BEST MANAGEMENT PRACTICES FOR

Orange Hawkweed

in the Metro Vancouver Region

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SERVICES AND SOLUTIONS FOR A LIVABLE REGION

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INVASIVE SPECIES COUNCIL OF METRO VANCOUVER

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Introduction

The impacts of invasive species on ecological, human, and economic health are of concern in the Metro Vancouver region. Successful control of invasive species requires concerted and targetted efforts by many players. This document - "**Best Management Practices for Orange Hawkweed in the Metro Vancouver Region**" - is one of a series of species-specific guides developed for use by practitioners (e.g., local government staff, crews, project managers, contractors, consultants, developers, stewardship groups, and others who have a role in invasive species management) in the region. Together, these best practices provide a compendium of guidance that has been tested locally by many researchers and operational experts.

Thousands of species and subspecies of hawkweeds exist around the world (Wilson, 2007). Orange hawkweed[1] is one of 14 invasive hawkweeds in BC, but the only orange-flowered species of all the native and non-native hawkweeds in BC. It is a perennial herb introduced to eastern North America from Northern and Central Europe in the 1800s as an ornamental and medicinal plant (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997). It has become more widespread than other non-native hawkweeds because it has repeatedly escaped cultivation and is desired as an ornamental plant (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997). Management information and outreach materials often cover invasive hawkweeds collectively rather than by species.

Academic institutions, government, and non-government organizations continue to study this species in British Columbia. As researchers and practitioners learn more about the biology and control of orange hawkweed, it is anticipated that the recommended best management practices will change. This document will be updated to reflect these changes as the information becomes available. Please check metrovancouver.org regularly to obtain the most recent version of these best management practices.

1 Orange hawkweed (*Pilosella aurantiaca*) is also known by the common names king devil, orange-red king devil, devil's paintbrush, red daisy, flameweed, orange paintbrush, orange aster. It is referred to as orange hawkweed in this document. The common name "orange hawkweed" is unique to *Pilosella aurantiaca*, whereas the other common names can be used to describe multiple species. Orange hawkweed is also known as *Hieracium aurantiacum*.

REGULATORY STATUS

Orange hawkweed is classed as a noxious weed within the Bulkley-Nechako, Cariboo, Central Kootenay, Columbia-Shuswap, East Kootenay, and Thompson-Nicola Regional Districts under the BC Weed Control Act, *Weed Control Regulation*, Schedule A, Part II – Regional Weeds. Under this Act, "an occupier must control noxious weeds growing or located on land and premises, and on any other property located on land and premises, occupied by that person". However, it is not listed as a noxious weed within Metro Vancouver.

Orange hawkweed is listed as an alien invasive species for the Bulkley-Nechako, Cariboo, Central Kootenay, Columbia-Shuswap, East Kootenay, Thompson-Nicola Regional Districts in Section 2 (1) (b) (iii) of the Community Charter, Spheres of Concurrent Jurisdiction – Environment and Wildlife Regulation, which states that "municipalities may regulate, prohibit and impose requirements in relation to control and eradication of alien invasive species". It is not listed as an invasive species under this Regulation within Metro Vancouver.

Under the *Forest and Range Practices Act*, Invasive Plants Regulation, a "person carrying out a forest practice or a range practice must carry out measures that are: (a) specified in the applicable operational plan, or (b) authorized by the minister, to prevent the introduction or spread of prescribed species of invasive plants." The list of invasive plants in the Regulation includes orange hawkweed.

IMPACTS

Indigenous Peoples have an intrinsic relationship with the natural world, built on reciprocity and stewardship. Many native plants and animals have cultural and spiritual significance for Indigenous Peoples, in addition to being important food and medicine sources. Indigenous communities in British Columbia have collectively called for invasive species prevention, management, and control due to their impact on infrastructure, the economy, human health, ecosystems, and cultural practices. Further collaboration with Indigenous Peoples will deepen our understanding about the impacts of invasive species, such as orange hawkweed, on Indigenous ways of life and our shared environment.

High seed production and aggressive vegetative spread allow orange hawkweed to outcompete native and ornamental plants (King County Noxious Weed Control Program, 2010). Orange hawkweed decreases agriculture crop yields (Invasive Species Council of BC, 2017) and reduces the quality of forage for grazing animals (King County Noxious Weed Control Program, 2010). The plants can easily establish in forest clearings and open timber lots, and spread along logging roads (Regional District Okanagan-Similkameen, 2005), impacting forest restoration.

If left unmanaged, orange hawkweed can form monocultures of seedlings or mats of rosettes, dominating sites. Hawkweed species have been observed at densities of 3,500 plants per square metre (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997).

Hawkweeds are reported to be 'allelopathic', meaning that they release chemicals into surrounding soil that inhibit the growth of other plants (King County Noxious Weed Control Program, 2010) (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997). In a grasslands study in Wisconsin, orange hawkweed was found to be detrimental to the germination, growth and survival of tree species (Dawes & Maravolo, 1973).

