MUNICIPALITY OF ANCHORAGE

WATERSHED & NATURAL RESOURCES ADVISORY COMMISSION
RESOLUTION NO. 2019-01

A RESOLUTION REGARDING THE USE OF HERBICIDES TO CONTROL MAYDAY TREES IN PARKS AND GREENBELTS.

(WNRC Case No. 2019-01)

WHEREAS, the Watershed & Natural Resources Advisory Commission was asked by public citizen Hans Thompson to recommend the use of herbicides for mayday eradication within 150 feet of Anchorage creeks, and specifically Chester Creek; and

WHEREAS, the Watershed & Natural Resources Advisory Commission was asked by the Anchorage Park Foundation's Invasive Plant Program to assess the pros and cons of using five "non-allowed" herbicides, as defined in AMC 15.75.020: glyphosate, imazapyr, aminopyralid, 2,4-D, and triclopyr; and

WHEREAS, mayday trees are an invasive species that must be controlled to preserve the natural diversity and environmental integrity of Anchorage parks and streams, based on the information provided in the Watershed & Natural Resources Advisory Commission report entitled "Using Herbicides to Control or Eradicate Mayday Trees in Anchorage Parks and Greenbelts"; and

WHEREAS, by replacing native broadleaf trees in riparian areas, mayday trees are significantly reducing the amount of browse available for moose, the biomass and diversity of leaf litter used by aquatic invertebrates that are eaten by fish in the aquatic stage of their life cycle and by birds and bats in the winged stage of their life cycle, and the biomass and diversity of terrestrial insects that are an important food source for salmonids, as well as insectivorous birds and bats; and

WHEREAS, the Anchorage Bowl Tree Canopy Assessment (2018) found that mayday trees are the only invasive plant species that "threatens tree canopy composition in natural forests," and the Anchorage Invasive Plant Management Plan (2010) found that mayday tree "control and containment efforts [including both manual methods and herbicides] must be focused along transportation corridors [e.g., roads and trails], nearby or on public lands, and on outlying infestations," and the Chester Creek Watershed Plan (2014) identifies creating and implementing an invasive removal and control strategy for mayday trees as a "highest priority" action item; and

WHEREAS, mayday trees are more toxic to humans and moose, if ingested, than the herbicides that have been proposed to control their spread; and

WHEREAS, monocultures of mayday trees have a much lower capacity to intercept stormwater runoff than the native trees they are replacing and in some instances may obstruct the visibility of trail users and other park visitors; and

WHEREAS, Anchorage residents are allowed to use herbicides on private property up to the water's edge, but the use is not allowed in municipal parks and greenbelts by AMC 15.75.025, except with the consent of the director of the municipal Department of Health and Human Services or designee; and

WHEREAS, AMC 15.75.025 allows exceptions for the use of "non-allowed" pesticides to control invasive species in parks and greenbelts if the director or designee finds they are necessary and unlikely to harm fish habitat or a public or private water source that is used for human consumption; and

WHEREAS, mechanical methods are often ineffective at controlling mayday trees because the trees re-sprout from the base and root fragments, and uprooting mayday trees may exacerbate erosion and sedimentation of fish habitat by removing root masses along stream banks; and

WHEREAS, herbicides are a "last resort" because there are also no known biological or other non-pesticide means of removal adequate for controlling mayday trees; and

WHEREAS, the definition of "allowed" pesticides in AMC 15.75.020 refers to a list of pesticides approved for gardening and consumption of organic produce, not for treating invasive species that aren't going to be consumed by humans; and

WHEREAS, most of the "allowed" pesticides are more toxic than glyphosate, imazapyr and aminopyralid; and

WHEREAS, most private citizens are not well acquainted with the impacts and restrictions imposed on the use of pesticides, even though the use of these pesticides is widespread in Anchorage, but the mayday control program has been designed and would be supervised by professionals to avoid or minimize any adverse environmental or health impacts; and

WHEREAS, the Environmental Protection Agency has found that glyphosate, imazapyr, and aminopyralid are unlikely to harm invertebrates, fish, birds, and mammals, including humans, if used according to the directions on the label; and

WHEREAS, the EPA has not classified the carcinogenicity of 2,4-D and triclopyr, and the Commission does not have the information needed at this time to approve their use within the 150-foot buffer; however, the Commission acknowledges that 2,4-D and triclopyr are effective at killing woody vegetation and have been approved for use in national parks and other natural areas by the National Park Service, The Nature Conservancy, and other agencies, and found to be acceptable for invasive plant control to the banks of streams inhabited by endangered species of salmon by a U.S. district court in Washington state; and

WHEREAS, it is the policy of the Parks and Recreation Department to require the approval of any community council that bounds a park or greenbelt before an invasive species may be treated with a "non-allowed" herbicide; and

WHEREAS, some parks and greenbelts are adjacent to more than one community council, and the approval of any community council may be overturned by a vote the following month; and

WHEREAS, mayday trees are a citywide problem that is not confined to any one community council area, and park resources that are likely to be affected by mayday trees – including moose, birds and salmon – are valued by residents from all community councils, not just those who live adjacent to the park; and

WHEREAS, mayday trees are a citywide problem that is not confined to any one community council area, and park resources that are likely to be affected by mayday trees – including moose, birds and salmon – are valued by residents from all community councils, not just those who live adjacent to the park; and

NOW, THEREFORE, BE IT RESOLVED THAT the Watershed & Natural Resources Advisory Commission recommends that:

A. The Parks and Recreation Department approve the Invasive Plant Project to use glyphosate, imazapyr, and aminopyralid to control mayday trees in parks and greenbelts, including within the 150-foot stream buffer, using the methods proposed.

B. The contractor use the least toxic formulation at the recommended effective amount based on the product label and environmental conditions with the least potential for human exposure, as required by AMC 15.75.025.

C. The contractor follow methods outlined in Table 1 in the 2019 Watershed and Natural Resources Advisory Commission report, "Using Herbicides to Control or Eradicate Mayday Trees in anchorage Parks and Greenbelts", and conform to instructions on the labels and all other state and federal restrictions on their use of 2,4-D and triclopyr to control mayday trees in parks and greenbelts outside of the 150-foot stream buffer and at least 600 feet from any public and private water source used for human consumption.

D. The Parks and Recreation Department reconsider its policy that requires the approval of all adjacent community councils before a "non-allowed" herbicide may be approved to control an invasive species in parks and greenbelts.

PASSED AND APPROVED by the Watershed & Natural Resources Advisory Commission on this 27th day of March, 2019.

Michelle J. McNulty, AICP
Secretary

David M. Nyman, PE
Chair

Attachment: March 2019 Report, *Using Herbicides to Control or Eradicate Mayday Trees in Anchorage Parks and Greenbelts*

(WNRC Case No. 2019-01)

USING HERBICIDES TO CONTROL OR ERADICATE MAYDAY TREES IN ANCHORAGE PARKS AND GREENBELTS

Anchorage Watershed & Natural Resources Advisory Commission
Municipality of Anchorage, Alaska
March 2019

Mayday trees (*Prunus padus*), also known as chokecherry or European bird cherry, are a highly invasive species in Anchorage.[1] Unlike many invasive species, the plant is not considered invasive by most other states.[2] A related chokecherry (*Prunus virginiana*) is native to most of North America but not Alaska, which has no native *Prunus* species. In Anchorage and other Alaska communities (e.g., Hope, Talkeetna, Fairbanks, and Juneau) the exotic, introduced trees are spreading into adjacent natural areas.

The invasive trees are spreading along riparian areas and replacing native woody vegetation like willows, poplars, birches and alders. The first three native species are important browse for moose, particularly in winter and early spring when food supplies are most scarce, as well as providing food for other endemic species of wildlife. Alders are important for fixing nitrogen in the soil, and riparian willows and alders are important for stream bank stabilization. Both species are also major sources of leaf litter for aquatic insects and terrestrial insect food for salmon and other aquatic animals.

Mayday trees are even overabundant from an urban forestry perspective. A partial inventory of Anchorage's street and park trees in 2008 found 29 different species; however, the list was dominated by a few species. *Prunus* species accounted for more than 18% of all trees, second only to the native birch (20%). A common guideline for maintaining species diversity in urban settings is the 10-20-30 rule; i.e., no one species should make up more than 10% of the trees in a population.[3] The fact that 18% of the street and park trees in Anchorage are *Prunus* – an introduced, invasive exotic – might be considered a wake-up call.

One valuable function of riparian vegetation is its capacity to intercept stormwater runoff. Mayday trees are much less adept at intercepting rainfall than common native trees.[4] For example, one acre of paper birch forest along Campbell Creek can intercept 304,779 gallons annually. Black cottonwood intercepts the greatest amount of rainfall annually (1,792 gallons per average tree), followed by white spruce (1,559 gallons), paper birch (1,074 gallons), willows, and alders. The average mayday tree has the lowest storm water benefit, intercepting only 94 gallons per tree annually. These values can vary somewhat based on the age structure and condition of the forest.

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[1] The mayday tree has earned an invasiveness rating of 74 on a scale of 100 from the Alaska Exotic Plants Information Clearinghouse (AKEPIC).
[2] Invasive plant atlas of the United States. A collaborative project of the National Park Service, the University of Georgia Center for Invasive Species and Ecosystem Health, and other organizations. https://www.invasiveplantatlas.org/index.cfm
[3] Flott, J. 2009. Urban forestry management plan. Prepared by Community Forestry Consultants, Inc., for the Municipality of Anchorage, Alaska. 95 pp. http://forestry.alaska.gov/Assets/pdfs/community/organizations/AnchorageUFMP-draft-.pdf
[4] Davey Resource Group. 2010. Anchorage forestland assessment and management plan. Prepared for the Municipality of Anchorage, Alaska. 154 pp. http://forestry.alaska.gov/Assets/pdfs/community/organizations/AnchorageFAMP-final_draft.pdf

Similarly, Anchorage trees remove a significant amount of carbon dioxide (CO_2) from the atmosphere through growth and sequestration of carbon as woody and foliar biomass. Compared to native broadleaf species – black cottonwood, willows, alders, and paper birch – mayday trees provide the least benefit in terms of annual CO_2 removal.[5]

Native trees are valuable trees. Replacing one acre of Anchorage's paper birch forest with trees of similar size, species, and condition was estimated to cost approximately $637,362 per acre in 2008.[6] Based on an inflation calculator, today's cost would be nearly $750,000.[7] Efforts to reduce or eliminate infestations of mayday trees in Anchorage parks and greenbelts should be encouraged and facilitated, and the cost to control this invasive species should be weighed against the value of the original forest.

ISSUE

The Anchorage Park Foundation's Invasive Plant Program has obtained a federal grant to remove mayday trees from municipal parks and greenbelts. The program contractor, Tim Stallard, has organized groups of volunteers to remove mayday trees from riparian areas, but as long as root fragments remain in the ground, new growth is stimulated. They would also like to employ an herbicide to be more efficient and to remove significantly more mayday trees for a longer duration.

The Invasive Plant Program developed a matrix for the effective and safe use of several herbicides to control mayday trees in municipal parks (Table 1). The matrix provides a methodology and technical justification for using five herbicides: glyphosate, imazapyr, triclopyr, 2,4-D, and aminopyralid. The herbicide will depend on the method used.

Stallard uses formulations of glyphosate that are registered for aquatic use by the Environmental Protection Agency (EPA), including Glyphosate 54 by Alligare and Rodeo by Dow. He uses a formulation of imazapyr registered for aquatic use called Ecomazapur by Alligare. Triclopyr comes in an oil soluble or aqueous acid formulation. Stallard uses only the former. The brands are Garlon 4 Ultra by Dow and Garlon 4 by Alligare. He uses the Milestone formulation for aminopyralid. For 2,4-D he uses the brand sold by Alaska Mill and Feed, which is called 2,4-D LV4 (low volatility) by Winfield Solutions. When the aforementioned formulations for the five herbicides might not be available, he occasionally substitutes. He also likes to try new formulations if there is a good reason to switch. In other words, he'd like to keep his options open as much as possible.

Pesticides are allowed in municipal parks, but only in compliance with AMC 15.75.025, which refers to "allowed" and "non-allowed" pesticides. "Allowed" pesticides may be used with no prior consultation or approval from the director of Health and Human Services or designee. "Non-allowed" pesticides require the director or designee's approval and may not be applied with 150 feet of a fish-bearing stream unless the director or designee determines that the application will not harm fish habitat.

[5] Ibid.
[6] Ibid.
[7] US Inflation Calculator. https://www.usinflationcalculator.com

Table 1. Herbicides and methods proposed for mayday tree (*Prunus padus*) control in Anchorage parks by the Anchorage Park Foundation's Invasive Plant Program.

