), then multi-year (approximately five-year) control efforts could potentially eradicate *Prunus padus* populations in the Anchorage area.

General ecology

A weak (R^2 = 0.18) trend exists between the percent cover of native vegetation and *Prunus padus* infestation level (Figure 10); suggesting that percent cover of native vegetation decreases with increasing severity of *Prunus padus* infestation. If these data underlie an actual negative and causal relationship, the trend could suggest differential niche utilization by native versus non-native species or replacement of native species by *Prunus padus*; however the correlation presented is not significant.

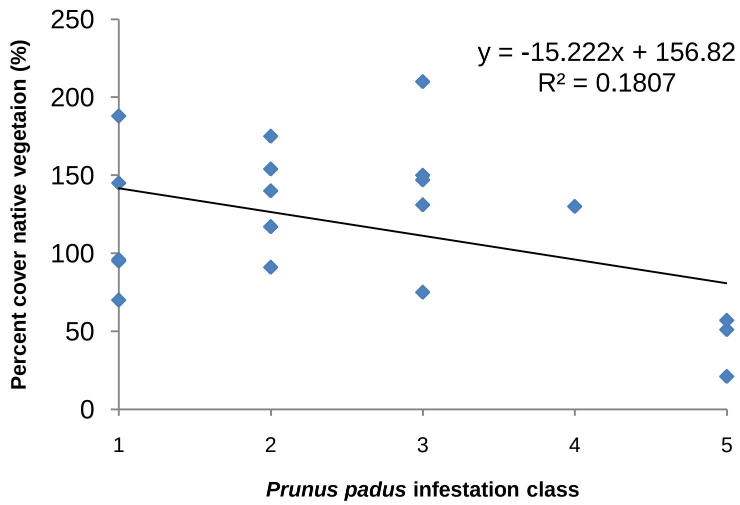

Figure 11: Percent cover of native vegetation compared to level of *Prunus padus* infestation at sites located along the Chester and Campbell Creeks, Anchorage, Alaska.
Percent cover of native vegetation exceeds 100% due to multiple and overlapping strata of vegetation (trees, shrubs, forbs and graminoids) at forested sites. *Prunus padus* infestation classes are explained in the methods section of this report.

The trend between native vegetation cover and *Prunus padus* infestation level was stronger when all strata of native vegetation (listed in Appendix II) were included in the regression suggesting that *Prunus padus* populations may not specifically suppress shrubs (*Alnus* and *Salix* spp.) as often hypothesized. Since *Prunus padus* populations are dominated by smaller size classes (see diameter distribution; Figure 8), it is reasonable that these seedlings and saplings would be competing more directly with understory forbs and graminoids. If the diameter distribution is weighted towards smaller size classes because *Prunus padus* is being recruited at increasing densities, these young cohorts may begin to compete more directly with native woody shrubs as they mature. As low-stature herbaceous species would likely be impacted by *Prunus padus* seedlings and saplings before impacts to taller and longer-living woody shrubs manifest, it is unlikely that suppression of shrubs would be reflected in the short-term dataset presented here. Also, because data was not collected on native tree and shrub recruitment, we cannot rule out the possibility that *Prunus padus* is impacting these species at the seedling stage. Alternatively, a negative correlation between native species and level of *Prunus padus* infestation could be due to *Prunus padus* establishing primarily in previously disturbed areas where native species were excluded. Experimental treatments are required to test for the degree and consequences of interspecific competition between *Prunus padus* and native shrubs.

No strong relationship was apparent between *Prunus padus* percent cover and percent cover of needleleaf to broadleaf species; *Prunus padus* appears to be recruiting in broadleaved as well as needleleaved forests.

If *Prunus padus* populations are left untreated, we anticipate that the vegetation along these two riparian corridors will continue to shift towards greater dominance of this invasive tree. If this does occur, it is probable that densities of keystone native woody species such as willows and alders will suffer with unknown consequences to wildlife species such as moose, fish, and birds.

Control Recommendations

The analysis and synthesis of the distributional, demographic and reproductive information collected in conjunction with this study provides guidance for the control of existing *Prunus padus* infestations as well as for the prevention of the further spread of this species along riparian corridors in the Anchorage area. Considering the apparent self-thinning in *Prunus padus* stands and their populations' inability to build long-term seed banks, we recommend that control efforts be directed towards the removal of mature, fruit-producing individual along both trail systems initially. Secondarily, effort should be directed at intercepting trees before they reach reproductive maturity.

Mature (fruit producing) individuals should be cut at the ground surface and treated with an herbicide approved for use by the MOA and Alaska Department of Environmental Conservation (ADEC). Painting or injecting stumps is generally a very effective way of delivering very small, yet localized doses of herbicides and in *Prunus padus*, is necessary to prevent basal and root sprouting. Herbicide should be applied to fresh-cut stumps late in the growing season so that the chemical is co-transported with other phloem-born resources to the roots for storage. It is important to note that phloem-transported compounds can pass to nearby trees through natural, intra-specific root grafts (Graham 1960).

If herbicide application is not an immediate option for the Municipality, the removal of mature trees <u>and</u> their stumps could be a labor-intensive, yet effective interim control measure. Cutting would restrict the dispersal of the species through reduction of fruit production. Lower fruit production would decrease the populations' ability to increase its local density or its potential to spread to more remote, uninfested habitats. Stump removal would hopefully cause enough damage to the plant to at least diminish root sprouting. Annual mowing or weed-whacking (depending on the roughness of the ground surface) could be initiated for populations where root sprouting continues to be a problem.

Accelerated decay methods, which encourage *in situ* composting of the stump, could also be incorporated to *Prunus padus* management plans. Following this method, stump decay is accelerated by increasing nitrogen available to microorganisms in the stump by the addition of slow-release fertilizer. Creating a concavity in the stump surface where rainwater could collect as well as mounding soil over the stump would help create a semi-anoxic environment that would further promote decay.