REPRODUCTION AND SPREAD

All hawkweeds spread by seed, and vegetatively by both stolons (ground-level horizontal stems) and rhizomes (belowground horizontal stem) (Wilson, 2007). It is likely that new populations establish from seeds, but infestations expand through vegetative growth (Province of BC, 2002). Stolons form from the base of the leaves after plants have flowered (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997). Stolons can root at the nodes and produce new rosettes the following growing season (Regional District Okanagan-Similkameen, 2005). Plants can re-sprout from root fragments left in the soil (King County Noxious Weed Control Program, 2010).

Seeds most commonly form by 'apomixis' – reproduction without fertilization or pollen (Wilson, 2007). Seeds can be spread by many vectors, including recreationalists, animals, garden waste, machinery, and soil (Province of BC, 2002). Rough ribs on the outside of the seeds allow them to easily stick to hair, fur, feathers, clothing, vehicles, and hay bales (Regional District Okanagan-Similkameen, 2005). Long-distance seed dispersal is likely through birds and animals, including humans (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997). There is widespread hybridization between native and non-native hawkweed species in North America (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997) (King County Noxious Weed Control Program, 2010).

Some hawkweeds, especially orange hawkweed, are maintained as ornamental plants (Wilson, 2007) and can be found in wildflower seed mixes (Regional District Okanagan-Similkameen, 2005).

HABITAT AND DISTRIBUTION

Hawkweeds grow in open fields, meadows, pastures, cleared timber lots, farmland, roadsides, abandoned property, cemeteries and disturbed sites (Wilson, 2007) (Province of BC, 2002) (Rinella, Sheley, Mangold, & Kittle, 2017). In the Metro Vancouver region, orange hawkweed is found along roadsides, trails, and ski runs, and in meadows, boulevards, lawns, gardens, flowerbeds, parks, and disturbed sites.

Orange hawkweed tolerates low- to mid-elevations (Province of BC, 2002) and full sun to partial shade (King County Noxious Weed Control Program, 2010). It thrives in a variety of soil conditions, but prefers well-drained, coarse-textured soils low in organic matter and nutrients (Wilson, 2007).

Orange hawkweed is widely distributed across the western North America (DiTomaso, Kyser, & et al, 2013). It is a major concern in the Kootenay, Okanagan, Thompson, Cariboo, Omineca, and Peace regions of BC because of the potential to infest rangeland, pasture land, meadows, and larger open spaces (Province of BC, 2002). It is scattered and locally abundant in the southern Kitimat Stikine, Bulkley Nechako, Fraser-Fort George and Cariboo regions of the province (Invasive Species Council of BC, 2017). Within Metro Vancouver, infestations have established in the North Shore municipalities, Vancouver, Burnaby, New Westminster, Tri-Cities, Belcarra, Anmore, and Maple Ridge. It is less common south of the Fraser River. It has spread primarily along transportation corridors and in residential neighbourhoods in the Metro Vancouver region.

Orange hawkweed dominates a meadow

CREDIT: L. SCOTT

CLIMATE CHANGE ADAPTATION

Climate models predict that the Metro Vancouver region will experience warmer temperatures; a decrease in snowpack; longer dry spells in summer months; more precipitation in autumn, winter and spring; more intense extreme events; and an extended growing season. In the past, our region had an average of 252 days in the growing season. In lower elevations, 45 days will be added to the growing season by the 2050s, and 56 days by the 2080s, resulting in nearly a year-round growing season of 357 days on average. In higher elevation ecosystems the growing season length will increase by 50% to 325 days by the 2080s (Metro Vancouver, 2016). These changes will stress many sensitive ecosystems, increasing their vulnerability to competition from invasive species.

A study by Beaumont et al (2009) provides evidence that invasive populations of *Hieracium* species can occupy areas with different climatic conditions than experienced in their native ranges. It is speculated that orange hawkweed may benefit from our future climate in several ways:

- **Extended growing season:** In favourable conditions, a single orange hawkweed generation can grow in 4 months (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997). With its ability to germinate, flower and set seed quickly, orange hawkweed may be able to take advantage of an extended growing season (i.e., two generations per year).
- **Warmer temperatures:** Populations of orange hawkweed in western North America have a broad climatic niche, and generally occur in warmer conditions compared to native populations (Beaumont, et al., 2009).

With these kinds of competitive advantages, this species is more adaptable than native species in a variety of ecosystems and climate conditions. Its ability to reproduce in multiple ways and spread quickly suggest that it will be able to withstand, and possibly thrive, with changing climate conditions.

Identification

Unless otherwise noted, the following identification information was collected from the Province of BC (2002) and Klinkenberg (2020).

Lifecycle: Perennial herb; rhizomes persist through the winter giving rise to rosettes in the spring to early summer. Plant longevity is believed to be up to 30 years (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997).

Stem: 10-60 centimetres tall, erect, solitary, unbranched, usually leafless, with stiff glandular hairs.

Leaves: 5-12 basal leaves clustered at the base of the stem form a rosette; covered with stiff hairs, oval to oblong shaped and 4-20 centimetres long (Invasive Species Council of BC, 2017).