European bird cherry herbicide control methods

Method name	Description	Herbicide AI	EPA Aquatic Registered	AI % in product	Rates of Product	Timing	Comments
Cut stump	herbicide applied to cut stump, typically with handheld spray bottle	glyphosate	X	53%	50%	"full leaf expansion" (June to late Sept.)	cut material must be hauled off or it will sprout
Frill (hack and squirt)	frill cuts to trunk, herbicide sprayed into cuts with handheld spray bottle	glyphosate	X	53%	50%	"full leaf expansion" (June to late Sept.)	leaves standing dead. Cutting gets laborious on multi-stemmed trees
Frill (hack and squirt)	frill cuts to trunk, herbicide sprayed into cuts with handheld spray bottle	imazapyr	X	28%	8%	likely broader window than glyphosate	leaves standing dead. Cutting gets laborious on multi-stemmed trees
Stem injection	herbicide filled shell is injected with EZ Ject tool	glyphosate	X	83%	1 shell per 4" dbh	Any time of year if bark is not too frozen	Relatively expensive, but effective, somewhat challenging for multi-steemed trees.
Stem injection	herbicide filled shell is injected with EZ Ject tool	imazapyr		83%	1 shell per 4" dbh	Any time of year if bark is not too frozen	Relatively expensive, but effective, somewhat challenging for multi-steemed trees.
Foliar spraying	shrubby trees 6 feet or less - leaves (50% or more of the tree) are directly sprayed with a backpack sprayer	glyphosate	X	53%	6-7%	"full leaf expansion" (June to late Sept.)	Foliar spraying is the only way to effectively kill shrubby bird cherry
Foliar spraying	shrubby trees 6 feet or less - leaves (50% or more of the tree) are directly sprayed with a backpack sprayer	imazapyr	X	28%	1%	likely broader window than glyphosate	imazapyr offers some residual control
Basal bark	herbicide solution is sprayed on the lower 18" of the trunk of the tree	triclopyr plus 2,4D or aminopyralid		60% / 41%	25% / 2-5%	Any time of year with no snow on the ground (fall better than spring	Less laborious for multi-stemmed trees, the best way to control large shrubby growth that is too tall to foliar spray. Expensive and can take more than one year to kill the trees. Still experimenting with the best formula and timing.

The relevant portions of AMC 15.75.025 are as follows:

No person or entity shall apply pesticides within municipal parks, public lands, greenbelts, municipal properties that are open to the public, or rights of way, except in compliance with this section. The Municipality of Anchorage shall follow the precautionary approach to the use of toxic pesticides in order to prevent harm to human health and the environment.

A. *Allowed pesticides* may be used with no prior consultation or approval from the department director or designee.

B. *Non-allowed pesticides* may be used only under the following circumstances in the determination of the department director or designee, and then only as a last resort after non-pesticide means of control are deemed inadequate: (1) when pests present a health or safety hazard; (2) to treat invasive species that have potential for causing environmental harm; or (3) for a specific research purpose. The department director or designee will respond to a completed request for the use of a non-allowed pesticide within ten working days using these criteria:

1. Non-allowed pesticides shall not be used for aesthetic purposes.
2. If non-allowed pesticides are necessary to meet a health or safety hazard, an invasive species problem, or for research purposes, the department director or designee will make a written determination of exception approving the application and identifying the circumstances and failure of the non-pesticide means of control. For use of single application aerosol cans against biting or stinging insects when applied according to label directions, a written determination from the department director is not required.
3. Any approved application will use the least toxic formulation at the recommended effective amount based on the product label and environmental conditions with the least potential for human exposure.
4. A non-allowed pesticide may not be applied within 150 feet of an anadromous or resident fish habitat or within 600 feet of a public or private water source that is used for human consumption unless:
   (a) Conditions of sections 15.75.025 and 15.75.065 are met; and
   (b) The department director or designee determines that the application will not harm anadromous or resident fish habitat and will not harm a public or private water source that is used for human consumption.

The remainder of the ordinance deals with preventing pests from becoming a problem but, as this report will explain, it's already too late to prevent the introduction and increasing dominance of mayday trees in Anchorage.

According to the definitions in AO 15.75.020, "allowed" pesticides are those listed as "minimum risk pesticides" pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and listed in 40 CFR 152.25(f)(1) or (2), as amended,[8] or listed as "allowed" on the USDA's National List of Allowed Substances.[9] None of the herbicides identified by the Invasive Plant Program are on the "minimum risk" or "allowed" lists.

Stallard and a concerned citizen who lives near the Chester Creek greenbelt, Hans Thompson, made presentations to Northstar and South Addition community councils, the two community councils surrounding the parks where they believed selected herbicides would be a cost-effective and safe alternative to manual removal, and the community councils wrote resolutions in support of the project. Stallard and Thompson subsequently obtained approval from the MOA to treat individual trees by injecting herbicide into the trunks of larger mayday trees or by spraying leaves of individual bushes at close range. After beginning their work in Valley of the Moon Park in September 2018, Pam Miller with Alaska Community Action on Toxics (ACAT) reminded the municipality of the 150-foot stream buffer recently adopted in the 2017 revision of the municipal code (AMC 15.75). The director of Health and Human Services, Natasha Pineda, appointed the director of Parks and Recreation, John Rodda, as her designee. Director Rodda told the project to stop using glyphosate and the other "non-allowed" herbicides within the stream buffer.

Stallard says he asked the Parks and Recreation Department for more details on the decision, and came away with the impression that they were unwilling to consider use of any "non-allowed" pesticides within the 150-foot buffer.

Because the ordinance allows "non-allowed" pesticides to be used within the 150-foot buffer in certain circumstances, it appears as if the division's decision to not allow the use of specified herbicides may have been arbitrary and capricious because it did not assess the need for using herbicides nor involve a technical or scientific determination of harm to fish-bearing waters or the public water supply, which is what the ordinance requires.

Thompson has asked the Anchorage Watershed and Natural Resources Advisory Commission to consider the technical and scientific pros and cons of using glyphosate, imazapyr, 2,4-D, triclopyr, and aminopyralid in Anchorage parks to control mayday trees and, if we believe any or all are justified, to draft a resolution or letter to Director Pineda and Director Rodda informing them of our recommendation.

This action falls within our advisory commission's mission to "sustain the economic and community benefits of healthy creeks, watersheds, and natural resource lands within the Municipality by providing technical advice and guidance to help facilitate coordinated and

[8] Environmental Protection Agency (EPA). 2015. Active ingredients eligible for minimum risk pesticide products (updated December 2015). https://www.epa.gov/sites/production/files/2018-01/documents/minrisk-active-ingredients-tolerances-jan-2018.pdf

[9] Government Printing Office. 2019. Electronic code of federal regulation. Title 7: Agriculture, Part 205 – National Organic Program. https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=9874504b6f1025eb0e6b67cadf9d3b40&rgn=div6&view=text&node=7:3.1.1.9.32.7&idno=7#se7.3.205_1601

collaborative local, state, federal, and private-sector watershed and natural resources stewardship, restoration, and protection actions."

After the advisory commission began debating this issue and looking for answers, Thompson made a presentation to Rogers Park and Fairview community councils. Pam Miller made an anti-herbicide presentation to the Rogers Park Community Council on March 11, 2019. Following her presentation, the community council voted 8-7 against the use of herbicides within the 150-foot stream buffer. However, Fairview Community Council voted unanimously to approve herbicide use.

Because members of the advisory commission are not experts on pesticides, our review of impacts and final recommendation rely heavily on analyses conducted by fisheries and pesticide experts in the EPA, National Oceanic and Atmospheric Administration (NOAA) Fisheries, U.S. Fish and Wildlife Service, and National Academy of Science.

THE NEED TO CONTROL MAYDAY TREES

At least some of the debate on this issue is engendered by two different perspectives on "pollution." Simply put, the American public has long been taught – at least since Rachel Carson's Silent Spring if not before – that pesticides are a form of pollution. More recently, invasive species have been cast as a form of pollution in the sense that they are spread by humans and often reduce natural diversity by outcompeting native species, particularly in areas "disturbed" by humans. One doesn't have to be a big fan of pesticides to be faced with making a choice between pesticides (mosquito repellent?) and environmental integrity all the time.

The Municipality of Anchorage acknowledged this conundrum in the Chester Creek Watershed Plan.[10] One of the city's water quality objectives is to reduce pollution from point and non-point sources, and yet the objectives for wildlife and fish habitat support actions to manage existing invasive species and prevent new introductions. In the end, the plan listed "create and implement invasive removal and control strategy for Bird Cherry, Purple Loosestrife, and Reed Canarygrass" as a "highest priority" action item under the Chester Creek restoration priorities. The action item was to be led by the municipality's Parks and Recreation and Watershed Management Services departments, the Anchorage Park Foundation and the UAF Cooperative Extension.[11]

The draft Municipality of Anchorage Invasive Plant Management Plan prepared for the Parks and Recreation Department in 2010 categorized mayday trees as "B-list," meaning non-native plants that are considered invasive and relatively widespread in the municipality. According to the plan, "preventing the spread of these species outside of the Municipality and into critical habitats within the Municipality is a high priority for management." To further this end, "control and containment efforts must be focused along transportation corridors [e.g., roads and trails], nearby or on public lands, and on outlying infestations."[12]

The city's draft invasive species plan is cited as a fait accompli in the final Chester Creek Watershed Plan (2014): "Efforts to control invasive species follow the Anchorage Invasive

[10] Anchorage Waterways Council. 2014. Chester Creek watershed plan: 2014. Prepared for the Municipality of Anchorage, Alaska. 83 pp. http://anchoragestormwater.com/Documents/ChCrkWshdPln062015.pdf
[11] Ibid.
[12] Gary, G. 2010. Municipality of Anchorage invasive plant management plant – draft. Prepared for the Municipality of Anchorage Parks and Recreation Department. 66 pp. http://www.muni.org/Departments/parks/Documents/ANC_Invasive_Plant_Management_DRAFT_landscape.pdf

Species Management Plan within the MOA's Parks and Recreation Department." It certainly appears to advocate for the control of mayday trees in public parks and greenbelts, in and near critical habitats such as streams, and along maintained trails. The plan recommends using chemical control in conjunction with mechanical methods because "herbicides often provide the only effective and feasible control of rhizomatous species, infestations in remote areas and on species for which hand pulling or cutting is not effective or feasible."[13] Herbicides are "a particularly important method of treatment for certain species when complete eradication of a population is the management objective" and "chemical control methods, along with appropriate mechanical and cultural practices, are likely to be the most appropriate control methods for large infestations" in the municipality.

So the first question to be answered is: how much environmental damage is the rapid spread of mayday trees causing in Anchorage? After making that case, the relative impacts of various herbicides can be weighed.

JUSTIFICATION FOR THE CAREFUL USE OF SOME HERBICIDES TO CONTROL MAYDAY TREES

Anchorage is blessed with lots of trees. Even in the Anchorage Bowl, the most heavily developed portion of the municipality, trees and shrubs cover 35% of the area.[14] As might be expected, the average tree cover in public parks and greenbelts is even higher (70%). However, tree cover in riparian areas, which are crucial to stream protection – providing a buffer to urban pollutants and many of the nutrients, shade, cover, woody debris, bank stability, and other resources vital to fish and other aquatic animals – has been greatly diminished. Based on a rough and probably conservative index (using a 25-foot-wide buffer from all lakes and a 70-foot buffer from all streams), the average tree cover in riparian areas throughout the Anchorage Bowl is only 33% – i.e., less than the average cover for the entire urbanized area.[15] Thus, the tree cover maintained in municipal parks and greenbelts is a crucial component of riparian habitat in the Anchorage Bowl, protecting the streams from pollution and erosion and providing essential resources to support aquatic flora and fauna.

Threats to streams and riparian areas can result from human actions other than development, sewage, and chemical pollutants. A growing concern in Anchorage involves invasive species. Some of these – like purple loosestrife, reed canarygrass and *Elodea* – directly impact aquatic habitat. Other invasive species impact riparian areas. The recent Anchorage Bowl Tree Canopy Assessment found "while there are numerous invasive weed species in Anchorage, there is currently only one that threatens tree canopy composition in natural forests."[16] According to the report, stands of mayday trees are outcompeting and eliminating native willow in riparian forests.

In an effort to forestall their negative effects, the municipality banned the sale of mayday trees in 2017. This was the same year as and related to the municipality's adoption of an ordinance greatly restricting the use of herbicides to control invasive species in municipal parks.

One way in which the profusion of mayday trees affects aquatic habitats is by outcompeting and replacing native shrubs and trees. Although the species is a relative newcomer to Anchorage –

[13] Ibid.
[14] Davey Resource Group, Inc. 2018. Anchorage Bowl tree canopy assessment. Prepared for the Alaska Department of Natural Resources, Anchorage, Alaska. 33 pp.
[15] Ibid.
[16] Ibid.

an ornamental tree that benefitted greatly from the urban growth and renewal stimulated by oil development in the 1970s and 1980s – it quickly spread to riparian areas and now comprises a substantial portion of riparian tree and shrub cover. *Prunus* species now make up 11.7% of the understory and 9.3% of the canopy cover (21% total) along Chester Creek and 3.0% of the understory and 3.5% of the canopy cover (6.4% total) along Campbell Creek.[17] In riparian areas along Chester Creek, mayday trees and shrubs are the most abundant species of woody vegetation. All native species combined averaged only 10.7% of the understory. Along Campbell Creek mayday trees and shrubs accounted for slightly less cover than native willows (5.5%) and alder (3.6%), but averaged more stems per plot than all native species combined. In a few locations the canopy cover was comprised solely of mayday trees, which had displaced native woody species entirely. This occurred in 12 plots (4.5%) along Chester Creek and 5 plots (1.5%) along Campbell Creek.

Mayday trees are most abundant in the urbanized areas of each watershed, where they have been established the longest. Farther upstream, mayday trees and shrubs become more sporadic and tend to be limited to the understory at present. While one recent study found *Prunus* on the Tony Knowles Coastal Trail, as well as the Chester and Campbell Creek greenbelts, the canopy cover of *Prunus* spp. was not yet high throughout the municipal parks system. Nevertheless, the trees are widely dispersed and most individuals are seedlings and saplings, which suggests they are poised to grow and spread rapidly.[18] The same report found evidence of another *Prunus* species (*P. virginiana*), which has escaped cultivation in Anchorage and may prove to be as invasive as *Prunus padus*. If the two species of *Prunus* are not controlled, they will continue to mature into large, fruit-bearing trees, causing a major shift in the plant community.[19] The distribution and abundance of mayday trees and shrubs are increasing rapidly, and the trees have almost certainly spread upstream and become more dominant now than they were four years ago when the assessment was conducted. Mayday trees have spread throughout the Anchorage Bowl, and *Prunus* appears to be capable of expanding into adjacent watersheds in Joint Base Elmendorf-Richardson, Chugiak-Eagle River, Chugach State Park, and beyond.[20]

There is no longer any question that *Prunus* outcompetes and is replacing native vegetation in the Anchorage Bowl and is likely to spread into neighboring areas if it isn't controlled. But why is that such a bad thing? Because when a non-native species is introduced and outcompetes native flora or fauna, the original ecosystem is often damaged, sometimes irreparably.