As with any non-native and potentially invasive species, prevention of introduction to uninfested habitats is the most important long-term control measure we can recommend. As a management practice, woody species that are invasive in south-central Alaska (e.g. *Prunus padus*, *Prunus virginiana* [chokecherry], and *Caragana arborescens* [Siberian pea shrub]) and those not recorded in Alaska but recognized a potential threats based on their invasive behavior in similar climates (e.g. *Alnus glutinosa* [European alder, black alder]) should not be used as ornamental plantings by the Municipality.

The recommendations provided herein constitute a first step towards the control of *Prunus padus* within the MOA. Knowledge of the longer-term viability of *Prunus padus* seed and the germination potential of *Prunus padus* from seed in local riparian habitats would allow a time-frame to be incorporated into a future invasive species management plan. To maximize treatment efficiency, the different control methods recommended here, specifically; herbicide application, stump removal, and accelerated decay techniques should be evaluated on a small-scale, trial basis prior to the implementation of a municipality-wide management plan. Determination of the type, duration and frequency of control treatments necessary to manage this species will better protect the ecological integrity of and public benefit from Municipal parklands.

Literature Cited

AKEPIC -Alaska Non-native Plant Information Clearing House (2005) Invasive Plants of Alaska. Alaska Association of Conservation Districts Publication. Anchorage, AK.

Association of Official Seed Analysts (AOSA). 2000. Tetrazolium Testing Handbook. Ed. J. Peters. (Rosaceae I Revision. 2007.) http://www.aosaseed.com/TZwebsite/TZupdateindex.html [January 15, 2010].

British Trees. 2004. Unsworth Associates Ltd. http://www.british-trees.com/treeguide/cherries/nbnsys0000003419.htm [January 12, 2010].

Brooks, M.L. 1999. Alien annual grasses and fire in the Mojave Desert. Madroño, 46:13–19.

Busch, D.E. 1995. Effects of fire on southwestern riparian plant community structure. Southwestern Naturalist, 40:259–267.

Carlson, M. L. and M. Shephard. 2007. Is the spread of non-native plants in Alaska accelerating? In: Meeting the challenge: invasive plants in Pacific Northwest ecosystems, Portland, OR (Harrington, T. B., and S. H. Reichard, tech. eds.). U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, En. Tech. Rep. PNW-GTR-694.: 111-127.

Carlson, M. L., Lapina, I. V., Shephard, M., Conn, J. S., Densmore, R., Spencer, P., Heys, J., Riley, J. and J. Nielsen. 2008. Invasiveness Ranking System for Non-Native Plants of Alaska. USDA Forest Service, R10, R10-TP-143. 218 pp.

Cortés-Burns, H., Lapina, I., Klein, S. C. and M. L. Carlson. 2007. Invasive Plant Species Monitoring and Control - Areas impacted by 2004 and 2005 Fires in Interior Alaska: A survey of Alaska BLM lands along the Dalton, Steese, and Taylor Highways. Report funded by the Bureau of Land Management, Alaska State Office, Anchorage, AK. 91 pp.

Cortés-Burns, H., Lapina, I., Klein, S. C., Carlson, M.L., and L. Flagstad. 2008. Invasive Plant Species Monitoring and Control - Areas impacted by 2004 and 2005 Fires in Interior Alaska: A survey of Alaska BLM lands along the Dalton, Steese, and Taylor Highways (revisit work). Report funded by the Bureau of Land Management, Alaska State Office, Anchorage, AK. 162pp.

DeVelice, R.L, C.J. Hubbard, K. Boggs, S. Boudreau, M. Potkin, T. Boucher, and C. Wertheim. 1999. Plant Community Types of the Chugach National Forest: southcentral Alaska. Alaska Region Technical Publication R10-TP-76. 375 pp.

Gordon A.G. and D.C.F. Rowe. 1982. Seed manual for trees and shrubs. Forestry Commission Bulletin 59. London: United Kingdom Forestry Commission. 132 pp.

Graham, B.F 1960. Transfer of Dye Through Natural Root Grafts of *Pinus Strobus* L. Ecology, 41:1, 56-64.

Granström, A. 1987. Seed viability of fourteen species during five years of storage in a forest soil. Journal of Ecology 75:321-331.

Grisez, T.J. 1974. *Prunus* L. Cherry, peach, and plum. In: Seeds of woody plants in the United States. p. 658-673. C.S. Schopmeyer, tech. coord. U.S. Department of Agriculture, Agriculture Handbook 450. Washington, DC.

Gubanov, I.A., K.B. Kiseleva, V.S. Novikov and B.N. Tihomirov. 1995. Flora of vascular plants of Central European Russia. Moscow. Argus. 558 pp. In Russian. University of Wyoming. Laramie, Wyoming. 630 pp.

Hobbs RJ, Huenneke LF (1992) Disturbance, diversity, and invasion: implications for conservation. Conservation Biology 6: 324-337.

Lapina, I., Klein, S. C. and M. L. Carlson. 2007. Non-native Plant Species of the Fairbanks Region: 2005 - 2006 Surveys. Alaska Natural Heritage Program, University of Alaska, Anchorage. Report funded and prepared for USDA, Forest Service, State and Private Forestry. 50 pp.

Leather, S.R. 1996. Biological flora of the British Isles. *Prunus padus* L. Journal of Ecology 84:125-132.

Myers, N. 1997. Global biodiversity II: Losses and threats. In G, K. Meffe and C. R. Carroll (eds.). Principles of Conservation Biology. Sinauer Associates, Sunderland, Massachusetts.

Oliver, C.D. and B.C. Larson. 1996. Forest Stand Dynamics, Update Edition. John Wiley & Sons, Inc. New York, 520 pp.

Randall, J. M. 1996. Weed control for the preservation of biological diversity. Weed technology, 10: 370-383.

Roon, D.A., M. Wipfli, T. Wurtz and P. Anupma. 2009. Ecological Effects of Introduced European Bird Cherry on Salmonid Food Webs in Anchorage Streams. The Committee for Noxious and Invasive Plant Management (CNIPM), 10th Annual Conference 2009 Poster Abstracts.