Flowers: Each rosette produces one flowering stem, with clusters of 5-30 small, dandelion-like flowers at the top (Rinella, Sheley, Mangold, & Kittle, 2017). Flowerheads are compound with ray flowers only with square edges and notched tips (King County Noxious Weed Control Program, 2010); bright orange to red-orange colour, drying to purple. Bracts located at the base of the flowers are lance-shaped with many black glandular hairs (Wilson, 2007).

Flowering begins between May and June and may continue until September (King County Noxious Weed Control Program, 2010). After blooming, flowers quickly form seeds (King County Noxious Weed Control Program, 2010).

Fruits: Achenes 1.5-2 millimetres long, dark brown or black with ridges and bristly plumes. Each flowerhead produces 12-30 seeds (approximately 50-600 per plant) (Klein, 2011). Seeds mature by July (King County Noxious Weed Control Program, 2010) and can be viable for up to 7 years (DiTomaso, Kyser, & et al, 2013).

Roots: Shallow, fibrous roots with a woody base; each plant produces 4-8 stolons each year (King County Noxious Weed Control Program, 2010); stolons are hairy, have leaves, and can root at the nodes.

Other characteristics: Stems and leaves contain a milky sap.

The following photos show orange hawkweed plant parts.

Stem with stiff glandular hairs

CREDIT: ISCMV

Leaf rosette

CREDIT: ISCMV

Rosette and flowering stem

CREDIT: L. SCOTT

Stolons arising from a rosette

CREDIT: ISCMV

Rhizome and roots

CREDIT: ISCMV

Flower

CREDIT: MICHAEL SHEPHARD, USDA FOREST SERVICE, BUGWOOD.ORG

Black-haired bracts visible at the base of the flowers

CREDIT: ISCMV

Seed heads

CREDIT: ISCMV

Dark seed capsule (achene) with white plumes

CREDIT: ISCMV

SIMILAR SPECIES

There are many native and invasive hawkweeds (genus *Hieracium and Pilosella*) in the Pacific Northwest region of North America. Wilson's Key to Identification of Invasive and Native Hawkweeds (Hieracium spp.) in the Pacific Northwest (2007) highlights 28 of these. Hawkweeds are members of the Tribe *Lactuceae* of the plant Family *Asteraceae*, all of which have strap-shaped flowers and a milky sap within the stems and leaves (Wilson, 2007). All hawkweed species found in BC have yellow flowers, except orange hawkweed and the native white hawkweed (*Hieracium albiflorum*). Hawkweeds can be difficult to distinguish taxonomically due to minor physiological differences and the potential for hybridization (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997). The size and abundance of hairs, leaf venation, and stolon and flower characteristics are mostly commonly used to distinguish between species (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997).

Other common hawkweed species found in the Metro Vancouver region, and other species that could easily be mistaken for orange hawkweed, are described below. Unless otherwise noted, the following identification information was collected from Klinkenberg (2020).

NATIVE SPECIES

All native *Pilosella/Hieracium* species lack stolons and have branched stems with multiple leaves.

- **White hawkweed (Hieracium albiflorum)** is 0.3-1.2 metres tall with solitary stems branched at the top. Ray flowers are white, bracts are greenish-blackish. Leaves are sparsely to moderately hairy on the upper surface. This species is common throughout BC in fields, grasslands, shrublands and along roadsides.
- **Scarlet paintbrush (*Castilleja miniata*)** is a native wildflower that can be mistaken for orange hawkweed in fields and when viewed from a distance due to the similar coloured flowers. Scarlet paintbrush is a perennial herb with alternate, lance-shaped leaves all along the stem which ends in a bracted terminal spike; the bracts are bright red-orange to scarlet (Klinkenberg, 2020). Scarlet paintbrush is found throughout BC in a variety of habitats.

White hawkweed flowers
CREDIT: ANDREY ZHARKIKH, FLICKR

Scarlet paintbrush
CREDIT: DAVE POWELL, USDA FOREST SERVICE (RETIRED), BUGWOOD.ORG

NON NATIVE SPECIES

- **Mouse-ear hawkweed (Pilosella officinarum or Hieracium pilosella)** most closely resembles orange hawkweed of all the hawkweed species (Regional District Okanagan-Similkameen, 2005). Mouse-ear hawkweed has a single yellow flower per stem that blooms from May to June, is low growing (25-40 centimetres) and rarely occurs in southern BC (Province of BC, 2002). Colonies of rosettes often grow in a circular pattern (King County Noxious Weed Control Program, 2010).

  Mouse-ear hawkweed is the only hawkweed that is a candidate for eradication under the BC Invasive Species Early Detection Rapid Response (EDRR) Program. More information is available on the Provincial invasive species alert page for mouse-ear hawkweed.

- **Meadow hawkweed, yellow hawkweed or yellow king devil (Pilosella caespitosa or Hieracium caespitosum)** has stems 25-90 centimetres tall and covered with glandular, star-shaped hairs (Klein, 2011); clusters of yellow flower heads grow at the top of the stem.