For example, invasive species in riparian habitats can affect stream ecosystems by altering the amount or composition of leaf litter, which is eaten by aquatic invertebrate shredders such as

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[17] Roon, D., M. Wipfli, T.L. Wurtz, and A. Prakash. 2015. Distribution of invasive European bird cherry (*Prunus padus*) in riparian forests along urban Alaskan streams. Pp. 40-43 *in* Forest Health Conditions in Alaska – 2014. U.S. Forest Service, Alaska Region, State & Private Forestry. https://www.researchgate.net/publication/286439236_Distribution_of_invasive_European_bird_cherry_Prunus_padus_in_riparian_forests_along_urban_Alaskan_streams

[18] Cortés-Burns, H., and L. Flagstad. 2009. Invasive plant inventory and bird cherry control trials. Phase I: Non-native plants recorded along four Anchorage municipality trails systems. Prepared by the Alaska Natural Heritage Program, University of Alaska Anchorage, for the Municipality of Anchorage and Anchorage Parks Foundation. 172pp. https://accs.uaa.alaska.edu/wp-content/uploads/Invasive_Plant_Inventory_and_Bird_Cherry_Control_Trials_Phase_I.pdf

[19] Ibid.

[20] Roon, D., M. Wipfli, T.L. Wurtz, and A. Prakash. 2015. Distribution of invasive European bird cherry (*Prunus padus*) in riparian forests along urban Alaskan streams. Pp. 40-43 *in* Forest Health Conditions in Alaska – 2014. U.S. Forest Service, Alaska Region, State & Private Forestry. https://www.researchgate.net/publication/286439236_Distribution_of_invasive_European_bird_cherry_Prunus_padus_in_riparian_forests_along_urban_Alaskan_streams

caddisflies and stoneflies. These aquatic insects are important food for fish and other taxa, including insectivorous birds and bats. Dippers and shorebirds feed on the insects during their aquatic stage, while other insectivorous birds feed on the insects after they emerge from the stream as winged adults.[21] The huge annual pulse of aquatic insects emerging from streams is one of the most important factors affecting the distribution and abundance of riparian-foraging bats.[22] Timing of the hatch is also important. Aquatic insects tend to emerge from freshwater streams in spring before trees are leafed out, while the peak abundance of terrestrial invertebrates occurs after leaves emerge. The two peaks greatly extend the period when flying insects are available for birds and bats. Even many terrestrial arthropods, like beetles, which are also eaten by birds and small mammals, depend on aquatic invertebrates emerging from streams as a food source.[23]

Caddisfly and stonefly populations tend to be eliminated or greatly reduced by pollution and sedimentation and thus function as indicator species for a stream's health. When leaf litter processing by aquatic invertebrate shredders is disrupted by an invasive species, impacts are expressed through multiple trophic levels, ultimately impacting the ecosystem function of streams.

A study conducted in Anchorage streams compared leaf litter input and decomposition of mayday leaves with those of three native trees: thin-leaf alder (*Alnus tenuifolia*), paper birch (*Betula neoalaskana*), and black cottonwood (*Populus trichocarpa).*[24] In a study area in Chester Creek in 2009, the researchers found that mayday leaf litter broke down significantly faster than birch or cottonwood, but at a similar rate to alder. Comparing the rate of decomposition in four reaches of Campbell and Chester creeks the following year (2010), they found that mayday leaf litter broke down significantly faster than alder in Chester Creek. Mayday leaf litter also broke down faster that year in Campbell Creek, but the difference was not significant. Other studies cited by the researchers have found that *Prunus* leaf litter breaks down quickly in streams; in fact it was also found to break down faster in Scottish streams than alder and birch leaves.

Although mayday leaf litter sometimes supported fewer shredders by both count and mass, communities of these aquatic insects did not differ significantly between mayday and native plants; thus, mayday trees did not appear to be exhibiting strong adverse impacts on leaf litter processing in Chester and Campbell creeks in 2009 and 2010. However, the researchers noted that mayday leaf litter input could become a problem if the trees continue to spread and displace native species. The researchers discussed three other concerns that were not addressed by their experimental design. Mayday trees retained their leaves later than the native species, delaying when leaf litter entered the stream. The timing of leaf fall, in conjunction with the rapid breakdown rate, could result in a pulse of organic matter that disappears quickly. Leaf litter

[21] Gray, L.J. 1993. Response of insectivorous birds to emerging aquatic insects in riparian habitats of a tallgrass prairie stream. American Midland Naturalist 129:288-300. https://www.jstor.org/stable/pdf/2426510.pdf?seq=1#page_scan_tab_contents

[22] Fukul, D., M. Murakami, S. Nakano, and T. Aoi. 2006. Effect of emergent aquatic insects on bat foraging in a riparian forest. Journal of Animal Ecology 75:1252-1258. https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2656.2006.01146.x

[23] Paetzold, A., and K. Tockner. 2005. Effects of riparian arthropod predation on the biomass and abundance of aquatic insect emergence. Journal of the North American Benthological Society 24:395-402. http://www.ephemeroptera-galactica.com/pubs/pub_p/pubpaetzolda2005p395.pdf

[24] Roon, D.A., M.S. Wipfli, and T.L. Wurtz. 2014. Effects of invasive European bird cherry (*Prunus padus*) on leaf litter processing by aquatic invertebrate shredder communities in urban Alaskan streams. Hydrobiologia DOI 10.1007/s10750-014-1881-x.

retention can be important to stream ecology and a "trophic mismatch" could reduce shredder abundance and affect litter processing in streams dominated by mayday trees.

The second concern was that as mayday trees continue to replace native trees in riparian areas, the diversity of leaf litter inputs could be reduced. In native deciduous forests, shredders receive a diverse assemblage of leaf litter that enters the stream at different times and breaks down at different rates. In a riparian area dominated by a single invasive species, the loss in diversity could have detrimental effects on the stream ecosystem.

Finally, some of the most common native shrubs in southcentral Alaska's riparian areas are alders. Alder is a nitrogen-fixing plant, an important source of nitrogen for stream and riparian ecosystems, including shredders and other aquatic invertebrates. Thus, a shift from alders to mayday trees could have direct and indirect effects by decreasing the amount of nitrogen available for nutrient cycling in plants and animals.

Why should we care about leaf litter in streams? Because the leaves support insects and other aquatic life that constitute the lower levels of the food web. In other words, leaf litter feeds aquatic invertebrates which feed other aquatic invertebrates, not to mention fish, birds, bats and other animals.

The fact that mayday trees are replacing native willows and alders along Anchorage streams raises another concern. Juvenile salmonids rearing in streams consume terrestrial insects that fall into the water from bordering riparian vegetation. In fact, in some productive salmon streams well over half of the coho salmon diet is of terrestrial origin.[25,26,27] Similarly, in some lakes 100% of the fish diet is comprised of terrestrial invertebrates "raining" onto the surface from overhanging vegetation.[28] Shoreline development has an adverse effect on this critical source of food.[29]

As do mayday trees. Roon and others analyzed the potential insect fall from riparian trees in the Anchorage Bowl by collecting invertebrates dropping from the foliage.[30] They observed that mayday trees supported 4 to 6 times less terrestrial invertebrate biomass and contributed 2 to 3 times less biomass to streams than native deciduous trees. Their results were consistent in two watersheds over two years. They found that juvenile coho salmon consumed similar amounts

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[25] Eberle, L.C., and J.A. Stanford. 2009. Importance and seasonal availability of terrestrial invertebrates as prey for juvenile salmonids in floodplain spring brooks of the Kol River (Kamchatka, Russian Federation). River Research and Applications 26:682-694. https://www.researchgate.net/publication/229746016_Importance_and_seasonal_availability_of_terrestrial_invertebrates_as_prey_for_juvenile_salmonids_in_floodplain_spring_brooks_of_the_Kol_River_Kamchatka_Russian_Federation

[26] Allan, J.D., M.S. Wipfli, J.P. Caouette, A. Prussian, and J. Rodgers. 2011. Influence of streamside vegetation on inputs of terrestrial invertebrates to salmonid food webs. Canadian Journal of Fisheries and Aquatic Sciences 60:309-320. https://www.nrcresearchpress.com/doi/a bs/10.1139/f03-019?journalCode=cjfas#.XIi02C3MzOQ

[27] Li, J.L., W.J. Gerth, R.P. Van Driesche, D.S. Bateman, and A.T. Herlihy. 2016. Seasonal and spatial fluctuations in *Oncorhynchus* trout diet in a temperate mixed-forest watershed. Canadian Journal of Fisheries and Aquatic Sciences 73:1642-1649. https://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2015-0520#.XIi5_i3MzOQ

[28] Francis, T.B., and D.E. Schindler. 2009. Shoreline urbanization reduces terrestrial insect subsidies to fishes in North American lakes. Oikos 118:1872-1882. https://www.researchgate.net/publication/227676957_Shoreline_urbanization_reduces_terrestrial_insect_subsidies_to_fishes_in_North_American_lakes

[29] Ibid.

[30] Roon, D.A., M.S. Wipfli, T.L. Wurtz, and A.L. Blanchard. 2016. Invasive European bird cherry (*Prunus padus*) reduces terrestrial prey subsidies to urban Alaskan salmon streams. Canadian Journal of Fisheries and Aquatic Sciences 73(11):1679–1690. https://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2015-0548#.XIiylC2ZPOQ

of terrestrial invertebrates in stream reaches bordered by mayday trees; however, more biomass would almost certainly support more juvenile salmon and reducing terrestrial prey subsidies to streams is likely to further reduce salmon populations as mayday trees continue to replace native trees and shrubs.

Bats are not the only mammals likely to be affected by the increasing distribution and abundance of *Prunus*. Moose are also being affected, both by consuming the plants and by the loss of native vegetation. Moose cannot safely eat mayday tree leaves, bark or drupes because they are acutely toxic. In fact, mayday trees are more toxic than glyphosate.

RELATIVE TOXICITY OF GLYPHOSATE VERSUS HYDROGEN CYANIDE IN MAYDAY TREES

Members of the advisory commission have expressed concerns regarding the use of glyphosate for controlling mayday trees in municipal parks. One commissioner, for example, voiced a concern that a cyclist might brush a bare leg against a leaf treated with glyphosate. All commissioners are concerned that glyphosate applied within 150 feet of a waterbody might be carried into the stream by runoff and affect fish and other aquatic organisms.

There is an implicit trade-off between using glyphosate to control mayday trees (a positive environmental impact) and the risk of the herbicide harming the environment, particularly humans, wildlife and fish (a negative environmental impact). None of the commissioners appeared to be familiar with the environmental impacts of glyphosate and other herbicides, so a literature review seemed appropriate.

When comparing toxicity keep in mind that there is “acute toxicity” and long-term toxicity (chronic and subchronic). Acute toxicity is quantified by a substance’s LD50, which is the dose at which 50% of the subjects who ingest that amount will die. LD50 is measured in units of mass of the substance per unit mass of the subject (usually mg/kg of body weight, although a similar measure for aquatic species – LC50 – is expressed in mg/L or ppm). Because it’s unethical to poison people, even for science, the lethal dose is typically found by testing various doses on a variety of animals, then using the LD50 from the most sensitive species and multiplying it by 100 to be on the safe side. Most substances have some threshold amount beyond which they become toxic. Even water can be toxic if you drink enough of it.

Glyphosate

Acute toxicity. The EPA ranks chemicals in four categories, with “I” being the most toxic and “IV” the least. Glyphosate is in category III, which signifies “slightly toxic.” Its LD50 is 5,600 mg/kg. Nevertheless, by the acute standard of LD50, glyphosate is less toxic than caffeine, vinegar, table salt, several vitamins, and over-the-counter painkillers like aspirin – or mayday trees for that matter (see below). The LD50 for caffeine is 192 mg/kg; i.e., a much lower dose is toxic.

A study that tested 14 formulations of glyphosate and compared their toxicity to glyphosate alone found the petroleum-based compounds in herbicide formulations were much more toxic than glyphosate.[31] In fact, heavy metals like arsenic, chromium, cobalt, lead, and nickel – which

[31] Defarge, N., J.S. de Vendômois, and G.E. Séralini. 2018. Toxicity of formulants and heavy metals in glyphosate-based herbicides and other pesticides. Toxicology Reports 5:156-163. https://www.sciencedirect.com/science/article/pii/S221475001730149X

are known to be toxic and endocrine disrupters – are found as contaminants in some glyphosate-based herbicides and other pesticides. This could explain some of the adverse effects of the pesticides that are reported in the literature. The term "active substance" or "active ingredient" in pesticides does not mean that it is the most toxic.[32]

It is important to note that the Anchorage project proposes to use two high-content formulations of glyphosate that are approved for aquatic use, not Roundup, which contains surfactants and other toxic and potentially toxic chemicals and heavy metals in addition to the active ingredient. This has been a major source of confusion in the interpretation of toxicological research because some researchers test technical (or "pure") glyphosate while others have tested Roundup.