Smith, D.M., B.C. Larson, M.J. Kelty and P.M.S. Ashton, 1997. The Practice of Silviculture: Applied Forest Ecology, Ninth Edition. John Wiley and Sons, Inc. New York. 537 pp.

Snow, B. and D. Snow. 1988. Birds and berries. A study of an ecological interaction. T&AD Poyser, Calton. pp. 56-57.

Stein, B., L. Kutner, and J. Adams. 2000. Precious heritage: the status of biodiversity in the United States. Oxford University Press, Oxford.

U.S. Congress, Office of Technology Assessment. 1993. Harmful non-indigenous species in the United States. OTA-F-565. U.S. Government Printing Office, Washington, D.C.

USDA, NRCS. 2010. The PLANTS Database. http://plants.usda.gov, [January 12, 2010]. National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick, 1992. The Alaska Vegetation Classification. USDA Forest Service General Technical Report PNW-GTR-286.

Villano, K. L. and C. P. H. Mulder. 2008. Invasive plant spread in burned lands of interior Alaska. Final report for National Park Service—Alaska Region and National Aeronautics and Space Administration. Fairbanks, AK. 25 pp.

Warring, R.H. and S.W. Running. 1998. Forest Ecosystems, Analysis at Multiple Scales, Second Edition. Academic Press, San Diego. 370 pp.

Welsch, S.L. 1974. Anderson's flora of Alaska and adjacent parts of Canada. Brigham University Press. 724 pp.

Appendix I. Field datasheet used for *Prunus padus* control trials

Plot #	Surveyors:	Date:	Plot Size: _____ x ____ (m)
	GPS used:	WP:	Area Surveyed: ________ acres
	Lat (dd):	Elevation (m):	Infested area: _________ acres
Chester CHE	Lon (dd):	GPS Error ±	Disturbance type
Campbell CAM	Photos taken:		

Biome: Alpine Subalpine Forest Bog Herb Meadow Riparian	**Slope** (0-100°):
Hydrologic Regime: Dry Mesic Wet **Aquatic:** FW Brackish SW	**Floodplain?** ( ) Yes ( ) No

***Prunus padus* 'classes'**	**Canopy Height**	**% Canopy cv**	**% Ground cv**	**DBH (cm)**	**Stem #**	**Sucker #**
PRU PAD 0						
non woody seedlings						
PRU PAD W0						
Woody Seedlings <1 inch DBH						
PRU PAD W01						
<1 inch DBH AND ≥ 1 meter tall						
PRU PAD 3						
DBH = 1-3 inches (2.5-7.5 cm)						
PRU PAD 5						
DBH = 3-5 inches (7.5-12.5 cm)						
PRU PAD 7						
DBH = 5-7 inches (12.5-17.5 cm)						
PRU PAD 7+						
DBH = 7+ inches (>17.5 cm)						
PRU PAD S						
"Suckering"						

Infested area:
0.001 acre - 3.7ft radius
0.01 acre - 12ft radius
0.1 acre - 37ft radius
0.5 acre - 83ft radius
1 acre - 118ft radius

Canopy height
Creeping [C] <1m
Low (L) - 1-2m
Medium (M) - 2-5m
High (H) - >5m

Stem Count
(1-5)
(6-25)
(26-50)
(51-150)
151-500)
(500+)*
* if possible, be specific

Disturbance type
Fill importation
Material extraction
ORV disturbance
Mowing
Trampling
Logging
Mining
Grazing
Plowing
Mechanical Brush
Tree Cutting
Other Mechanical
Herbicide application
Abandonded
Homesite
River Action
(Flooding/
Erosion-Ice scour/
Deposition
Stream Action
Forest Fire
Land Slide/Avalanche
Caribou, moose
animal disturbance
Windthrow
Wind erosion
/deposition
Thermal disturbance
Glaciation
Volcanic action
Costal/Beach

Notes:

Native/other vegetation	**Canopy Height:**	**% Canopy cv**	**% Ground cv**	**DBH (cm)**	**Stem #**	**Sucker #**
Needleleaf						
Alder						
Birch						
Cottonwoods						
Willow						
Other shrubs						
Forbs						
Grasses/Sedges						
Unvegetated						

Unvegetated	**% Cover**
Litter, duff	
Wood (>2.5cm)	
Silt (feel on tongue)	
Sand (feel b/w fingers)	
Small rocks (gravel <7.6cm)	
Large rocks (cobbles 7.6-20.3cm, boulders >20.3cm)	
Bedrock	
Trunks of trees (basal area)	
Other (describe):	

Overall Succession Type-Classes: check the option that best reflects the overall site being surveyed		
Completely native (tree) vegetation. **No PRU PAD.**	0	
Native dominant. C, L, M, H **canopy:** PRUPAD **absent or trace**. **Understory: few** [<10%] PRUPAD seedlings and/or W0 saplings.	1	
Native dominant. **M-H canopy: few** (<10%) PRUPAD 3+. **Understory and C-L** canopy: **some** [10-25%] PRUPAD seedlings, W0/W01 saplings.	2	
Mixed native-non-native. **C-L-M-H canopy: some** [10-25%] PRUPAD 3+. **Understory: many** [25-50%] PRUPAD seedlings and saplings.	3	
PRUPAD dominant. **C-L-M-H canopy: some** (25-50%) PRUPAD (3+). **Understory: dominant** [25-75%] PRUPAD seedlings, saplings, suckers.	4	
PRUPAD near-**monoculture. C-L-M-H canopy: >50%** PRUPAD (3+). **Understory: very dominant [>75%]** PRUPAD seedlings, saplings, suckers	5	