- **Hairy cat's ear (*Hypochaeris radicata*)** has stems 15-60 centimetres tall, usually branched. It has a cluster of yellow flower heads that grow at the top of the stems similar to meadow hawkweed, however hairy cat's ear leaves are narrow at the base, rounded at the tips and have curved lobes.

- **Common dandelion (*Taraxacum officinale*)** has a thick, deep taproot, and one to many hollow stems 6-60 centimetres tall that release milky juice when broken. The leaves are 5-40 centimetres long, tapering at the base with toothed, jagged edges. A single yellow flowerhead grows at the top of the stems. This plant is common in Southern BC along roadsides and in fields, gardens, and disturbed areas.

Mouse-ear hawkweed

CREDIT: JANIE MARLOW, NAMETHATPLANT.NET, BUGWOOD.ORG

Meadow hawkweed

CREDIT: JOSHUA MAYER

Hairy cat's ear rosette of leaves

CREDIT: OHIO STATE WEED LAB, THE OHIO STATE UNIVERSITY, BUGWOOD.ORG

Dandelion

CREDIT: HOWARD F. SCHWARTZ, COLORADO STATE UNIVERSITY, BUGWOOD.ORG

Tracking

The provincial government maintains the Invasive Alien Plant Program (IAPP) application (Ministry of Forests, 2022) which houses information about invasive plant surveys, treatments, and monitoring. Many agencies, including local governments, have their own internal invasive species inventory and mapping protocols that are used by staff, contractors, and, in some cases, the public. For example, the City of North Vancouver has its own system called AlienMap. Agencies in British Columbia that do not enter data into IAPP are encouraged to check it regularly because it contains public reports and data from other agencies and it is important to consider as much data as possible when making management decisions. The Map Display module of IAPP is publicly accessible.

Orange hawkweed can be difficult to detect in tall grass and other vegetation, unless it is flowering (King County Noxious Weed Control Program, 2010). Targetted surveying should occur during the flowering window from mid-May to late June. Hawkweeds often establish in remote and high elevation meadows and go undetected (Rinella, Sheley, Mangold, & Kittle, 2017). Consider targeted inventory of orange hawkweed in areas with prime habitat near known locations.

When carrying out an orange hawkweed inventory it is useful to record the following information as it will later inform treatment plans:

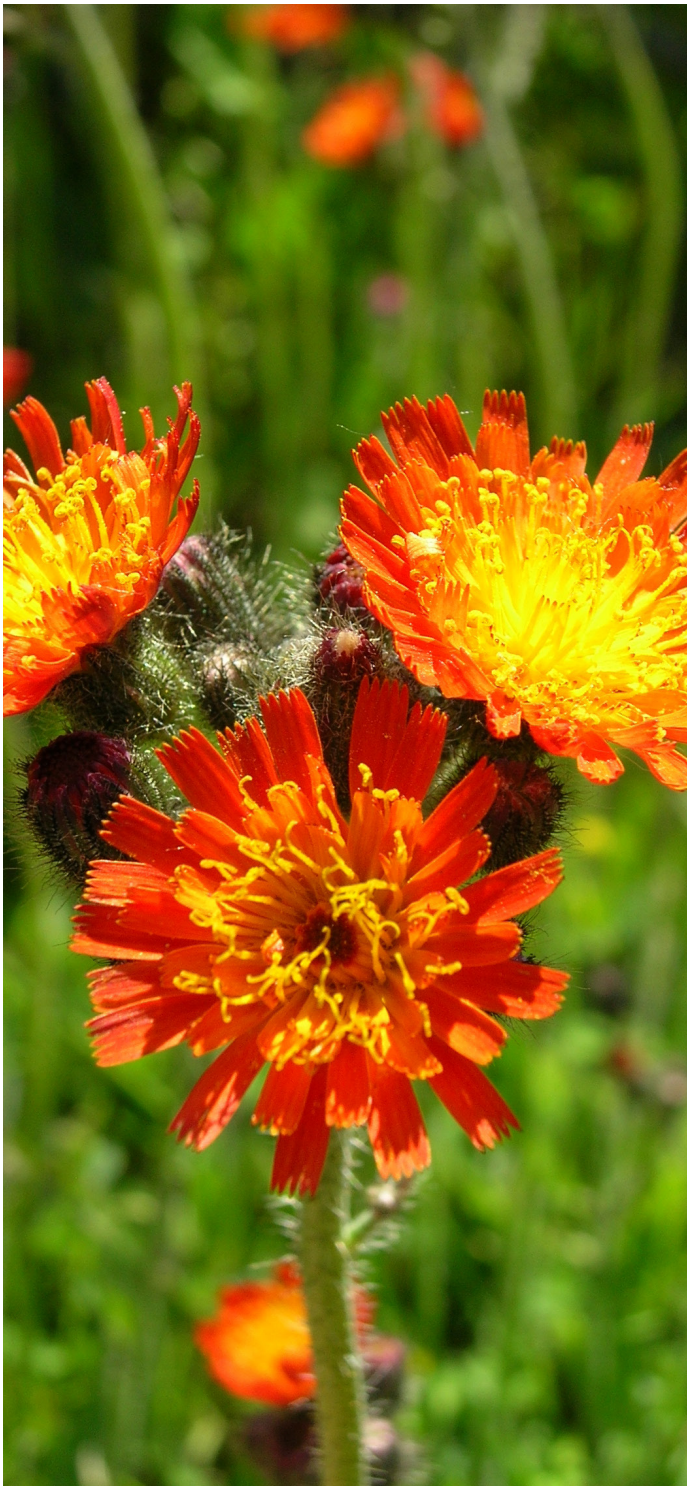
- Size and density of infestation;
- Location in relation to the 10 metre Pesticide Free Zone adjacent to water courses;
- Location in relation to other water sources, such as wells;
- Location in relation to tree driplines; and
- Presence of other invasive hawkweeds