The list of substances allowed within 150 feet of Anchorage's fish-bearing streams, pursuant to AMC 15.75.025, gives one a false sense of security. For example, *Bacillus thuringiensis* (commonly known as Bt, an organic insecticide), vinegar (a natural insecticide), and lime sulfur (a natural fungicide) are on the "allowed" list,[33] yet these substances all have LD50s higher than glyphosate.

Ironically, no one would be concerned about toxicity if the Anchorage project proposed spraying mayday tree leaves with vinegar.

Bt, lime sulfur, glyphosate and many other organic and synthetic pesticides are EPA-approved for home use. Home use of these pesticides is not supervised by professionals; we assume (and hope) that homeowners will use them in accordance with the instructions on the label. However, this is certainly a factor in the overuse and misuse of pesticides in urban areas.

Chronic toxicity. The EPA determines chronic toxicity in animal tests by measuring the "no observable effect limit" of the most sensitive species tested and then multiplying that by a factor of 100. Glyphosate doses showed no observable effects at doses up to 31 mg/kg/day (for rats) and 500 mg/kg/day (for dogs).[34] The EPA's threshold for glyphosate consumption by humans is 2 mg/kg/day. Based on the EPA's conservative threshold for glyphosate on produce, a person would need to eat 62 pounds of produce per day for an extended period. That's a lot of broccoli.

With few exceptions, current levels of glyphosate in our air, water, and food result in a typical human exposure well below the "levels of concern" or "acceptable daily intakes" established by regulatory bodies around the world. Glyphosate is regarded as among the least chronically toxic herbicides for mammals. Only three EPA-registered synthetic pesticides in current agricultural use have a higher chronic Reference Dose (i.e., are less chronically toxic) and one of those is imazapyr, which is also being considered for use on mayday trees.

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[32] Ibid.

[33] Hollyer, J., F. Brooks, L. Fernandez-Salvador, L. Castro, D. Meyer, T. Radovich, and S. Russo. 2013. The allowed use of commercial fertilizers, pesticides, and synthetic substances on U.S. farms under the USDA National Organic Program. College of Tropical Agriculture and Human Resources, University of Hawai'i at Manoa. https://www.ctahr.hawaii.edu/oc/freepubs/pdf/FST-56.pdf

[34] Loftus, M. 2015. Glyphosate toxicity: Looking past the hyperbole, and sorting through the facts. The Credible Hulk blog. http://www.crediblehulk.org/index.php/2015/06/02/glyphosate-toxicity-looking-past-the-hyperbole-and-sorting-through-the-facts-by-credible-hulk/

Carcinogenicity. EPA'S draft risk assessment published in December 2017 concluded that glyphosate is not likely to be carcinogenic to humans.[35] EPA's assessment found no other meaningful risks to human health when the product is used according to the label instructions. EPA's scientific findings are consistent with the conclusions of scientific reviews by a number of other countries as well as the 2017 National Institute of Health Agricultural Health Survey.[36]

The EPA also revised its "Glyphosate Issue Paper: Evaluation of Carcinogenic Potential" in December 2017.[37] Glyphosate is one of the most widely used and most studied pesticides. The EPA's revision was based on an extensive database for evaluating the carcinogenic potential of glyphosate, including 63 epidemiological studies, 14 animal carcinogenicity studies, and nearly 90 genotoxicity studies for the active ingredient glyphosate.

In the epidemiological studies there was no evidence of an association between glyphosate exposure and numerous cancer outcomes. Due to conflicting results and various limitations identified in studies investigating non-Hodgkin lymphoma, a conclusion regarding the association between glyphosate exposure and risk of NHL could not be determined based on the available data. Nevertheless, the conclusion supported by the most evidence was that glyphosate is "not likely to be carcinogenic to humans".

In 2015, the EPA also conducted a preliminary ecological risk assessment in support of the registration review of glyphosate.[38] Exposure to glyphosate residues in water resulting from spray drift is not anticipated to impact survival, growth or reproduction of aquatic invertebrates, fish, aquatic non-vascular plants, or submerged vascular plants in surface waters adjacent to a treated field. It may impact survival and/or biomass of aquatic emergent vascular and non-vascular plants in surface waters adjacent to a treated field or in the treated water body.

While available studies suggest toxicity is low, it is unclear if exposure to glyphosate residues on foliage resulting from direct deposition or spray drift at application rates greater than or equal to 1.92 pounds a.e./A (acid equivalent per acre) could impact survival, growth and/or reproduction of honeybee larvae. The typical use rate for post-emergence weed control in glyphosate-tolerant crops is 0.75 lb a.e./A.[39] Chronic exposure on foliage at relatively high doses (8 lbs a.e./A) may impact growth of birds, but may not impact reproduction. Chronic exposure on foliage at relatively high doses (8 lbs a.e./A) may impact growth and reproduction to terrestrial mammals for aerial application to sugar cane as well as for most uses generally applied by ground applications up to the combined maximum annual rate. Note that these are all agricultural measures of use, far exceeding the methods and amounts proposed for mayday tree control in Anchorage parks.

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[35] Environmental Protection Agency (EPA). 2017. EPA releases draft risk assessments for glyphosate. https://www.epa.gov/pesticides/epa-releases-draft-risk-assessments-glyphosate

[36] Andreotti, G., S. Koutros, J.N. Hofman, D.P. Sandler, J.H. Lubin, C.F. Lynch, C.C. Lerro, A.J. De Roos, C.G. Parks, M.C. Alavanja, D.T. Silverman, L.E. Beane Freeman. 2018. Glyphosate use and cancer incidence in the Agriculture Health Study. Journal of the National Cancer Institute 110:509-516. https://www.ncbi.nlm.nih.gov/pubmed/29136183

[37] Environmental Protection Agency (EPA). 2017. Revised glyphosate issue paper: Evaluation of carcinogenic potential. Office of Pesticide Programs. 216 pp. https://www.regulations.gov/document?D=EPA-HQ-OPP-2009-0361-0073

[38] Environmental Protection Agency (EPA). 2015. Registration review – Preliminary ecological risk assessment for glyphosate and its salts. Memorandum. Environmental Fate and Effects Division, Office of Chemical Safety and Pollution Prevention. 318 pp. https://www.regulations.gov/document?D=EPA-HQ-OPP-2009-0361-0077

[39] Sprague, C. 2006. Glyphosate confusion: What are the differences in formulations? MSU Extension, Michigan State University, East Lansing, Michigan. https://www.canr.msu.edu/news/glyphosate_confusion_what_are_the_differences_in_formulations

EPA's risk analysis also found that based on glyphosate's strong adsorption to soil and sediments alone, leaching to ground water or entering surface water dissolved in runoff would be minimized.

If you have any questions concerning the risks to human health and the environment posed by glyphosate, please read the lengthy and detailed EPA documents cited above.

Hydrogen cyanide

Acute toxicity. Unfortunately, all *Prunus* species are toxic to ruminants like cattle, sheep and moose. All parts of the plant are toxic except the mature fruits (pits are also toxic). Chewing the plant releases a host of cyanogenic glycosides which are quickly broken down by enzymes, a process which is speeded up by bacteria in the rumen, into sugars and hydrogen cyanide (HCN). The cyanide gas prevents red blood cells from releasing oxygen, so the victim suffocates. Highest concentrations are in leaves and pits.[40]

An 880-pound cow (close to the average size of an adult moose in the winter and spring) can be killed by eating just 2.2 pounds of leaves.[41] Death typically occurs within minutes. Adult moose and other animals are unlikely to eat *Prunus* when more palatable plants are available; however, as browse declines in late winter and early spring (before green-up), even adult moose may become hungry enough to consume *Prunus*. Calves are more likely to eat the leaves, twigs and fruits than adults and more likely to die because they require a smaller lethal dose. Necropsies have shown that moose in Anchorage have died from eating *Prunus*, but there is no way of knowing how many of the scores (or sometimes hundreds) of moose that die in Anchorage over winter are weakened or killed by eating *Prunus*.[42] HCN kills moose so quickly that Fish and Game's veterinarian has advised biologists that any moose found dead next to a mayday tree may have been poisoned by that tree.

Prunus is also poisonous to humans. Glyphosate has an LD50 of 5,600 mg/kg. The LD50 of hydrogen cyanide for humans (0.35 to 0.5 mg/kg) is considerably less than that required to kill a cow (2.0 mg/kg). However, despite its high toxicity to humans, HCN poisoning is rare except as an occupational hazard or as a means for Nazis to kill millions of Jews (HCN is also known as Zyklon B).

RECOMMENDED CONTROL METHODS

The Anchorage Park Foundation and Anchorage Cooperative Weed Management Area (CWMA) have partnered to control invasive mayday trees on municipal lands every year since at least 2011. Efforts have included using volunteers to hand pull and dig up mayday trees and shrubs, but glyphosate has also been employed.[43] In 2011 around 135 volunteers helped pull

[40] Bhaduri Hauck, S. 2015. Toxic plant profile: *Prunus* species. University of Maryland Extension, College of Agricultural and Natural Resources, College Park, Maryland. https://extension.umd.edu/about
[41] Wright, B., A. Bebbington, and T. Leuty. 2008. *Prunus* poisoning in horses and other livestock. Infosheet. Ontario Ministry of Agriculture, Food and Rural Affairs, Fergus, Ontario, Canada. http://www.equineguelph.ca/pdf/facts/Prunus%20Poisoning%20June%2026_08.pdf
[42] Woodford, R., and C. Harms. 2011. Cyanide-poisoned moose: ornamental chokecherry tree a devil in disguise. Alaska Fish & Wildlife News. Alaska Department of Fish and Game, Juneau, Alaska. March issue. http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=501
[43] Stallard, T. 2012. Anchorage invasive plant program and CWMA: 2012 field season projects. Invasive Plant Program, Anchorage Parks Foundation. https://anchorageparkfoundation.org/wp-content/uploads/2012/06/2012-CNIPM_ANC-IPP-poster.pdf

an estimated 6,500 mayday trees along Chester Creek.[44] Forty acres of *Prunus* were treated in 2012 in an effort guided by the draft Anchorage Invasive Plants Management Plan.

Initial attempts to reduce or eliminate mayday trees and shrubs by cutting or uprooting them have been largely unsuccessful because the plant readily re-sprouts from stumps and stems. Cutting stimulates growth, and root suckers and fallen trees can create thickets of new saplings. Seedlings and small trees have been pulled by hand using specialized tools; however all of the roots must be removed, even root fragments, and the tree and its roots disposed of or it will re-sprout.[45]

Persistent and determined researchers in Europe have attempted to control or eradicate a similar species, the black cherry (*Prunus serotina*), by mechanical means. Black cherry trees appear to be as invasive in Europe as the mayday tree is in Alaska. Some readers may appreciate the irony that black cherry trees brought to Europe are called American bird cherries on that side of the Atlantic. Cutting high stumps and girdling the trees several times each year over repeated years are simply not effective, although the researchers suggest that these methods are better than nothing in protected areas where herbicides use is not permitted.[46]

According to Gino Graziano, an invasive plant specialist with the University of Alaska Fairbanks Cooperative Extension Service office in Anchorage, pulling mayday trees is effective where individual small trees are present in relatively low densities (under 50% canopy cover). In denser infestations the roots of the trees are intertwined, and multiple stems over a large area can represent a single plant due to root suckering. In these situations it is impossible to remove a tree by hand without leaving roots behind. Pulling trees can also disturb significantly more ground, which may facilitate erosion or the introduction of other invasive plants. Large trees cannot be pulled out of the ground and simply cutting the tree down leaves ample opportunity for regeneration from the stump or buried roots.

A systematic, experimental effort to find an “environmentally friendly alternative control method” for black cherry trees in Europe found no mechanical or biological method worked better than glyphosate.[47] Glyphosate was applied to leaves and stumps, by the hack and squirt method, the EZ-Ject Capsule Injection System and the Silvaxe Tree Injector. These methods are similar to those proposed for use in Anchorage parks. All chemical control methods except the Silvaxe treatment showed a significantly higher proportional mortality than mechanical and biological control methods. Hack and squirt and the EZ-Ject Capsule Injection System in summertime resulted in a significantly higher proportional mortality than treating leaves or stumps in autumn. The high lethal effect of the hack and squirt method confirmed its practical value. Number of notches and doses of glyphosate were easily adjusted to the diameter-at-breast-height (dbh) class of trees, which minimized the amount of herbicide used.

No significant effect was found after treating stumps with a biological control method, a mycoherbicide based on the Silverleaf disease fungus, and stem treatments proved inappropriate. A high variability in proportional mortality was detected for the mechanical

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[44] Alaska Committee for Noxious and Invasive Plant Management. 2016 strategic plan. 50 pp. https://www.uaf.edu/files/ces/invasives/cnipm/CNIPM-Strategic-Plan_2016.pdf

[45] Alaska Plant Materials Center. 2015. Invasion Alert! European bird cherry (*Prunus padus*). Brochure.

[46] Otreba, A., K. Marciszewska, and D. Janik. 2017. Is cut-stump and girdling an efficient method of black cherry *Prunus serotina* Ehrh. eradication? Folia Forestalia Polonica, series A – Forestry 59:14-24. https://content.sciendo.com/view/journals/ffp/59/1/article-p14.xml

[47] Van Den Meersschaut, D., and N. Lust. 1997. Comparison of mechanical, biological and chemical methods for controlling black cherry (*Prunus serotina*) in Flanders (Belgium). Silva Gandavensis 62:90-109.

methods (girdling and felling with periodic removal of new sprouts) and, to a lesser degree for the biological methods, although the mortality rate sometimes approached or even equaled the mortality rate of chemical methods. However, the variable mortality rate can lead to unpredictable and unsatisfactory results. Like the previous researchers, they concluded that if chemical control is prohibited, biological stump treatment and girdling in spring or possibly winter, with at least one subsequent treatment, is better than doing nothing.