Appendix II. Vegetation survey data

Plot name	**Total canopy cover** (%)	***Prunus padus* total cover#** (%)	***Prunus padus* canopy cover+** (%)	**Needleleaf cover** (%)	**Alder cover** (%)	**Birch cover** (%)	**Cottonwood cover** (%)	**Willow cover** (%)	**Other shrub cover** (%)	**Forb cover** (%)	**Graminoid cover** (%)	**Total unvegetated groundcover** (%)	**Litter/duff cover** (%)	**Wood cover** (<2.5 cm dia.[%])	**Water** (%)
BCT-001	82	85	0	0	T	0	82	0	0	25	10	20	20	0	0
BCT-002	80	48	0	0	0	60	20	5	3	65	1	5	5	T	0
BCT-003	60	115	40	10	0	0	10	0	0	1	0	75	75	1	0
BCT-004	95	70	5	0	0	65	25	0	1	T	0	50	50	0	0
BCT-005	100	88	65	20	0	25	0	0	0	2	4	65	65	0	0
BCT-006	40	18	0	0	5	10	30	25	T	15	60	5	5	0	0
BCT-007	95	120	50	0	12	0	45	0	0	0	0	90	85	5	0
BCT-008	55	103	40	0	0	5	10	10	20	30	0	20	15	5	0
BCT-009	93	53	0	3	0	90	0	0	0	2	T	75	65	10	0
BCT-010	100	123	45	0	0	60	35	0	2	50	T	10	8	2	0
BCT-011	35	32	20	15	25	0	0	0	15	15	70	10	10	0	0
BCT-012	45	20	0	20	20	25	0	0	30	70	10	5	0	5	0
BCT-013	0	66	0	0	40	0	0	0	T	50	40	10	5	5	0
BCT-014	57	40	0	15	0	2	40	5	5	25	25	10	10	T	0
BCT-015	85	28	0	55	0	30	0	2	40	60	1	15	15	0	0
BCT-016	0	6	0	0	15	0	0	0	0	15	40	25	0	0	25
BCT-017	25	50	20	5	95	0	0	0	30	30	50	50	50	0	0
BCT-018	16	20	0	15	10	1	0	5	40	60	0	25	15	5	5
BCT-019	100	30	0	T	0	40	95	0	0	5	10	75	75	T	0
BCT-020	60	17	0	10	0	50	0	10	10	15	1	10	5	5	0

Prunus padus total cover includes plants at all canopy levels (demographic classes 0 – 7+ and suckers). This total may exceed 100% when *Prunus padus* occurs as multiple, overlapping strata.

+ *Prunus padus* canopy cover does not include plants in the creeping and low canopy (demographic classes 0, W0, W01 and 3 not included)

Appendix III. Site attribute data

Plot name	2008 survey date	2009 survey date	Latitude (decimal degrees, NAD83)	Longitude (decimal degrees, NAD 83)	Elevation (meters)	Surveyors	Biome	Slope (degrees)	Hydrologic Regime	*Prunus padus* infestation class
BCT-001	25-Sep	23-Jun	61.20601	-149.90986	11	Roberts, T. & Wright, C.	Forest	0	Mesic	2
BCT-002	27-Sep	23-Jun	61.20520	-149.89840	8	Roberts, T. & Wright, C.	Forest	0	Mesic	2
BCT-003	27-Sep	23-Jun	61.20400	-149.89362	16	Roberts, T. & Wright, C.	Forest	0	Mesic	5
BCT-004	27-Sep	23-Jun	61.20359	-149.88869	11	Roberts, T. & Wright, C.	Forest	0	Mesic	2
BCT-005	27-Sep	25-Jun	61.20232	-149.87816	17	Roberts, T.; Wright, C.; Wheatall, A.	Forest	0	Mesic	4-5
BCT-006	3-Oct	24-Jun	61.20288	-149.87479	27	Roberts, T.; Wright, C.; Wheatall, A.	Forest	0	Mesic	1
BCT-007	27-Sep	24-Jun	61.20075	-149.86264	17	Roberts, T.; Wright, C.; Wheatall, A.	Forest	0	Mesic	5
BCT-008	3-Oct	24-Jun	61.20069	-149.85617	28	Roberts, T.; Wright, C.; Wheatall, A.	Wet forest	0	Mesic-wet	3
BCT-009	26-Sep	24-Jun	61.20094	-149.84642	26	Roberts, T.; Wright, C.; Wheatall, A.	Forest	0	Mesic	1
BCT-010	26-Sep	24-Jun	61.20068	-149.84165	41	Roberts, T.; Wright, C.	Forest-riparian	10	Mesic-wet	3
BCT-011	30-Sep	26-Jun	61.13999	-149.92123	10	Roberts, T.; Wright, C.; Wheatall, A.	Forest-riparian	0	Mesic	2
BCT-012	30-Sep	26-Jun	61.14207	-149.90887	9	Roberts, T.; Wright, C.	Forest-riparian	0	Mesic	2
BCT-013	30-Sep	26-Jun	61.14507	-149.89657	23	Roberts, T.; Wright, C.	Forest	0	Mesic-wet	4
BCT-014	30-Sep	26-Jun	61.14894	-149.88458	26	Roberts, T.; Wright, C.; Wheatall, A.	Forest	0	Mesic	2
BCT-015	30-Sep	30-Jul	61.15574	-149.87534	27	Roberts, T.; Wright, C	Forest	0	Mesic	1
BCT-016	30-Sep	30-Jul	61.16525	-149.87688	25	Roberts, T.; Wright, C.	Forest-herb meadow-riparian	0	Mesic-wet	1
BCT-017	30-Sep	25-Jun	61.17152	-149.87222	39	Roberts, T.; Wright, C.	Forest-riparian	0	Mesic-wet	3
BCT-018	30-Sep	25-Jun	61.17478	-149.86111	41	Roberts, T.; Wright, C.; Wheatall, A.	Forest-riparian	0	Mesic-wet	3
BCT-019	30-Sep	25-Jun	61.17756	-149.84552	46	Roberts, T.; Wright, C.; Wheatall, A.	Forest	0	Mesic	3
BCT-020	30-Sep	25-Jun	61.17788	-149.83127	57	Roberts, T.; Wright, C.; Wheatall, A.	Forest	10	Wet	1

Prunus padus infestation classes:

0: **Completely native** (tree vegetation). No *Prunus padus* present

1: **Native dominant**. *Prunus padus* is absent from or is present in trace amounts in the creeping, low, medium and/or high canopy; *Prunus padus* seedlings and/or woody seedlings with diameter less than 2.5 cm are present at less than 10% in the understory

2: **Native dominant**. *Prunus padus* trees with diameter of 2.5 or greater are present at 10% or more in the medium and high canopy. Some (10-25%) *Prunus padus* seedlings and/or woody seedlings with diameter less than 2.5 cm are present in the understory and/or the creeping or low canopy.