Reporting

Please report orange hawkweed occurrences to:

- The Provincial Report Invasive Species program (via smart phone app www.gov.bc.ca/invasive-species).
- The Invasive Species Council of Metro Vancouver: 604-880-8358 or www.iscmv.ca.
- The municipality where the orange hawkweed was found.
- The landowner directly – If the landowner is unknown, the Invasive Species Council of Metro Vancouver can provide support to identify the appropriate authority.

Reports submitted through these channels are reviewed by invasive species specialists who coordinate follow-up activities when necessary with the appropriate local authorities. However, some people may be hesitant to report infestations as their presence may affect property values.



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Prevention and Control Strategies

Effective invasive plant management may include a variety of control techniques ranging from prevention, chemical, manual, mechanical, biological, and/or cultural methods. Each method is described below in order of effectiveness.

Many invasive hawkweeds can be managed with the same strategies. Recommendations for orange hawkweed may also be suitable for other invasive hawkweeds and vice versa. Many of the sources referenced in this document cover impacts, biology and management for multiple invasive hawkweeds found in the Pacific Northwest.

Except for individual plants or small infestations, controlling hawkweeds successfully relies on the application of selective herbicides and re-invasion can occur quickly unless other plants fill the gaps left by the hawkweed control (Wilson, 2007). Large, established infestations take many years to control, and eradication may not be possible (King County Noxious Weed Control Program, 2010).

STRATEGY COLOUR LEGEND

GREEN: RECOMMENDED

ORANGE: CAUTION

RED: NOT RECOMMENDED OR NOT AVAILABLE

PREVENTION: IMPERATIVE

Prevention is the most economical and effective way to reduce the spread of orange hawkweed over the long term.

When working in or adjacent to orange hawkweed, it is best to inspect and remove plants, plant parts, and seeds from personal gear, clothing, pets, vehicles, hay, and equipment. Ensure soil, gravel, and other fill materials are not contaminated with orange hawkweed before leaving an infested area. Plants, plant parts, and seeds should be tarped or bagged before transport to an appropriate disposal site (see Disposal section). Minimize soil disturbance at impacted sites to prevent seed germination (King County Noxious Weed Control Program, 2010).

Orange hawkweed is desired as an ornamental plant due to its attractive flowers and can be found in wildflower seed mixes (Regional District Okanagan-Similkameen, 2005). When selecting plants for a site, do not purchase, trade, or transplant orange hawkweed. The Invasive Species Council of BC's 'Grow Me Instead' Program or Metro Vancouver's Grow Green website provide recommendations for non-invasive, drought-tolerant plants, and garden design ideas. All materials used onsite (e.g., topsoil, gravel, mulch, compost, wood chips, plant stock) should be weed-free. Orange hawkweed can be introduced via these materials and sites where they are used should be monitored carefully for any growth (Crosby, 2023).

Healthy green spaces are more resistant to invasion by invasive plants, so it is also important to maintain or establish healthy plant communities.

CHEMICAL: RECOMMENDED

Chemical control is an effective method for roadsides and non-pasture sites (King County Noxious Weed Control Program, 2010). Complete eradication is very difficult, but spring treatments of both herbicide and a cultural control method such as installing/maintaining competitive vegetation and fertilizer application is the best overall treatment for hawkweeds (see Cultural control section).

Chemical control should be used with caution for the following reasons (Crosby, 2023):

1. Weather conditions greatly influence treatment efficacy;
2. Orange hawkweed may be found in in riparian areas where pesticide use is restricted; and
3. Since orange hawkweed growth is closely associated with other plants, including crops and forage plants, chemical control can easily damage non-target species (Province of BC, 2002).

With the exception of substances listed on Schedule 2 of the BC Integrated Pest Management Regulation, the use of herbicides is highly regulated in British Columbia. Site characteristics must be considered with herbicide prescribed, based on site goals and objectives and in accordance with legal requirements. This summary of BC's *Integrated Pest Management Act* provides an overview of the provincial legislation.