Another study found that injection using the EZ-Ject system was twice as expensive (for equipment and herbicide) as the cut and paint method but required less time, was less tiring for the applicator, decreased applicator exposure to the herbicide, and minimized impact to non-target vegetation.[48] The two methods were equally effective.

Systemic herbicides are the most effective way to control mayday trees because they are absorbed directly into the tree's vascular system and kill all parts of the plant so it cannot re-sprout.[49] The University of Alaska Anchorage's Alaska Natural Heritage Program has conducted several non-native plant surveys (2006 and 2009) in Campbell Tract, concluding that mayday trees are one of ten invasive species of greatest concern. It recommended cutting stems at the ground surface and treating them with herbicide. 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."[50]

The Alaska Department of Transportation and Public Facilities has published strategies for controlling invasive plants, including mayday trees. It recommends cutting trees in conjunction with chemical application; e.g., by applying the herbicide to fresh-cut stumps at the end of the growing season.[51] Glyphosate is effective at controlling *Prunus*.

The Nature Conservancy is a well-known conservation organization – having protected more than 119 million acres of land and thousands of miles of rivers worldwide – whose mission is "saving the last great places on Earth." The organization is renowned for its science-based and collaborative approaches to conservation. Recognizing the need to eradicate, or at least control, invasive plants in natural areas, The Nature Conservancy has published a manual of weed control tools and techniques.[52] The manual devotes a lot of attention to herbicides. The organization believes herbicides are warranted only when they can be used safely and will do more conservation good than harm. The herbicides covered in the manual are regarded as posing relatively low risk for use in natural areas because they are not likely to contaminate groundwater, have limited persistence in the environment, and are of low toxicity to animals. The eleven herbicides that have met the high standards of The Nature Conservancy include 2,4-D, glyphosate, imazapyr, and triclopyr.[53]

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[48] Hartman, K.M., and B.C. McCarthy. 2004. Individual study: The efficacy of EZ-Ject lance vs. cut and paint glyphosate application in the control of invasive Amur honeysuckle *Lonicera maackii* at the Fernald Environmental Management Project Site, Ohio, USA. Conservation Evidence. https://www.conservationevidence.com/individual-study/406

[49] Alaska Plant Materials Center. 2015. Invasion Alert! European bird cherry (*Prunus padus*). Brochure.

[50] Flagstad, L. 2010. 2009 Campbell Tract non-native plant survey: revisiting permanent monitoring transects established in 2006. Prepared by the Alaska Natural Heritage Program, University of Alaska Anchorage, for the Bureau of Land Management, Anchorage Field Office, Alaska. 45 pp. https://accs.uaa.alaska.edu/wp-content/uploads/2009_Campbell_Tract_Revisiting_Permanent_Monitoring_Transects.pdf

[51] Three Parameters Plus, Inc. 2014. Disposal and control of invasive plant species. Prepared for the Alaska Department of Transportation and Public Facilities, Southeast Region, Juneau, Alaska.

[52] Tu, M., C. Hurd, and J.M. Randall. 2001. Weed control methods handbook: Tools & techniques for use in natural areas. Wildland Invasive Species Team. https://www.invasive.org/gist/products/handbook/methods-handbook.pdf

[53] Ibid.

Closer to home, the Alaska Natural Heritage Program recommends that initial control efforts be focused on removing mature, fruit-producing mayday trees, especially in and near riparian areas.[54] Secondarily, efforts should be directed towards removing mayday trees and shrubs before they reach reproductive maturity.

According to the Alaska Natural Heritage Program, mature, fruit-producing trees should be cut at ground level and treated with an herbicide approved for use by the municipality and DEC. If herbicide application is not an immediate option, the removal of mature trees and their stumps would be a labor-intensive but effective interim measure. Stump removal would "hopefully" cause enough damage to the plant to at least diminish root sprouting. Accelerating the decay process of any stump left in place is also considered an interim solution. Notwithstanding the interim measures, herbicides ultimately would be required if infestations are to be substantially reduced or eradicated.[55]

Another necessary, interim solution is to avoid planting even more mayday trees as ornamentals on residential and commercial properties or land managed by a government agency. The municipality took that step in 2017 when it prohibited the sale of *Prunus padus*.[56]

It is notable that, after weighing the pros and cons, the National Park Service, The Nature Conservancy, the Alaska Natural Heritage Program, and the Anchorage Parks Foundation have all exhibited a willingness to use herbicides, including glyphosate, to control invasive species in protected natural areas.

Use of herbicides, particularly in parks, nature preserves and other sensitive or critical habitats, should be limited to situations in which managers or other decision-makers determine that no other reasonable means of control are available. Cutting, pulling and other mechanical means have not been effective at controlling, much less reducing mayday tree infestations in Anchorage, despite the efforts of hundreds of volunteers and thousands of worker-days. In fact, cutting and pulling stimulate the growth and spread of the plants, resulting in even denser thickets and reduced vegetative diversity. We appear to have arrived at the crossroads where "reasonable means of control" must include herbicides.

Thus, several of the provisions of AMC 15.75.025 have been satisfied. Mayday trees are pests that present a health and safety hazard, "non-allowed" herbicides are necessary as a last resort because non-pesticide means of control have been deemed inadequate by invasive species experts and conservation agencies and organizations, and the pesticides will not be used for aesthetic purposes. Now let's look at the proposed herbicides.

HERBICIDES PROPOSED FOR USE WITHIN THE 150-FOOT STREAM BUFFER

The Anchorage Park Foundation's Invasive Plant Program would like to control mayday trees in Anchorage parks with five herbicides and has asked for permission to use the herbicides within 150-feet of fish-bearing streams by using methods designed to limit exposure to non-target species, including humans.

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[54] Flagstad, L.A., H. Cortes-Burns, and T.L. Roberts. 2010. 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 for the Municipality of Anchorage & Anchorage Parks Foundation. 61 pp.
[55] Ibid.
[56] AMC 15.90.010 – Sale of invasive species unlawful. To date only the sale of mayday trees and reed canarygrass are prohibited.

Although the methods described in Table 1 are intended to limit exposure to non-target species, concerns remain regarding whether the herbicides might affect the environment and human health. Adverse impacts are considered throughout this document; however, a brief summary of the impacts for each herbicide is provided below. The impacts described are for the technical form of the herbicide, not commercial formulations, unless otherwise noted. The information for this section was obtained from The Nature Conservancy's weed control methods handbook[57] unless noted otherwise. The Nature Conservancy is one of the world's leading, non-governmental, science-based stewards of natural areas and its weed control manual is well-researched; cognizant of the special needs of plants, wildlife, fish and people in protected natural areas; and relatively recent.

Glyphosate

Half-life: In soils ranges from several weeks to years, but averages 2 months; in water it dissipates rapidly through adsorption to suspended and bottom sediments and has a half-life of 12 days to 2 weeks.

Toxicity: Relatively low to birds and mammals, moderate to fish (the Rodeo formulation is registered for aquatic weeds).

Carcinogenicity: According to the EPA, glyphosate is "not likely to be carcinogenic to humans."[58]

Other: One of the most commonly used herbicides in natural areas. Formulations of glyphosate are the second most widely used herbicide in the home and garden market.[59] Strongly adsorbed to soil, which can slow microbial metabolism and prevents excessive movement in the environment. It appears that under most conditions, rapid dissipation from aquatic environments of even the most toxic glyphosate formulations prevents build-up of herbicide concentrations that would be lethal to most aquatic species. Poorly absorbed, both orally and dermally, and does not bioaccumulate.[60]

Imazapyr

Half-life: In soils ranges from 25-141 days; in water 2 days.

Toxicity: Relatively low to birds and mammals; low for fish and aquatic invertebrates. EPA classifies imazapyr as "practically non-toxic" to mammals, birds, honeybees, fish, and aquatic invertebrates.[61,62] Even when applied at concentrations up to 1,600 ppm, it did not

[57] Tu, M., C. Hurd, and J.M. Randall. 2001. Weed control methods handbook: Tools & techniques for use in natural areas. Wildland Invasive Species Team. https://www.invasive.org/gist/products/handbook/methods-handbook.pdf

[58] Environmental Protection Agency (EPA). 2017. Revised glyphosate issue paper: Evaluation of carcinogenic potential. Office of Pesticide Programs. 216 pp. https://www.regulations.gov/document?D=EPA-HQ-OPP-2009-0361-0073

[59] Atwood, D., and C. Paisley-Jones. 2017. Pesticides industry sales and usage: 2008-2012 market estimates. Biological and Economic Analysis Division, Office of Pesticide Programs, Office of Chemical Safety and Pollution Prevention, U.S. Environmental Protection Agency (EPA), Washington, D.C. https://www.epa.gov/sites/production/files/2017-01/documents/pesticides-industry-sales-usage-2016_0.pdf

[60] Rose, M.T., T.R. Cavagnaro, C.A. Scanlan, T.J.Rose, T. Vancov, S. Kimber, I.R. Kennedy, R.S. Kookana, and L. Van Swieten. 2016. Impact of herbicides on soil biology and function. Advances in Agronomy 136:133-220. [cited in ScienceDirect] https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/glyphosate

[61] Durkin, P.R. 2011. Imazapyr: human health and ecological risk assessment. Final report submitted to USDA Forest Service, Southern Region, Atlanta, Georgia. https://www.fs.fed.us/foresthealth/pesticide/pdfs/Imazapyr_TR-052-29-03a.pdf

[62] Carey, S., L. Shanaman, and P. Hurley. 2005. EFED risk assessment supporting the reregistration eligibility decision for the use of the herbicide, imazapyr, in previously registered non-agricultural and horticultural settings, and

affect osmoregulatory capacity of chinook salmon smolts, and the 96-hour LC50 for rainbow trout fry is 77,716 to 22,305 ppm, which is a greater concentration of imazapyr than that found in commercially-sold containers. The EPA has concluded that there is minimal risk of direct acute effects and no chronic risks to freshwater fish and aquatic invertebrates at maximum application rates (there remains, however, uncertainty for estuarine and marine fish and invertebrates since no toxicity data were available).[63] At least one formulation (Habitat) is registered for use in aquatic areas.

Carcinogenicity: Shows no mutagenic or teratogenic potential. Although the EPA assessment found equivocal evidence for carcinogenicity in rats, "when other data are considered, the overall weight of the evidence indicates no concern for human carcinogenicity."[64]

Other: Relatively slow-acting, does not readily break down in the plant, so it is particularly good at killing large woody species. Under most field conditions, it does not bind strongly to soils and can be highly available in the environment if applied to soil. Because of persistence in environment, it may be preferable to apply directly to vegetation instead of broadcasting. There is no basis for asserting that members of the general public are likely to be at risk due to applications of imazapyr.[65]

Triclopyr

Half-life: Average 30 days in soils; several hours in water, however the ester formulation is not water-soluble and can take significantly longer to degrade.

Toxicity: Both ester and salt formulations are slightly toxic to birds and mammals; however, the ester formulation can be extremely toxic to fish and aquatic organisms.

Carcinogenicity: Studies have produced conflicting results. The EPA has long considered triclopyr to be in "Group D," meaning its carcinogenicity was not yet classifiable, and reaffirmed that assessment in 2016.[66]

Other: Triclopyr is one of the most commonly used herbicides against woody species in natural areas. It is particularly effective at controlling woody species with cut-stump or basal bark treatments. The acid and ester formulations bind well with soils and are not likely to be mobile in the environment. Federal law allows the EPA to establish a tolerance (the legal limit for a pesticide chemical residue in or on a food) only if the agency determines that the tolerance is "safe," which is defined to mean that "there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information" including through drinking water and in residential settings, but does not include occupational exposure.[67]

2,4-D

Half-life: In soils averages 10 days; less than 10 days in water.

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on Clearfield corn. Memorandum dated September 30. U.S. Environmental Protection Agency, Washington, D.C. https://www3.epa.gov/pesticides/chem_search/cleared_reviews/csr_PC-128821_30-Sep-05_a.pdf

[63] Ibid.

[64] Durkin, P.R. 2011. Imazapyr: human health and ecological risk assessment. Final report submitted to USDA Forest Service, Southern Region, Atlanta, Georgia. https://www.fs.fed.us/foresthealth/pesticide/pdfs/Imazapyr_TR-052-29-03a.pdf

[65] Ibid.

[66] Environmental Protection Agency (EPA). 2016. Triclopyr; pesticide tolerances. Federal Register. February 25. https://www.federalregister.gov/documents/2016/02/25/2016-03910/triclopyr-pesticide-tolerances

[67] Ibid.

Toxicity: Moderate toxicity for birds and mammals; however, dogs are significantly more sensitive to 2,4-D organic acids than rats and humans. Can bioaccumulate in animals. Ester formulations are toxic to fish and aquatic invertebrates, but salt formulations are registered for use against aquatic weeds.

Carcinogicity: Humans and dogs exposed to 2,4-D show an increase in lymphomas. No cause-effect relationship between exposure and human cancer has been found, but exposure has been correlated with an increase in non-Hodgkin lymphoma. The EPA has categorized 2,4-D in Group D, meaning it is not classifiable as to human carcinogenicity; however, the agency does not believe the existing data support a conclusion that links human cancer to 2,4-D exposure.[68]

Other: 2,4-D is the most commonly used pesticide for the home and garden market.[69] Some aquatic ecosystems have few of the microbes that readily degrade 2,4-D, while others may have many 2,4-D degrading microbes. In 1984 the World Health Organization concluded that 2,4-D did not accumulate or persist in the environment. However, 2,4-D can accumulate in fish exposed to concentrations as low as 0.05 ppm and concentrations of 1.5 ppm can kill the eggs of fathead minnows in 48 hours. 2,4-D can be absorbed through the skin or through the lungs if inhaled (although the EPA does not believe the amount of absorption is "significant"[70]). 2,4-D is not believed to accumulate in tissues of human adults. However, fetal accumulation as a result of maternal exposure has been observed on rare occasions (because it is rapidly cleared from the body by the kidneys) and mental retardation has been correlated with prenatal exposure.[71]

Aminopyralid[72]

Half-life: In soils ranged from 31.5 to 533.2 days (rates are soil dependent); EPA uses a half-life of 103.5 days for risk assessment purposes. A lab experiment yielded a 0.6-day half-life in water; however, in aerobic sediment-water systems degradation proceeded slowly, with an observed half-life of 462 to 990 days.