3: **Mixed native-non-native**. Some (10-25%) *Prunus padus* trees with diameter greater than 2.5 cm are present in the canopy (at any canopy level). Many (25-50%) *Prunus padus* seedlings and saplings are present in the understory.

4: ***Prunus padus* dominant**. Many (25-50%) *Prunus padus* trees with diameter greater than 2.5 cm are present in the canopy (at any canopy level). The understory is dominated (25-75%) by *Prunus padus* seedlings, saplings, and suckers.

5: ***Prunus padus* near-monoculture**. *Prunus padus* trees with diameter greater than 2.5 cm dominate (>50%) the canopy (at any canopy level). The understory is strongly dominated (>75%) by *Prunus padus* seedlings, saplings, and suckers.

Appendix IV. Stem counts of *Prunus padus* by demographic class

	***Number of Prunus padus* stems by demographic class**						
Plot Name	**0**	**W0**	**W01**	**3**	**5**	**7**	**7+**
BCT-001	325.5	38	26	1	0	0	0
BCT-002	15.5	38	26	1	0	0	0
BCT-003	15.5	38	3	1	1	0	0
BCT-004	100.5	38	38	0	0	0	0
BCT-005	51	10	3	0	0	0	1
BCT-006	3	10	7	0	0	0	0
BCT-007	7	30	14	1	1	0	0
BCT-008	100.5	15.5	15	0	0	1	0
BCT-009	10	7	9	0	0	0	0
BCT-010	70	20	17	6	1	0	0
BCT-011	8	1	1	0	0	0	0
BCT-012	6	2	3	0	0	0	0
BCT-013	6	15	10	5	0	0	0
BCT-014	3	1	0	2	0	0	0
BCT-015	3	0	1	2	0	0	0
BCT-016	15.5	15.5	5	0	0	0	0
BCT-017	60	5	0	0	1	0	0
BCT-018	3	0	0	13	0	0	0
BCT-019	3	10	5	1	0	0	0
BCT-020	3	7	4	0	0	0	0
Averages:	40.5	15.1	9.4	1.7	0.2	0.1	0.1

Notes: When quantified, suckers were included with the appropriate demographic class. Dead stems and stems recorded outside the plot were not included in demographic class totals.

Prunus padus demographic classes:

- **0**: non-woody seedlings
- **W0**: woody saplings <2.5 cm DBH
- **W01**: woody saplings <2.5 cm DBH and ≥ 1 meter tall
- **3**: trees with DBH 2.5-7.5 cm
- **5**: trees with DBH 7.5-12.5 cm
- **7**: trees with DBH 12.5-17.5 cm
- **7+:** trees with DBH >17.5 cm

Appendix V. *Prunus padus* seedling data

(page 1 of 3)

Plot Number (Plot.Transect.Meter)	**First annual sampling** Sampling date	Total number of seedlings	**Second annual sampling** Sampling date	Total number of seedlings
BCT-001.1.1A	10/2/2008	0	6/23/2009	0
BCT-001.1.4A	10/2/2008	5	6/23/2009	5
BCT-001.1.11D	10/2/2008	32	6/23/2009	8
BCT-001.2.1A	10/2/2008	9	6/23/2009	10
BCT-001.2.4A	10/2/2008	6	6/23/2009	1
BCT-001.2.11D	10/2/2008	101	6/23/2009	32
BCT-002.1.1A	10/2/2008	0	6/23/2009	0
BCT-002.1.4A	10/2/2008	0	6/23/2009	3
BCT-002.1.11D	10/2/2008	0	6/23/2009	1
BCT-002.2.1A	10/2/2008	0	6/23/2009	0
BCT-002.2.4A	10/2/2008	15	6/23/2009	6
BCT-002.2.11D	10/2/2008	10	6/23/2009	22
BCT-003.1.1A	10/2/2008	25	6/23/2009	30
BCT-003.1.4A	10/2/2008	0	6/23/2009	2
BCT-003.1.11D	10/2/2008	0	6/23/2009	3
BCT-003.2.1A	10/2/2008	87	6/23/2009	72
BCT-003.2.4A	10/2/2008	0	6/23/2009	0
BCT-003.2.11D	10/2/2008	6	6/23/2009	7
BCT-004.1.1A	10/2/2008	95	6/23/2009	42
BCT-004.1.4A	10/2/2008	17	6/23/2009	20
BCT-004.1.11D	10/2/2008	13	6/23/2009	71
BCT-004.2.1A	10/2/2008	134	6/23/2009	42
BCT-004.2.4A	10/2/2008	147	6/23/2009	72
BCT-004.2.11D	10/2/2008	7	6/23/2009	3
BCT-005.1.1A	10/2/2008	0	6/25/2009	0
BCT-005.1.4A	10/2/2008	27	6/25/2009	2
BCT-005.1.11D	10/2/2008	0	6/25/2009	0
BCT-005.2.1A	10/2/2008	0	6/25/2009	0
BCT-005.2.4A	10/2/2008	6	6/25/2009	11
BCT-005.2.11D	10/2/2008	0	6/25/2009	1
BCT-006.1.1A	10/3/2008	0	6/24/2009	0
BCT-006.1.4A	10/3/2008	0	6/24/2009	0
BCT-006.1.11D	10/3/2008	0	6/24/2009	0
BCT-006.2.1A	10/3/2008	0	6/24/2009	0
BCT-006.2.4A	10/3/2008	2	6/24/2009	1
BCT-006.2.11D	10/3/2008	0	6/24/2009	0
BCT-007.1.1A	10/3/2008	0	6/24/2009	0
BCT-007.1.4A	10/3/2008	10	6/24/2009	1
BCT-007.1.11D	10/3/2008	0	6/24/2009	1
BCT-007.2.1A	10/3/2008	0	6/24/2009	0
BCT-007.2.4A	10/3/2008	4	6/24/2009	2
BCT-007.2.11D	10/3/2008	3	6/24/2009	0