PESTICIDE LICENCE AND CERTIFICATION

A valid pesticide licence is required to:

- offer a service to apply most pesticides;
- apply most pesticides on public land including local government lands[2]; and
- apply pesticides to landscaped areas on private land, including outside office buildings and other facilities.

Pesticides (e.g., herbicides, insecticides, fungicides) are regulated by the Federal and Provincial governments, and municipal governments often have pesticide bylaws.

- Health Canada evaluates and approves chemical pest control products as per the *Pest Control Products Act*.
- The BC *Integrated Pest Management Act* sets out the requirements for the use and sale of pesticides in British Columbia. This Act is administered by the Ministry of Environment and Climate Change Strategy.
- Several municipalities have adopted bylaws that prohibit the use of certain pesticides.

Everyone who uses pesticides must be familiar with all relevant laws.

ONLY companies or practitioners with a valid Pesticide Licence and staff who are certified applicators (or working under a certified applicator) may apply herbicide on invasive plants located on public lands in British Columbia. Applicators must be either the land manager/owner or have permission from the land manager/owner prior to herbicide application.

On private property the owner may obtain a Residential Applicators Certificate (for Domestic class products only) or use a qualified company. Residents do not require a Residential Applicator Certificate for certain uses of domestic class glyphosate including treatment of plants that are poisonous for people to touch, invasive plants and noxious weeds listed in legislation, and weeds growing through cracks in hard surfaces such as asphalt or concrete. Refer to the 'Pesticides & Pest Management' and 'Home Pesticide Use' webpages listed in the Additional Resources Section for more information.

Questions? Contact the BC Integrated Pest Management Program: Telephone: (250) 387-9537

Email: bc.ipm@gov.bc.ca

2 on up to 50 ha/year by a single organization. Organizations looking to treat over 50 hectares of land per year are also required to submit a Pest Management Plan and obtain a Pesticide Use Notice confirmation.

Pesticide applicator certificates can be obtained under the category 'Industrial Vegetation Management' to manage weeds on industrial land, roads, power lines, railways, and pipeline rights-of-way for control of noxious weeds on private or public land. However, since orange hawkweed is not a regulated noxious weed in the Metro Vancouver region, the 'Landscape' certification category is needed for herbicide use on public and private lands. Assistant applicator training is also available and the online course and exam are free.

It is best practice for personnel supervising or monitoring pesticide contracts to also maintain a pesticide applicator licence so they are familiar with certification requirements.

For more information on how to obtain a licence and the requirements when working under the provincial Integrated Pest Management Act and Regulation, please review the Noxious Weed & Vegetation Management section on this webpage: gov.bc.ca/PestManagement.

HERBICIDE LABELS

Individual herbicide labels must always be reviewed thoroughly prior to use to ensure precautions, application rates, and all use directions, specific site and application directions are strictly followed. Under the federal *Pest Control Products Act* and the BC Integrated Pest Management Regulation, **persons are legally required to use pesticides (including herbicides) only for the use described on the label and in accordance with the instructions on that label**. Failure to follow label directions could cause damage to the environment, create poor control results, or pose a danger to health. Contravention of laws and regulations may lead to cancellation or suspension of a licence or certification, requirement to obtain a qualified monitor to assess work, additional reporting requirements, a stop work order, or prohibition from acquiring authorization in the future. A conviction of an offence under legislation may also carry a fine or imprisonment.

Herbicide labels include information on both the front and back. The front typically includes trade or product name, formulation, class, purpose, registration number, and precautionary symbols. Instructions on how to use the pesticide and what to do in order to protect the health and safety of both the applicator and public are provided on the back (BC Ministry of Environment, 2011).

Labels are also available from the Pest Management Regulatory Agency's online pesticide label search or mobile application as a separate document. These label documents may include booklets or material safety data sheets (MSDS) that provide additional information about a pesticide product. Restrictions on site conditions, soil types, and proximity to water may be listed. If the herbicide label is more restrictive than Provincial legislation, the label must be followed.

CREDIT: L. SCOTT

HERBICIDE OPTIONS

Selective broadleaf herbicides are preferred for orange hawkweed treatment, as they allow grass to survive which helps suppress germination of orange hawkweed seeds (King County Noxious Weed Control Program, 2010). The following herbicides can be used on orange hawkweed. Unless otherwise noted, information is from the Province of BC (2002), King County Noxious Weed Control Program (2010) and DiTomaso, Kyser et al (2013).