Toxicity: "Practically non-toxic to birds, fish, honeybees, earthworms and aquatic invertebrates," according to the EPA. There are no acute or chronic risks to non-target fish, birds, wild mammals, terrestrial and aquatic invertebrates, algae or other aquatic plants. The Bureau of Land Management's risk analysis found aminopyralid poses "little to no acute or chronic toxicity to mammals via dermal and oral exposure and little toxic impact on birds, terrestrial invertebrates, amphibians, fish and aquatic invertebrates; however, some aquatic

[68] Lowe, K.M., K. King, and L. Taylor. 2016. 2,4-D: human health risk assessment for registration review. Memorandum dated June 21. Environmental Protection Agency, Washington, D.C. https://www.24d.org/Studies/PDF/24D_EPA_Human_Health_Risk_Assmnt_2017.pdf

[69] Atwood, D., and C. Paisley-Jones. 2017. Pesticides industry sales and usage: 2008-2012 market estimates. Biological and Economic Analysis Division, Office of Pesticide Programs, Office of Chemical Safety and Pollution Prevention, U.S. Environmental Protection Agency (EPA), Washington, D.C. https://www.epa.gov/sites/production/files/2017-01/documents/pesticides-industry-sales-usage-2016_0.pdf

[70] Ibid.

[71] Sweet, D.H. 2010. Renal organic cation and anion transport: from physiology to genes. Pp. 23-53 in Comprehensive Toxicoloty (second edition). [cited in ScienceDirect] https://www.sciencedirect.com/science/article/pii/B9780080468846008022

[72] Except where noted, all of the information for aminopyralid is from the EPA's conditional registration fact sheet (Environmental Protection Agency. 2005. Pesticide fact sheet: aminopyralid. https://www3.epa.gov/pesticides/chem_search/reg_actions/registration/fs_PC-005100_10-Aug-05.pdf) and final ruling for pesticide tolerances (Environmental Protection Agency. 2010. Aminopyralid; pesticide tolerances. Federal Register. April 7. https://www.federalregister.gov/documents/2010/04/07/2010-7749/aminopyralid-pesticide-tolerances).

plants are sensitive, with some species being affected by concentrations as low as 88 ppm.[73] Not expected to bioaccumulate in fish tissue. EPA has concluded that there is reasonable certainty that no harm will come to humans from aggregrate exposure to residues.

Carcinogenicity: "Not likely to be carcinogenic to humans." No increase in tumors were found in studies on rats and mice.

Other: A relatively new herbicide registered by the EPA for the control of invasive weeds.[74] Unlike many other herbicides, technical aminopyralid (EPA Category I - danger) appears to be more toxic than a common formulation, Milestone (EPA Category IV – Caution). The higher rating for technical aminopyralid was based solely on an acute eye irritation study (the chemical is acidic). Likely to be non-persistent and relatively immobile in the field.

WATER QUALITY

Water quality in streams in the Anchorage Bowl is already heavily impacted by urban development, and the magnitude of the effects increases as one moves downstream.[75] A relatively recent, comprehensive study of pollutants collected and analyzed water samples from Chester Creek from 1998 to 2001. It found concentrations of calcium, magnesium, sodium, chloride and sulfate increased downstream.[76]

Water samples collected near Arctic Boulevard contained concentrations of the insecticide carbaryl that exceeded the guideline for protecting aquatic life. Carbaryl is widely used throughout the Anchorage area to control spruce bark beetle infestations and other insect pests. Eight other pesticides were detected in the stream. In addition to carbaryl, prometon, diazinon and 2,4-D were the most frequently found. Prometon, a nonselective herbicide commonly used to control broadleaf weeds and grasses around homes, was detected in 70% of the samples. Diazinon and 2,4-D were detected in 25% and 40% of the samples, respectively. Notably, with the exception of 2,4-D, traces of the other herbicides that the Invasive Plant Program has proposed for controlling mayday trees were not detected in Chester Creek, possibly because they are less mobile in the environment or degrade more rapidly.

Every water sample revealed a low concentration of volatile organic compounds, including benzene, toluene, tetrachloroethylene, methyl *tert*-butyl ether, and chloroform. Most were components of gasoline and other petroleum products, solvents, or the by-products of chlorinated disinfection of public water supplies. Fecal-indicator bacteria concentrations near Arctic Boulevard commonly exceeded federal and state guidelines for water-contact recreation. Concentrations of chromium, lead, and zinc increased in streambed sediments in downstream reaches, and some concentrations were at levels that can adversely affect aquatic organisms. The diversity and biomass of pollution-sensitive aquatic invertebrates – such as mayflies, caddisflies and stoneflies – decreased from the headwaters to the mouth of Chester Creek, while the biomass of pollution-tolerant worms increased, an indication that water-quality degradation has substantially affected the stream ecosystem, particularly in the lower reaches.

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[73] Bureau of Land Management (BLM). 2016. Aminopyralid ecological risk assessment: final. U.S. Department of the Interior, Washington, D.C. https://eplanning.blm.gov/epl-front-office/projects/nepa/70301/94286/113789/Aminopyralid_Ecological_Risk_Assessment.pdf

[74] Durkin, P.R. 2007. Aminopyralid: Human health and ecological risk assessment – Final report. Prepared for USDA Forest Service and National Park Service. https://studylib.net/doc/10523709/aminopyralid-human-health-and-ecological-risk-assessment-...

[75] Glass, R.L., and R.T. Ourso. 2006. Water-quality conditions of Chester Creek, Anchorage, Alaska, 1998-2001. U.S. Geological Survey, Scientific Investigations Report 2006-5229. https://pubs.usgs.gov/sir/2006/5229/pdf/SIR2006-5229.pdf

[76] Ibid.

In other words, the sections of Chester Creek where the Invasive Plant Program is proposing to use specified herbicides is already profoundly affected by pollutants, including pesticides, present in urban runoff. Pollutants from roads, sewage systems, and residential and commercial property pest control – not to mention barriers such as roads and perched culverts, channelization, bank damage, and loss of riparian areas – have already impacted salmon populations throughout the Anchorage Bowl. During the early 1970s coho salmon were the most common salmonid species, but are now the least abundant.[77] Rainbow trout, an introduced species, are now the most abundant salmonid.

This is not to suggest that adding more pollutants to a polluted stream is automatically or universally acceptable. However, knowing that a stream is already polluted should factor into a decision to risk a slight increase of a low-toxicity herbicide that degrades rapidly in order to reduce or eradicate an invasive species that also "pollutes" the stream and is adversely impacting other natural resources. Just because Anchorage streams are impacted by herbicides used to maintain lush lawns or healthy trees, runoff carrying petroleum products, and fecal bacteria doesn't mean that employing an herbicide to control an invasive species is out of the question.

Although no salmonids are considered threatened or endangered in Alaska, many species are included on the national list in other states. Thus, adopting the policies and safeguards practiced on endangered salmonids would set a relatively high threshold for the protection of Anchorage's salmon and trout. A lawsuit in Washington state, brought by Earthjustice, a law firm representing the Washington Toxics Coalition and other environmental and fishing organizations, resulted in a 2006 court order banning the use of certain pesticides within 60 feet of waterbodies inhabited by endangered salmon.[78] The lawsuit asked the U.S. District Court for the Western District of Washington at Seattle to weigh the evidence for 54 pesticides. 2,4D and two formulations of triclopyr were on the list.[79] Glyphosate, imazapyr and aminopyralid were not included, presumably because all evidence to date has found no impacts on fish.

The final court order exempted several pesticide uses from the 60-foot buffer zone requirement. The exemptions included pesticides used by government agencies for noxious weed control, but only when the control program implements the safeguards routinely required by the National Marine Fisheries Service for such programs. Several pesticides allowed within the 60-foot buffer zone – including triclopyr BEE and 2,4-D – required mandatory educational materials be provided at the point of sale in urban areas to alert users of the potential risks near salmonid habitat.[80]

[77] Davis, J.C., and G.A. Muhlberg. 2001. Chester Creek stream condition evaluation. Technical Report No. 01-7. Habitat and Restoration Division, Alaska Department of Fish and Game, Anchorage, Alaska. 41 pp. http://www.arrialaska.org/reports/Chester%20Creek%20Report.pdf

[78] Washington State Department of Agriculture. 2005. Pesticides subject to buffer zones in Washington state: Pesticide/ESA effects determinatins listed by Evolutionary Significant Unit (ESU). https://agr.wa.gov/PestFert/natresources/docs/EffectsbyESU.pdf

[79] Washington State Department of Agriculture. 2017. ESA-related lawsuits. https://agr.wa.gov/pestfert/natresources/esarelatedlawsuits.aspx

[80] Ibid.

OPPOSITION TO USING GYPHOSATE IS BASED LARGELY ON OUTDATED INFORMATION, MISINFORMATION, OR IS SIMPLY NOT APPLICABLE

It's wise to limit our exposure to pesticides of all kinds and, for better or worse, new pesticides are being developed every decade and their overall use is increasing. It's worthwhile, however, to keep pesticide use in perspective. Much of the problem with pesticides today results from overuse and misapplication.

About 90% of glyphosate use in the U.S. is for agricultural purposes, which increased substantially with the advent of Roundup Ready genetically modified crops – although a more recent analysis found use was beginning to stabilize. Several factors explain the increased use of glyphosate: its effectiveness at controlling weeds, its relatively low toxicity to humans and animals, and the fact that it has replaced many other more toxic and harmful herbicides.[81]

Many homeowners use glyphosate (as Roundup for example). This use is unsupervised and it's largely for aesthetic reasons (e.g., a lush lawn). Unlike home use, the application of glyphosate in Anchorage parks would be limited as much as possible by injecting it into trunks of the larger mayday trees or by spraying leaves of individual bushes at close range.

As for rubbing off on the leg of a cyclist, Stallard says their application would become rainfast as soon as it dries, in approximately 10-15 minutes on leaves, and the quantity that will be used is orders of magnitude less than the LD50, which is typically an oral dose.

Mayday trees, like other invasive species, are not controlled for purely aesthetic reasons. Mayday trees reduce environmental diversity and habitat complexity and increase stormwater runoff. Mayday trees are toxic to moose and people, and they outcompete native species that moose eat like willows, birches, and poplars. Mayday trees also form dense thickets that obscure visibility and present a public safety hazard in some parks.

One commissioner has diligently provided a host of scientific articles and commentary based on scientific articles that raise important questions regarding the carcinogenicity of glyphosate. However, upon close examination none of the 10 articles seem to be applicable to the issue at hand. Because others may also cite these articles as reasons for not using glyphosate on mayday trees, the findings of each article will be summarized below, with a brief explanation for why they aren't applicable.

Myers, J.P., M.N. Antoniou, B. Blumberg, L. Carroll, T. Colborn, L.G. Everett, M. Hansen, P.J. Landrigan, B.P. Lanpear, R. Mesnage, L.N. Vandenberg, F.S. vom Saal, W.V. Welshons, and C.M Benbrook. 2016. Concerns over use of glyphosate-based herbicides and risks associated with exposures: A consensus statement. Environmental Health 15:19

The authors' concern was triggered by news that the World Health Organization's (WHO) International Agency for Research on Cancer (IARC) had concluded that glyphosate is "probably carcinogenic to humans." The authors also claimed that glyphosate-based herbicides are the most heavily applied herbicide in the world and usage continues to rise; glyphosate-based herbicides often contaminate drinking water sources, precipitation, and air; human

[81] Loftus, M. 2015. About those harsher herbicides that glyphosate helped replace. The Credible Hulk blog. http://www.crediblehulk.org/index.php/2015/06/02/about-those-more-caustic-herbicides-that-glyphosate-helped-replace-by-credible-hulk/

exposures are rising; and regulatory estimates of tolerable daily intakes are based on outdated science. The authors did not recommend suspension of its use, but further study.

The primary source for much of this article's claims was a note in the Lancet by several authors on behalf of the IARC Working Group.[82] All of the authors were members of the organization and had helped write the IARC's monograph on glyphosate.[83] They noted that glyphosate has been detected in the air – during aerial spraying. They reported there was limited evidence for carcinogenicity in humans. High levels of occupational exposure (e.g., in pesticide applicators and farm workers) was correlated with increased risk for non-Hodgkin lymphoma.

The IARC classified glyphosate in Group 2A, which means they believe it is "probably carcinogenic to humans." This rather ambiguous category is used "when there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals," where "limited evidence means that a positive association has been observed between exposure to the agent and cancer but that other explanations for the observations (called chance, bias, or confounding) could not be ruled out."[84]

By the way, other substances the IARC includes in Group 2A are red meat, emissions from frying food at high-temperature, household combustion of wood fuels, and "very hot beverages (more than 65°C [or 149°F])."[85] Coffee, tea and hot chocolate are frequently served at temperatures between 160°F and 185°F, with the preferred temperature being 140±15°F.[86]

This article bemoaned the lack of recent compilations of research on the risks of glyphosate and referred to an upcoming risk assessment and final re-registration on glyphosate-based herbicides to be completed by the EPA in 2015 or 2016. These assessments have now been completed; the EPA found that glyphosate is "not likely to be carcinogenic to humans" and was of limited concern to other mammals, birds and fish.[87,88] Thus, the EPA's more recent findings have rendered this article moot.