Plot Number (Plot.Transect.Meter)	**First annual sampling** Sampling date	Total number of seedlings	**Second annual sampling** Sampling date	Total number of seedlings
BCT-008.1.1A	10/3/2008	0	6/24/2009	0
BCT-008.1.4A	10/3/2008	7	6/24/2009	10
BCT-008.1.11D	10/3/2008	4	6/24/2009	5
BCT-008.2.1A	10/3/2008	1	6/24/2009	0
BCT-008.2.4A	10/3/2008	1	6/24/2009	0
BCT-008.2.11D	10/3/2008	1	6/24/2009	3
BCT-009.1.1A	10/3/2008	2	6/24/2009	0
BCT-009.1.4A	10/3/2008	1	6/24/2009	0
BCT-009.1.11D	10/3/2008	0	6/24/2009	0
BCT-009.2.1A	10/3/2008	0	6/24/2009	1
BCT-009.2.4A	10/3/2008	29	6/24/2009	10
BCT-009.2.11D	10/3/2008	0	6/24/2009	1
BCT-010.1.1A	10/3/2008	0	6/24/2009	0
BCT-010.1.4A	10/3/2008	0	6/24/2009	5
BCT-010.1.11D	10/3/2008	0	6/24/2009	3
BCT-010.2.1A	10/3/2008	0	6/24/2009	0
BCT-010.2.4A	10/3/2008	0	6/24/2009	2
BCT-010.2.11D	10/3/2008	0	6/24/2009	2
BCT-011.1.1A	9/30/2008	0	6/26/2009	0
BCT-011.1.4A	9/30/2008	0	6/26/2009	0
BCT-011.1.11D	9/30/2008	0	6/26/2009	0
BCT-011.2.1A	9/30/2008	0	6/26/2009	0
BCT-011.2.4A	9/30/2008	0	6/26/2009	2
BCT-011.2.11D	9/30/2008	0	6/26/2009	0
BCT-012.1.1A	9/30/2008	0	6/26/2009	0
BCT-012.1.4A	9/30/2008	0	6/26/2009	2
BCT-012.1.11D	9/30/2008	0	6/26/2009	1
BCT-012.2.1A	9/30/2008	0	6/26/2009	0
BCT-012.2.4A	9/30/2008	0	6/26/2009	0
BCT-012.2.11D	9/30/2008	0	6/26/2009	0
BCT-013.1.1A	9/30/2008	0	6/26/2009	0
BCT-013.1.4A	9/30/2008	0	6/26/2009	0
BCT-013.1.11D	9/30/2008	0	6/26/2009	0
BCT-013.2.1A	9/30/2008	0	6/26/2009	0
BCT-013.2.4A	9/30/2008	0	6/26/2009	0
BCT-013.2.11D	9/30/2008	0	6/26/2009	0
BCT-014.1.1A	9/30/2008	0	6/26/2009	0
BCT-014.1.4A	9/30/2008	0	6/26/2009	0
BCT-014.1.11D	9/30/2008	0	6/26/2009	0
BCT-014.2.1A	9/30/2008	0	6/26/2009	0
BCT-014.2.4A	9/30/2008	0	6/26/2009	0
BCT-014.2.11D	9/30/2008	0	6/26/2009	0

Prunus padus seedling data (page 3 of 3)

Plot Number (Plot.Transect.Meter)	First annual sampling: Sampling date	First annual sampling: Total number of seedlings	Second annual sampling: Sampling date	Second annual sampling: Total number of seedlings
BCT-015.1.1A	9/30/2008	0	unable to relocate plot	
BCT-015.1.4A	9/30/2008	0		
BCT-015.1.11D	9/30/2008	0		
BCT-015.2.1A	9/30/2008	0		
BCT-015.2.4A	9/30/2008	2		
BCT-015.2.11D	9/30/2008	0		
BCT-016.1.1A	9/30/2008	37		
BCT-016.1.4A	9/30/2008	3		
BCT-016.1.11D	9/30/2008	0		
BCT-016.2.1A	9/30/2008	9		
BCT-016.2.4A	9/30/2008	2		
BCT-016.2.11D	9/30/2008	1		
BCT-017.1.1A	10/4/2008	64	6/25/2009	115
BCT-017.1.4A	10/4/2008	6	6/25/2009	4
BCT-017.1.11D	10/4/2008	4	6/25/2009	3
BCT-017.2.1A	10/4/2008	3	6/25/2009	9
BCT-017.2.4A	10/4/2008	109	6/25/2009	20
BCT-017.2.11D	10/4/2008	4	6/25/2009	13
BCT-018.1.1A	10/4/2008	4	6/25/2009	35
BCT-018.1.4A	10/4/2008	1	6/25/2009	1
BCT-018.1.11D	10/4/2008	4	6/25/2009	0
BCT-018.2.1A	10/4/2008	17	6/25/2009	10
BCT-018.2.4A	10/4/2008	5	6/25/2009	5
BCT-018.2.11D	10/4/2008	2	6/25/2009	0
BCT-019.1.1A	10/4/2008	0	6/25/2009	0
BCT-019.1.4A	10/4/2008	0	6/25/2009	0
BCT-019.1.11D	10/4/2008	0	6/25/2009	0
BCT-019.2.1A	10/4/2008	0	6/25/2009	2
BCT-019.2.4A	10/4/2008	0	6/25/2009	1
BCT-019.2.11D	10/4/2008	1	6/25/2009	1
BCT-020.1.1A	10/4/2008	0	6/25/2009	0
BCT-020.1.4A	10/4/2008	0	6/25/2009	0
BCT-020.1.11D	10/4/2008	0	6/25/2009	0
BCT-020.2.1A	10/4/2008	0	6/25/2009	0
BCT-020.2.4A	10/4/2008	0	6/25/2009	0
BCT-020.2.11D	10/4/2008	0	6/25/2009	0