ACTIVE INGREDIENT (EXAMPLE BRAND NAMES)+	APPLICATION	PERSISTENCE	GROWTH STAGE	TYPE++	COMMENT
Picloram alone or Picloram + 2,4-D^ (example: Tordon™, Grazon™)	foliar application	short residual	actively growing in spring and early summer	selective, no effect on most grasses	Picloram not suitable for wet, coastal soils (SSISC)
Dicamba (example: Banvel™)	foliar application	short residual	before flowers open	selective	Spring applications for turf and lawns; may require multiple treatments even in ideal conditions
Aminopyralid alone (example: Milestone™) or with 2,4-D^	foliar application	residual	rosettes after emergence or during flowering	selective	Use in pastures where grasses are preferred, as aminopyralid controls more shrub and herb species (Seefeldt & Conn, 2011); not effective for fall treatment
2,4-D^ + dicamba	foliar application	residual	rosettes after emergence or during flowering	selective	Use in pastures where grasses are preferred
Clopyralid (example: Lontrel 360™)	foliar application	residual	rosettes after emergence or during flowering	selective	Use in natural areas where high biodiversity is the goal, as clopyralid has less impact on non-target species (Seefeldt & Conn, 2011)
Triclopyr alone (example: Garlon™) or with 2,4-D^	foliar application	residual	actively growing	selective, no effect on grasses	Apply to actively growing plants from spring to early summer; recommended to use with a surfactant
Glyphosate§ (many products)	foliar application	non-residual*	actively growing	non-selective	Unknown effectiveness on orange hawkweed; not recommended at sites with other vegetation, as glyphosate will kill all plants including grasses, which are essential to reducing regrowth; glyphosate treatments should be followed by seeding with a grass or native seed mix

+ The mention of a specific product or brand name of pesticide in this document is not, and should not be construed as, an endorsement or recommendation for the use of that product.

++ Active growing periods vary from year to year depending on weather and other factors. There may be more than one active growing period for a plant in a year.

+++ Herbicides that control all vegetation are non-selective, while those that control certain types of vegetation (e.g., only grasses or only broadleaf plants) are termed selective.

^ 2,4-D alone does not provide good control; 2,4-D products not currently permitted on BC Ministry of Transportation and Infrastructure jurisdiction.

§ Glyphosate can impact trees with roots within or adjacent to the treatment area.

* Non-residual herbicides are active only on growing plant tissue and have little or no persistence in the soil whereas residual herbicides persist in the soil, remaining effective over an extended period.

NOTE: Orange hawkweed may not be specifically listed on these herbicide labels. However, it falls under the general application provision for broadleaved plants or perennial pasture weeds (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997).

APPLYING PESTICIDE IN RIPARIAN AREAS

Provincial legislation prohibits the use of herbicides within 10 metres of natural water courses and 30 metres of domestic or agricultural water sources on public lands. On private lands herbicide labels need to be followed (which means for glyphosate products treatment can happen up to the water's edge) and other restrictions may apply (e.g. industrial sites, forestry sites, golf courses, etc.). On public lands, glyphosate is the only active ingredient that can be applied within the 10 metre Pesticide-Free Zone (PFZ)[3] in British Columbia in accordance with the *Integrated Pest Management Act* and Regulation and all public land Pesticide Management Plans (PMPs) but not within 1 metre of the high water mark (HWM)[4]. A plant must be either a listed Noxious Weed (under the *Weed Control Act*) or appear in the *Forest and Range Practices Act* Invasive Plants Regulation to be treated within the 10 metre PFZ. **Orange hawkweed is listed in the *Forest and Range Practices Act*, Invasive Plants Regulation and therefore glyphosate can be applied on orange hawkweed up to 1 metre away from the HWM**. The 30 metre no-treatment zone around a water supply intake or well used for domestic or agricultural purposes may be reduced if the licencee or PMP holder is "reasonably satisfied" that a smaller no-treatment zone is sufficient to ensure that pesticide from the use will not enter the intake or well.

When managing orange hawkweed with herbicide in riparian areas:

- Observe and mark all PFZs while on site.
- The HWM should be determined by careful evaluation by the applicator.
- Distances in PFZs should be measured as horizontal distance.
- Herbicides restricted in a PFZ must not enter these zones by leaching (lateral mobility) through soil or by drift of spray mist or droplets.
- Treatments should be conducted when water levels are low (e.g. summer months) to reduce risk.
- Note that efficacy may be dependent on site conditions, including moisture in the soil.

3 The Pesticide-Free Zone (PFZ) is an area of land that must not be treated with pesticide and must be protected from pesticide moving into it, under the *Integrated Pest Management Act and Regulation*.

4 The High Water Mark (HWM) is defined as the visible high water mark of any lake, stream, wetland or other body of water where the presence and action of the water are so common and usual and so long continued in all ordinary years as to mark upon the soil of the bed of the lake, river stream, or other body of water a character distinct from that of the banks, both in vegetation and in the nature of the soil itself. Typical features may include, a natural line or "mark" impressed on the bank or shore, indicated by erosion, shelving, changes in soil characteristics, destruction of terrestrial vegetation, or other distinctive physical characteristics. The area below the high water mark includes the active floodplain (BC Ministry of Environment, 2011).

APPLICATION METHODS

Foliar application can be undertaken by hand sprayer, backpack sprayer, or wick applicator. For large, contiguous infestations, rather than targetting individual plants, it is best to uniformly spray the infested area to ensure good coverage to stolons and small seedlings in between larger plants (King County Noxious Weed Control Program, 2010).