Furthermore, the concerns expressed in this article do not appear to be applicable to the Anchorage project. More reasons why it is not will become evident in rebuttals to the following articles. Like most of the following articles, this article highlights a correlation between the intense and long-term exposure of pesticides by agricultural workers and a rare disease in humans or lab animals, but it does not differentiate between glyphosate, glyphosate-based

[82] Guyton, K.Z., D. Loomis, Y. Grosse, F. El Ghissassi, L. Benbrahim-Tallaa, N. Guha, C. Scoccianti, H. Mattock, K. Straif. 2015. Carcinogenicity of tetrachlorvinphos, parathion, malathion, diazinon, and glyphosate. Lancet 16:490-491. https://www.thelancet.com/action/showPdf?pii=S1470-2045%2815%2970134-8

[83] International Agency for Research on Cancer. 2017. IARC Monographs Volume 112: Evaluation of five organophosphate insecticides and herbicides – list of participants. World Health Organization. https://monographs.iarc.fr/iarc-monographs-on-the-evaluation-of-carcinogenic-risks-to-humans-4/

[84] International Agency for Research on Cancer. 2015. IARC Monographs Volume 112: Evaluation of five organophosphate insecticides and herbicides. World Health Organization. https://www.iarc.fr/wp-content/uploads/2018/07/MonographVolume112-1.pdf

[85] Wikipedia. 2019. List of IARC Group 2A carcinogens. https://en.wikipedia.org/wiki/List_of_IARC_Group_2A_carcinogens

[86] Brown, F., and K.R. Diller. 2008. Calculating the optimum temperature for serving hot beverages. Burns 34:648-654. https://www.ncbi.nlm.nih.gov/pubmed/18226454

[87] Environmental Protection Agency (EPA). 2017. Revised glyphosate issue paper: Evaluation of carcinogenic potential. Office of Pesticide Programs. 216 pp. https://www.regulations.gov/document?D=EPA-HQ-OPP-2009-0361-0073

[88] Environmental Protection Agency (EPA). 2015. Registration review – Preliminary ecological risk assessment for glyphosate and its salts. Memorandum. Environmental Fate and Effects Division, Office of Chemical Safety and Pollution Prevention. 318 pp. https://www.regulations.gov/document?D=EPA-HQ-OPP-2009-0361-0077

herbicides and a whole host of other pesticides used by the workers. Establishing a correlation is not the same as proving causation.

Fallon, S.M., and J. Sass. 2018. Comments submitted from the Natural Resources Defense Council on the draft human health and ecological risk assessments for glyphosate and on the EPA's preliminary ecological risk assessment for glyphosate and its salts. Letter to the EPA dated April 30.

The authors, the wildlife director and senior scientist with the Natural Resources Defense Council, disagree with the EPA's draft assessment of the low risk of glyphosate to humans and other animals. However, they were referencing an earlier draft (i.e., not the 2017 "revised" assessment).[89] They also refer to the 2015 IARC assessment and monograph[90,91] and the 2017 consensus statement,[92] all mentioned in the preceding article. Their opposition to EPA's preliminary finding appears to be based on concerns about glyphosate-based herbicides, not technical (or "pure") glyphosate. For example, during an extended discussion of the potential risks of glyphosate-based herbicides, the authors state "even Monsanto experts agree in internal memos that the glyphosate-based products carry additional health risks, compared with glyphosate alone." However, they never focused on the different risk assessments for technical glyphosate versus glyphosate-based herbicides, perhaps because the article that compared the EPA and IARC assessments had yet to be published.[93]

The authors also devoted considerable discussion to monarch butterflies; however, monarch butterflies are not found in Alaska. Because the authors were commenting on a draft EPA risk assessment, not the final, and they didn't differentiate between the risks of technical glyphosate and glyphosate-based herbicides, these comments are out-of-date and potentially misleading. The EPA's final conclusion is that glyphosate is "not likely to be carcinogenic to humans."

Landrigan, P.J., and F. Belpoggi. 2018. The need for independent research on the health effects of glyphosate-based herbicides. Environmental Health 17:51.

The authors referred to two recent assessments of glyphosate's health risks. One was the IARC report that claimed that glyphosate was a "probable human carcinogen." The other was a review by the European Food Safety Agency (EFSA) that found no evidence of carcinogenicity. The authors noted that the disparate findings have produced regulatory uncertainty and proposed that an independent study be conducted by their institute. However, the EPA, based on a more recent and more exhaustive assessment than that conducted by the IARC, has

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[89] Environmental Protection Agency (EPA). 2017. Revised glyphosate issue paper: Evaluation of carcinogenic potential. Office of Pesticide Programs. 216 pp. https://www.regulations.gov/document?D=EPA-HQ-OPP-2009-0361-0073

[90] International Agency for Research on Cancer (IARC). 2015. IARC Monographs Volume 112: Evaluation of five organophosphate insecticides and herbicides. World Health Organization. https://www.iarc.fr/wp-content/uploads/2018/07/MonographVolume112-1.pdf

[91] International Agency for Research on Cancer (IARC). 2016. IARC monographs on the identification of carcinogenic hazards to humans: glyphosate. World Health Organization. https://monographs.iarc.fr/iarc-monographs-on-the-evaluation-of-carcinogenic-risks-to-humans-4/

[92] Myers, J.P., M.N. Antoniou, B. Blumberg, L. Carroll, T. Colborn, L.G. Everett, M. Hansen, P.J. Landrigan, B.P. Lanpear, R. Mesnage, L.N. Vandenberg, F.S. vom Saal, W.V. Welshons, and C.M Benbrook. 2016. Concerns over use of glyphosate-based herbicides and risks associated with exposures: A consensus statement. Environmental Health 15:19

[93] Benbrook, C.M. 2019. How did the US EPA and IARC reach diametrically opposed conclusions on the genotoxicity of glyphosate-based herbicides? Environmental Sciences Europe 31:2.

already concluded that glyphosate is "not likely to be carcinogenic to humans." Thus, the regulatory uncertainty engendered by the conflicting reports has been addressed.

Benbrook, C.M. 2019. How did the US EPA and IARC reach diametrically opposed conclusions on the genotoxicity of glyphosate-based herbicides? Environmental Sciences Europe 31:2.

The EPA considers glyphosate as "not likely to be carcinogenic to humans." The IARC has classified glyphosate as "probably carcinogenic to humans." The EPA and IARC reached diametrically opposed conclusions for three primary reasons: 1) the EPA relied mostly on registrant-commissioned, unpublished regulatory studies, while the IARC relied mostly on peer-reviewed studies; 2) EPA's evaluation was largely based on data from studies on technical (or "pure") glyphosate, whereas IARC's review emphasized test results for formulated glyphosate-based herbicides; and 3) EPA's evaluation was focused on typical, general population dietary exposures assuming legal, food-crop uses, while the IARC assessment placed more emphasis on occupational and elevated-exposure scenarios. Benbrook, who was a co-author of the consensus statement discussed above, noted that multiple studies have reported that formulated glyphosate-based herbicides are more toxic than technical glyphosate, and that European regulators have also concluded that technical glyphosate poses no significant cancer risks to the general public. He concluded that more research is needed on real-world exposures to the other chemicals used in formulated glyphosate-based herbicides and the biological fate and consequences of such exposures.

Although there is good reason to be concerned about the use (and especially the misuse and overuse) of most formulated glyphosate-based herbicides, the Anchorage project proposes to use Rodeo, which is registered for use in aquatic habitats, not Roundup. The relatively low toxicity of glyphosate compared to other ingredients in glyphosate-based formulations was confirmed by toxicological research.[94] Rodeo doesn't seem to have been included in that study; however, because it is registered by the EPA for use in aquatic habitats, it is less likely to include substances that are known to be toxic to fish. Based on the findings in this analysis of the two conflicting claims, the EPA's methodology and conclusion is more relevant to the use of glyphosate in a non-agricultural setting than the IARC's.

It's also worth noting that the IARC has been involved in controversy due to its lack of transparency and its promise to participants that any documents relating to its assessment would not be shared with state or federal agencies, despite the fact that at least some of the research resulted from government-funded research.[95]

Helander, M., I. Saloniemi, and K. Saikkonen. 2012. Glyphosate in northern ecosystems. Trends in Plant Science 17:569-574.

The authors observed that most of the testing on the effects of glyphosate has been based either on laboratory bioassays or short-term field studies in more temperate climatic conditions. Because there is a tendency to treat target species late in the season, the half-life of glyphosate may be much longer in northern ecosystems than has been found in the Lower 48 states and Europe. The authors' concern is heightened by the fact that agricultural soils in Finland have

[94] Defarge, N., J.S. de Vendômois, and G.E. Séralini. 2018. Toxicity of formulants and heavy metals in glyphosate-based herbicides and other pesticides. Toxicology Reports 5:156-163. https://www.sciencedirect.com/science/article/pii/S221475001730149X

[95] Fitzpatrick, J. 2016. Scientist briefly resigned from cancer group over transparency. Morning Consult. https://morningconsult.com/2016/10/31/exclusive-scientist-briefly-resigned-cancer-group-transparency/

been fertilized with phosphate for decades in excess of what is absorbed and removed by the crops, which leads to a lower capacity to absorb glyphosate. Repeated glyphosate applications, particularly those that are broadcast from the air in large-scale agricultural quantities, may decrease the number and diversity of microbes capable of degrading glyphosate, thus increasing the risk of leaching into nearby waterways. The authors recommend further research on the biochemical action and fates of glyphosate in northern soils.

The author's main concerns seem to hinge on the widespread agricultural use of glyphosate, including aerial application. Furthermore, the average air (and presumably soil) temperatures of Finland, where they live, are more like Fairbanks (or Minnesota, Wisconsin or North Dakota, for that matter) than Anchorage. More research may be required, but this concern has little bearing on the limited use of glyphosate in Anchorage parks.

Motta, E.V.S., K. Raymann, and N.A. Moran. 2018. Glyphosate perturbs the gut microbiota of honey bees. PNAS 115:10305-10310.

The authors note that glyphosate is considered one of the least toxic pesticides used in agriculture because animals lack the shikimate pathway, which glyphosate inhibits to prevent the biosynthesis of aromatic amino acids and other secondary metabolites found only in plants and some microorganisms. Nevertheless, glyphosate can affect honeybees and bumblebees by affecting their gut microbiota. Bees deprived of their normal microbiota show reduced weight gain and altered metabolism, increased pathogen susceptibility, and increased mortality. While some species of microorganisms in the bee gut can tolerate high concentrations of glyphosate, others are more sensitive.

The environmental exposure of bees to glyphosate – as it has been proposed to be applied in Anchorage (primarily into and on stems or stumps, but in some instances sprayed at close range onto the leaves of shrubs) – is anticipated to be insignificant because bees are primarily attracted to flowers, which are unlikely to be present or come into contact with the herbicide when it is applied.

Zhang, L., I. Rana, R.M. Shaffer, E. Taioli, and L. Sheppard. 2019. Exposure to glyphosate-based herbicides and risk for non-Hodgkin lymphoma: A meta-analysis and supporting evidence. Mutation Research/Reviews in Mutation Research.

The authors initially screened 866 studies based on titles and abstracts, including studies cited by the recent IARC, WHO, and EPA evaluations. The meta-analysis, however, excluded all but 6 studies for various reasons. The authors suggest that their meta-analysis has demonstrated a "compelling link between exposures to GBHs [glyphosate-based herbicides] and increased risk for NHL [non-Hodgkin lymphoma]." Perhaps so, but the link is due to correlation; causation has not been demonstrated. This is important because the meta-analysis didn't account for the effects of glyphosate separate from the other chemicals and heavy metals in the glyphosate-based herbicides much less the ingredients of other pesticide formulations being used. Most agricultural workers and pesticide applicators are exposed to a host of toxic and potentially toxic substances. The researchers intentionally selected agricultural workers with the highest demonstrable intensities and longest durations of exposures to glyphosate-based herbicides and, undoubtedly, other herbicides.

While the meta-analysis may illustrate the worst-case scenario for some people – those whose work with pesticides constitutes a long-term occupational hazard – it does little to predict real-world exposures, particularly those anticipated by the Anchorage project which will not involve

long-term public contact with intense, large-scale agricultural treatments of glyphosate-based herbicides.

KTUU. 2019. Study: High levels of weedkiller significantly raise risk of non-Hodgkin lymphoma. February 15. Anchorage, Alaska.

A KTUU Anchorage television news story reported on recent research that found exposure to high levels of glyphosate "can drastically increase the risk of cancer."[96] The article claimed that glyphosate, "the most widely used weedkiller in the world, may increase risk of non-Hodgkin lymphoma by as much as 41%." According to KTUU, the "senior author," L. Sheppard, claimed that "as a result of this research, I am even more convinced that [glyphosate is carcinogenic]." Finally, the article mentioned that the study "incorporated more than 54,000 people who work with pesticides."

This was a typical television news piece in that it eschewed nuance, oversimplified the findings of the research, and highlighted the controversial aspects of an issue with an aim toward freaking people out, one of several pieces on glyphosate reported on KTUU recently.[97,98] The news piece referred to a scientific article "published in ScienceDirect," which was the same article discussed above.[99]

In fact, the researcher who was interviewed was not the "senior author." The research wasn't published in ScienceDirect, it was published in Mutation Research/Reviews in Mutation Research and it didn't test the effects of glyphosate, it tested the effects of glyphosate-based herbicides, which contain many other toxic chemicals and heavy metals. Most importantly, the research didn't differentiate between the effects of glyphosate-based herbicides and other pesticides that may have been used. Its choice of subjects with the most exposure to pesticides may have been justified from the perspective of establishing correlation between the highest possible occupational exposure to pesticides and a rare form of cancer, but it doesn't help determine how small amounts of glyphosate applied to mayday trees in Anchorage parks will affect anyone besides the applicators.