Appendix VI. *Prunus padus* seed viability data

Plot Number (Plot.Transect.Meter)	Date of seed collection	Number of seeds collected	Number of seeds tested	Number of viable seeds	Percent viability
BCT-001.1.11D	5/22/2009	26	3	3	100
BCT-001.2.4A	5/26/2009	52	10	9	90
BCT-002.1.4A	5/26/2009	0			
BCT-002.2.11D	5/26/2009	25	3	3	100
BCT-003.1.11D	5/26/2009	238	25	18	72
BCT-003.2.4A	5/26/2009	235	20	18	90
BCT-004.1.4A	5/26/2009	trap missing			
BCT-004.2.11D	5/26/2009	2			
BCT-005.1.11D	5/26/2009	0			
BCT-005.2.4A	5/26/2009	13	1	1	100
BCT-006.1.4A	5/26/2009	0			
BCT-006.2.11D	5/26/2009	0			
BCT-007.1.11D	5/29/2009	30	3	3	100
BCT-007.2.4A	5/29/2009	28	3	3	100
BCT-008.1.4A	5/29/2009	259	25	14	56
BCT-008.2.11D	5/29/2009	42	4	3	75
BCT-009.1.11D	5/29/2009	1			
BCT-009.2.4A	5/29/2009	1			
BCT-010.1.4A	5/29/2009	0			
BCT-010.2.11D	5/29/2009	22	2	2	100
BCT-011.1.11D	6/5/2009	0			
BCT-011.2.4A	6/5/2009	18	1	1	100
BCT-012.1.11D	6/5/2009	0			
BCT-012.2.4A	6/5/2009	11	1	1	100
BCT-013.1.4A	6/5/2009	2			
BCT-013.2.11D	6/5/2009	45	5	4	80
BCT-014.1.11D	6/5/2009	4			
BCT-014.2.4A	6/5/2009	16	1	1	100
BCT-015.1.4A	6/5/2009	53	5	4	80
BCT-015.2.11D	6/5/2009	trap missing			
BCT-016.1.11D	6/5/2009	1			
BCT-016.2.4A	6/5/2009	3			
BCT-017.1.4A	6/11/2009	56	5	4	80
BCT-017.2.11D	6/11/2009	29	2	2	100
BCT-018.1.11D	6/11/2009	2			
BCT-018.2.4A	6/11/2009	8			
BCT-019.1.4A	6/11/2009	trap buried			
BCT-019.2.11D	6/11/2009	1			
BCT-020.1.11D	6/11/2009	trap missing			
BCT-020.2.4A	6/11/2009	0			
		Totals:	119	94	79

Appendix VII. *Prunus padus* diameter and age data

Plot name	**Core extraction date**	**Diameter at breast height***	**Estimated age** (years)
BCT-001	6/23/2009	1.0	15
near BCT-002	6/23/2009	8.0	25
near BCT-002	6/23/2009	8.2	26
BCT-002	6/23/2009	0.6	9
BCT-002	6/23/2009	0.5	8
BCT-002	6/23/2009	1.5	12
BCT-003	6/23/2009	4.0	15
BCT-003	6/23/2009	1.5	11
BCT-004	6/23/2009	3.5	18
BCT-007	6/24/2009	6.3	20
BCT-007	6/24/2009	2.7	12
BCT-008	6/24/2009	5.2	26
BCT-009	6/24/2009	0.7	7
BCT-010	6/24/2009	2.5	16
BCT-010	6/24/2009	3.0	11
BCT-010	6/24/2009	1.2	9
BCT-011	6/26/2009	1.5	10
BCT-011	6/26/2009	4.9	20
BCT-013	6/26/2009	2.5	10
BCT-014	6/26/2009	1.5	9
BCT-017	6/25/2009	2.6	12
BCT-019	6/25/2009	1.0	9
BCT-019	6/25/2009	0.5	7
BCT-021	6/25/2009	0.5	6
BCT-020	6/25/2009	0.8	10

Diameter at breast height corresponds to 3.5 feet above the ground surface

Appendix VIII. Plot photographs and azimuths

BCT001

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ [4]= 320°,
Observer tree azimuth from tree to $R_{1.0}$ = 174.5° (note: observer tree is in transect 1)

Plot overview

Observer tree no. 1 with tag

Observer tree no. 2 with tag

Looking down transect 1

Looking down transect 2

[4] Note: azimuth given parallels the azimuth between $R_{2.0}$ to $R_{2.1}$ for this and all subsequent plots

BCT002

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 336°,
Observer tree azimuth from tree to $R_{1.0}$ = 194°
Observer tree azimuth from tree to $R_{2.0}$ = 158°

View from BCT002 east towards Arctic Blvd.

View south from BCT002

View west from BCT002

Observer tree with tag

Transect 1

Transect 2

BCT003

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 176°,
Observer tree azimuth from tree to $R_{1.0}$ = 6°
Observer tree azimuth from tree to $R_{2.0}$ = 336°

View east of plot

View west of plot

$R_{1.0}$ to $R_{1.1}$

Observer tree to $R_{1.0}$

$R_{1.1}$ to Trail

$R_{1.1}$ Marker

Observer tree to $R_{2.0}$

$R_{2.0}$ to $R_{2.1}$

BCT004

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 348°,
Observer tree azimuth from tree to $R_{1.0}$ = 88°
Observer tree azimuth from tree to $R_{2.0}$ = 112°

View east from plot

View west from plot

Chester Creek south of plot

Plot overview

Observer tree to trail

Observer tree to $R_{1.0}$

BCT004 continued

$R_{1.1}$ marker

$R_{1.1}$ to $R_{1.0}$

$R_{2.0}$ to $R_{2.1}$

BCT005

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 215°,
Observer tree azimuth from tree to $R_{1.0}$ = 19°
Observer tree azimuth from tree to $R_{2.0}$ = 32°

View west from plot

View east from plot

Observer tree to $R_{1.0}$

$R_{1.0}$ to $R_{1.1}$

$R_{1.1}$ to $R_{1.0}$

$R_{2.0}$ to $R_{2.1}$

$R_{2.1}$ marker

$R_{2.1}$ to $R_{2.0}$

BCT006

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 178°,
Observer tree azimuth from tree to $R_{1.0}$ = 316°
Observer tree azimuth from tree to $R_{2.0}$ = 12°

View east from plot

View west from plot

$R_{1.1}$ marker

$R_{1.0}$ to $R_{1.1}$

$R_{1.1}$ to $R_{1.0}$

BCT007

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 170°,
Observer tree azimuth from tree to $R_{1.0}$ = 4°
Observer tree azimuth from tree to $R_{2.0}$ = 22.5°

Plot overview

Woodside Park east of plot

Woodside Park east of plot

Forest edge adjacent to plot

Clearing adjacent to plot

Looking back towards trail from plot

BCT008

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 350°
Observer tree azimuth from tree to $R_{1.0}$ = 206°
Observer tree azimuth from tree to $R_{2.0}$ = 160°

View west from plot

View east from plot

Observer tree (birch, photo right)

Observer tree

$R_{1.0}$ to $R_{1.1}$

$R_{2.0}$ to $R_{2.1}$

BCT009
Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 350°,
Observer tree azimuth from tree to $R_{1.0}$ = 186°
Observer tree azimuth from tree to $R_{2.0}$ = 9.2°

Plot overview

View west of plot

View east of plot

Observer tree with tag

Observer tree (indicated by field staff)

BCT010

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 150°,
Observer tree azimuth from tree to $R_{1.0}$ = 20°
Observer tree azimuth from tree to $R_{2.0}$ = 18°

Plot overview

Duck pond at far end of plot

View west of plot

View east of plot

Trail and trailside opposite plot

Observer tree (as indicated by field staff)

BCT011

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 110°,
Observer tree azimuth from tree to $R_{1.0}$ = 258°
Observer tree azimuth from tree to $R_{2.0}$ = 252°

View south of plot

View north of plot

Field west of plot

Observer Tree to $R_{1.0}$

$R_{1.0}$ to $R_{1.1}$

Transect 1

BCT011 continued

Transect 1

Transect 2

Transect 2

BCT012

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 272°,
Observer tree azimuth from tree to $R_{1.0}$ = 118°
Observer tree azimuth from tree to $R_{2.0}$ = 75°

View west of plot

View east of plot

$R_{1.1}$ to $R_{1.0}$

Transect 1

Transect 1

BCT012 continued

Campbell Creek at far end of Transect 2

Transect 2

BCT013

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 142°,
Observer tree azimuth from tree to $R_{1.0}$ = 272°
Observer tree azimuth from tree to $R_{2.0}$ = 358°

View west from plot

View east from plot

Observer tree (one of two)

Observer tree (two of two)

$R_{1.1}$ to $R_{1.0}$

BCT013 continued

Transect 1

Transect 1

Transect 2

Transect 2

BCT014

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 25°,
Observer tree azimuth from tree to $R_{1.0}$ = 250°
Observer tree azimuth from tree to $R_{2.0}$ = 49°

View south of plot

View north of plot

Taku Lake, opposite plot

$R_{1.0}$ to $R_{1.1}$

$R_{1.1}$ to $R_{1.0}$

BCT014 continued

Transect 1

Transect 2

BCT015

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 340°,
Observer tree azimuth from tree to $R_{1.0}$ = 125°
Observer tree azimuth from tree to $R_{2.0}$ = 212°

Bridge west of plot

Bridge east of plot

Plot overview

Plot overview

$R_{1.0}$ to $R_{1.1}$

BCT015 continued

Observer tree to $R_{1.0}$

Observer tree to $R_{2.0}$

Transect 1

Transect 2

BCT016

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 330°,
Observer tree azimuth from tree to $R_{1.0}$ = 204°
Observer tree azimuth from tree to $R_{2.0}$ = 102°

Bridge southwest of plot

Trail northeast of plot

$R_{2.0}$ to $R_{2.1}$

Observer tree to $R_{1.0}$

Observer tree to $R_{2.0}$

Transect 1

BCT016 continued

Transect 2

Campbell Creek at the far end of Transect 2

BCT017

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 136°,
Observer tree azimuth from tree to $R_{1.0}$ = 268°
Observer tree azimuth from tree to $R_{2.0}$ = 280°

View south from plot

View north from plot

Plant community on opposite side of trail

BCT017 continued

Observer tree to $R_{1.0}$

Observer tree to $R_{2.0}$

Transect 1

Transect 2

BCT018

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 11.5°,
Observer tree azimuth from tree to $R_{1.0}$ = 164°
Observer tree azimuth from tree to $R_{2.0}$ = 150°

View north from plot

Campbell Creek north from plot

View south from plot

Campbell Creek south from plot

Observer tree (with wire showing)

$R_{1.0}$ to $R_{1.1}$

BCT018 continued

Plant community on opposite side of the trail

Transect 2

Transect 2

BCT019

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 352°,
Observer tree azimuth from tree to $R_{1.0}$ = 118°
Observer tree azimuth from tree to $R_{2.0}$ = 137°

View south from plot

View north from plot

Transect 1

Transect 2

BCT019 continued

Observer tree

Observer tree to $R_{1.0}$

Observer tree to $R_{2.0}$

Plant community/land use on opposite side of the trail

BCT020

Transect azimuth from $R_{1.0}$ to $R_{1.1}$ = 166°,
Observer tree azimuth from tree to $R_{1.0}$ = 294°
Observer tree azimuth from tree to $R_{2.0}$ = 17°

View west from plot

View north from plot

Plant community/land use on opposite side of trail

Observer tree to $R_{1.0}$

$R_{1.0}$ to $R_{1.1}$

$R_{2.1}$ to $R_{2.0}$

BCT020 continued

Transect 1

Transect 2