Van Bruggen, A.H.C., M.M. He, K. Shin, V. Mai, K.C. Jeong, M.R. Finckh and J.G. Morris, Jr. 2018. Environmental and health effects of the herbicide glyphosate. Science of the Total Environment 616-617:255-268.

The authors note that research on a link between glyphosate and antibiotic resistance is still scarce, but hypothesize that the selection pressure for glyphosate-resistance in bacteria could lead to shifts in microbiome composition and increases in antibiotic resistance in clinically important antimicrobial agents. They recommend research on the associations between low-

[96] KTUU. 2019. Study: High levels of weedkiller significantly raise risk of non-Hodgkin lymphoma. February 15. Anchorage, Alaska. https://www.ktuu.com/content/news/Study-High-levels-of-weedkiller-significantly-raise-risk-of-non-Hodgkin-lymphoma-505890801.html

[97] Associated Press. 2018. Judge: Experts can testify that Roundup linked to cancer. KTUU, Anchorage, Alaska. July 10. https://www.ktuu.com/content/news/Judge-Experts-can-testify-that-Roundup-linked-to-cancer-487796591.html

[98] Thanawala, S. 2019. High-stakes trial starts in Roundup weed killer cancer claim. Associated Press and KTUU, Anchorage, Alaska. February 25. https://www.ktuu.com/content/news/High-stakes-trial-starts-in-Roundup-weed-killer-cancer-claim-506333551.html

[99] Zhang, L., I. Rana, R.M. Shaffer, E. Taioli, and L. Sheppard. 2019. Exposure to glyphosate-based herbicides and risk for non-Hodgkin lymphoma: A meta-analysis and supporting evidence. Mutation Research/Reviews in Mutation Research. https://www.sciencedirect.com/science/article/pii/S1383574218300887

level chronic glyphosate exposure, distortions in microbial communities, expansion of antibiotic resistance, and the emergence of animal, human and plant diseases.

The authors' primary concern appears to focus on large-scale agricultural applications of glyphosate-based herbicides. They cite the IARC evaluation, which concluded that glyphosate is "probably carcinogenic to humans" but not the EPA assessment that glyphosate is "not likely to be carcinogenic to humans." The only EPA document that was cited was dated 2013, before the EPA's most recent preliminary and final assessments.

This article engages in scientific speculation based on a solid foundation of previous studies, but it places much weight on the IARC's assessment and fails to consider the latest research evaluated by the EPA. Thus, it is out-of-date and, due to its focus on large-scale agricultural treatments, it is not particularly relevant to the Anchorage project.

Casassus, B. 2019. French court bans sale of controversial weedkiller. Nature. January 24.

A recent news item in this international journal of science reported that France recently banned the application of glyphosate for home use and a French court extended the ban to professional use.[100] The court decision was based on the 2015 IARC claim that glyphosate is "probably carcinogenic" to humans although, the article noted, other studies disagreed. The court ruling revoked a 2017 authorization from the French Agency for Food, Environmental and Occupational Health for the use of Roundup Pro 360. The French Committee for Research and Independent Information on Genetic Engineering, which filed the lawsuit to get Roundup Pro 360 banned, hopes the ruling leads to the prohibition of all glyphosate products in France.

By now an observant reader can pick the holes in this argument. Roundup Pro 360 is not glyphosate, it's a glyphosate-based herbicide. The EPA's finding that glyphosate is "not likely to be carcinogenic to humans" doesn't seem to have been considered by the court, or at least that wasn't reported by the article. Germany, Australia, Japan and other countries (not to mention the EPA) continue to believe that glyphosate is not likely to cause cancer based on extensive study. So far the "evidence" that glyphosate-based herbicides may cause cancer is based on correlation, not causation.

Kathryn Guyton, a participant in the IARC's classification of glyphosate as a "probable carcinogen,"[101] has claimed "I don't think home use is the issue. It's agricultural use that will have the biggest impact. For the moment, it's just something for people to be conscious of."[102] That off-the-cuff remark is telling because not one of the articles discussed above suggested that home use wasn't a problem. If home use isn't an issue, then neither is the careful use of glyphosate on mayday trees by experts.

Public comments, news articles and court decisions that highlight a controversy but fail to critically assess the science, to be skeptical of broad claims that intentionally feed our fears,

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[100] Casassus, B. 2019. French court bans sale of controversial weedkiller. Nature. January 24. https://www.nature.com/articles/d41586-019-00259-x?utm_source=Nature+Briefing&utm_campaign=6614f4d674-briefing-dy-20190125&utm_medium=email&utm_term=0_c9dfd39373-6614f4d674-43739305

[101] International Agency for Research on Cancer (IARC). 2017. IARC monographs on the identification of carcinogenic hazards to humans: Some organophospate insectides and herbicides. Volume 112. World Health Organization. https://monographs.iarc.fr/iarc-monographs-on-the-evaluation-of-carcinogenic-risks-to-humans-4/

[102] Cheng, M. 2015. Popular weed killer deemed probable carcinogen by UN. Associated Press. March 20. https://apnews.com/e166afbe1a3b414493ec4144ffa43d9c

drive defenders of the scientific method and debunkers of anti-science conspiracy theories to distraction. For example, Matthew Loftus recommends "looking past the hyperbole and sorting through the facts."[103]

He compares the toxicity of glyphosate to substances most of us are more likely to come into contact with, like caffeine, aspirin, vinegar, and salt (all more acutely toxic than glyphosate, measured by LD50). He also addresses the WHO and IARC claims that glyphosate is a "probable carcinogen." Their category 2A includes other "probable" (but unconfirmed) carcinogens such as emissions from frying food, hairdresser products and burning wood. The research was based on application protocols, not miniscule trace amounts found in or on food. He argues that alcohol and sunlight, which are not "probable" but "known" carcinogens, are more dangerous than glyphosate.

Finally, he notes that "the extreme emphasis some people are putting on glyphosate's reclassification to the exclusion of the other 'natural' compounds [used as pesticides] is quite a double standard, and double standards are pretty good indication of a strong bias on the part of the people making the most noise about it." He refers to an article on D-limonene, which is found in nutmeg, orange juice, mangoes and black pepper and is listed as an organic pesticide by the Organic Materials Review Institute (OMRI), yet is acutely toxic to cats and causes cancer in male rats and mice.[104] Many household cleaners, the article points out, are also acutely toxic and dangerous if you don't use them in accordance with the label instructions.

By the way, OMRI's perspective on organic versus synthetic pesticides is a keystone to the entire issue at hand. OMRI's logo may only be used on pesticides that would also be acceptable for EPA's "For Organic Production" or "For Organic Gardening" designation under the National Organic Program,[105] which has approved the USDA's list of "allowed" and prohibited substances that the municipality adopted in AMC 15.75.025. Thus, OMRI, which appears to have a certain (and justifiable, from its perspective) bias in favor of organic pesticides and an equal but opposite bias against synthetic pesticides, participated in and supports the national legislation that left glyphosate, imazapyr, 2,4-D, triclopyr and aminopyralid off the list of pesticides that are now "allowed" within 150 feet of fish-bearing streams in Anchorage parks. So the list of "allowed" pesticides referenced in AMC 15.75.020 was originally intended to help gardeners and consumers identify which produce is certifiably organic for human consumption, not to dictate which herbicide might be most efficiently and safely employed on invasive plants in a city park.

When scientific or technical findings or issues become controversial, television news shows, many print articles, and conventional wisdom are often unequipped to deal with reality. At best the uproar over the adverse effects of glyphosate is "misguided activism."[106] At worst the public's naiveté and fears are being fanned by deniers in much the same way that certain industries and their proponents have agitated for decades against the idea of anthropogenic

[103] Loftus, M. 2015. Glyphosate toxicity: Looking past the hyperbole, and sorting through the facts. The Credible Hulk blog. June 2. http://www.crediblehulk.org/index.php/2015/06/02/glyphosate-toxicity-looking-past-the-hyperbole-and-sorting-through-the-facts-by-credible-hulk/

[104] Anonymous. 2011. Organic pesticides cause cancer in rats and mice – OMRI LISTED. Pesticide Truths blog. November 27. http://pesticidetruths.com/2011/11/27/organic-pesticides-cause-cancer-in-rats-and-mice-omri-listed/

[105] Environmental Protection Agency (EPA). No date. Clarification of PR Notice 2003-1. https://www.epa.gov/pesticide-registration/clarification-pr-notice-2003-1

[106] Splinter, J. 2017. Removing glyphosate from our food won't make us safer. Tonic blog. June 15. https://tonic.vice.com/en_us/article/9k5gn3/removing-glyphosate-from-our-food-wont-make-us-safer

climate change, warnings and bans on the use of cigarettes in public places, and vaccinations to control the spread of communicable diseases.

AMC 15.75.025 is not a bad law. It's good policy to be skeptical of both pesticides and government. However, if an agency refuses to allow the application of a synthetic herbicide to combat an invasive species because it's not on a list of organic pesticides intended to guarantee that produce is organic for consumptive purposes – when the decision is supposed to be based on a scientific and technical evaluation of the herbicide – that is bad policy.

It's important to maintain perspective. According to the EPA, frying food, hairdresser products and wood smoke are "probable" causes of cancer. Much more commonly encountered substances like alcohol and sunlight are not "probable" but known carcinogens. Yet even these substances are unlikely to cause cancer if exposure is managed carefully.

CONCLUSIONS

- Mayday trees are an invasive species that must be controlled to preserve the natural diversity and environmental integrity of Anchorage parks and streams.
- By replacing native broadleaf trees in riparian areas, mayday trees are significantly reducing browse used by moose, the biomass and diversity of leaf litter used by aquatic invertebrates eaten by fish in their aquatic stage and by birds and bats in their winged stage, and the biomass and diversity of terrestrial insects that are an important food source for salmonids, as well as birds and bats.
- Mayday trees are more toxic to humans and moose, if ingested, than the herbicides that have been proposed to control their spread.
- Monocultures of mayday trees are hazardous to human safety because they have a much lower capacity to intercept stormwater runoff than the native trees they are replacing and in some instances may obstruct the visibility of trail users and other park visitors.
- Anchorage residents are allowed to use herbicides on private property up to the water's edge that are not allowed in municipal parks and greenbelts by AMC 15.75.025.
- Most private citizens are not well acquainted with the impacts and restrictions imposed on the use of glyphosate or other pesticides, and yet the use of these pesticides is widespread in Anchorage. The mayday control program has been designed and would be supervised by professionals to avoid or minimize any adverse environmental or health impacts.
- AMC 15.75.025 allows exceptions to the use of "non-allowed" pesticides to control invasive species if the director or designee finds they are necessary and unlikely to harm fish habitat or a public or private water source that is used for human consumption; however, a technical or scientific assessment does not appear to have been conducted.
- Mechanical methods are often ineffective at controlling mayday trees because the trees re-sprout from the base and root fragments, and pulling mayday trees may exacerbate erosion and sedimentation of fish habitat by removing root masses along stream banks.
- Herbicides are a "last resort" because there are also no known biological or other non-pesticide means of removal adequate for controlling mayday trees.
- The definition of "allowed" pesticides in AMC 15.75.025 refers to a list of pesticides approved for gardening and consumption of organic produce, not for treating invasive species that aren't going to be consumed.

- Our advisory commission was asked to assess the pros and cons of using five “non-allowed” herbicides: glyphosate, imazapyr, aminopyralid, 2,4-D, and triclopyr.
- The EPA has not classified the carcinogenicity of 2,4-D and triclopyr. Although these herbicides appear to be effective at killing woody vegetation and safe enough for limited and careful application in parks and natural areas outside of the 150-buffer, we do not have the information needed at this time to approve of their use within the 150-foot stream buffer. We see no reason, however, to restrict their use in parks outside of the 150-foot stream buffer and at least 600 feet from any public or private water source used for human consumption as long as the applicator follows the methods outlined in Table 1 and conforms to the instructions on the label and all other state and federal restrictions on their use. It is notable that both of these herbicides have been approved for use in national parks and other natural areas by the National Park Service, The Nature Conservancy, and other agencies, and found to be acceptable for invasive plant control to the banks of streams inhabited by endangered species of salmon by a U.S. district court in Washington state.
- Based on the information provided in this report, our advisory commission supports the use of glyphosate, imazapyr, and aminopyralid in the 150-foot stream buffer using the methods proposed by the Invasive Plant Program. Glyphosate, imazapyr, and aminopyralid are unlikely to harm invertebrates, fish, birds and mammals, including humans if used according to the directions on the label. The applicator should use the least toxic formulation at the recommended effective amount based on the product label and environmental conditions with the least potential for human exposure, as required by AMC 15.75.025.
- Mayday trees are a citywide problem that is not confined to any one community council area, and park resources – including moose, birds, and salmon – are valued by residents from all community councils not just those who live adjacent to the park. The Parks and Recreation Department should reconsider its policy that requires the approval of any community council that bounds a park or greenbelt before an invasive species may be treated with a “non-allowed” herbicide. Some parks and greenbelts are adjacent to more than one community council, and the approval of any community council may be overturned by a vote the following month. Community councils were created to advise municipal government, not to exercise veto power over municipal programs or permits that are intended to benefit the entire city, which is essentially what the Parks and Recreation policy allows.