In general, herbicide treatment is best in the early spring to encourage growth of perennial grasses (DiTomaso, Kyser, & et al, 2013). Targetting the plants before the flowers are mature can prevent seed development as flowering plants may produce seeds immediately after being sprayed (King County Noxious Weed Control Program, 2010). Herbicide application later in the season is less effective and may not prevent seed development.

Orange hawkweed chemical treatment site on a ski run in North Vancouver

CREDIT: ISCMV

MANUAL/MECHANICAL: RECOMMENDED

- **Hand pulling or digging** is appropriate for small and isolated infestations in the spring or early summer, when the soil is moist and before seeds mature (King County Noxious Weed Control Program, 2010). The fibrous roots and stems are easy to dig up but break easily. Sites should be thoroughly covered to ensure every plant has been targeted (Yong, 2023). It is best to remove as much of the roots and stolons as possible and avoid breakage as plants can re-grow from fragments (King County Noxious Weed Control Program, 2010). This technique may cause soil disturbance, which can encourage germination of the seed bank and seedling growth. Removed soil or divots should be replaced to decrease disturbance. The site should be monitored after treatment and restored with competitive vegetation (see follow-up monitoring and restoration sections).

  If flowers and flower buds are present, the plants should be bagged or contained to prevent seed spread, as seeds can mature even after flowering stems have been removed (King County Noxious Weed Control Program, 2010). It is not recommended to undertake pulling or digging if seeds are present.

- **Flower removal** is only successful for very small patches, for example in a residential garden setting, as a measure to prevent seed-set in the absence of other management techniques. Flowers must be bagged and removed offsite as seeds can mature even after flowering stems have been cut (King County Noxious Weed Control Program, 2010).

- **Mowing** while the plants are in flower prevents seed production but encourages vegetative reproduction as mowing blades miss low-lying rosettes (Rinella, Sheley, Mangold, & Kittle, 2017). After mowing, a shorter stem will grow and quickly flower again, and energy is diverted into stolon growth (King County Noxious Weed Control Program, 2010). Mowed infestations typically increase in size and density (King County Noxious Weed Control Program, 2010).

REMOVAL TIMING

Manual control methods should be targetted prior to flowering to prevent seed production (King County Noxious Weed Control Program, 2010).

APPLYING PESTICIDE IN RIPARIAN AREAS

Orange hawkweed often grows in large contiguous patches right up to the edge of water courses. Consider the impact of control techniques and the resulting bare soil on the adjacent aquatic environment. Schedule removal works during a period of least risk to fish species, outside of the fish window. Adhere to Provincial and Federal riparian regulations. It is recommended to consult with a qualified environmental professional when working around water bodies.

CREDIT: ISCMV

CULTURAL: RECOMMENDED

Recommended cultural control techniques for orange hawkweed focus on cultivating healthy soils and a competitive plant community.

- **Maintaining competitive vegetation** can help discourage orange hawkweed growth. In natural areas, plant a diversity of native shrubs and trees; in grassy areas, apply a mix of grass or forage seeds (King County Noxious Weed Control Program, 2010). This method is recommended in combination with other manual, chemical or cultural management strategies. The Restoration section below outlines additional guidelines for restoration.
- **Cultivating and rotating annual agricultural crops** fosters productive and healthy farmland that is much less prone to hawkweed invasion (King County Noxious Weed Control Program, 2010). Orange hawkweed persists in over-utilized and poorly-maintained pastures and hayfields but does not compete well in cultivated settings with a dense, healthy annual crop (Ministry of Agriculture, Food and Fisheries, 2022).

  If pasture sites are grazed, it is best to schedule the animals to encourage uniform grazing and avoid over-grazing (King County Noxious Weed Control Program, 2010). Where possible, grazed vegetation should be maintained at 10 to 15 centimetres. Grazing should be conducted when soil is relatively dry, since grazing during wet conditions creates pockets, significant soil disturbance and more opportunity for re-invasion (King County Noxious Weed Control Program, 2010).

  This method can be used with herbicide for further success (Ministry of Agriculture, Food and Fisheries, 2022).

- **Fertilizer application** can be a complimentary technique to herbicide application. A spring application of a nitrogen fertilizer after herbicide treatments can encourage competition from other plants, especially in new hawkweed infestations or where hawkweed density is relatively low and grasses and forbs are present (Wilson, 2007). This method is most successful in pastures and rangeland where nitrogen levels are not high enough for optimal grass growth (Rinella, Sheley, Mangold, & Kittle, 2017). A reduction of density and spread can be expected, but this method will not eradicate orange hawkweed (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997). Fall fertilizer application is not recommended due to nitrogen loss through leaching during the winter (Invasive Species Council of BC, 2017).
- In turf or garden settings **soil irrigation** can create healthier soils and encourage competition from other plants; this will be most successful at sites where other grasses and herbaceous plants are present (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997).
- Although modifying grazing practices in agricultural settings can contribute to the control of orange hawkweed in combination with other practices, **grazing** alone is not a recommended as a management option for this species. Under intensive grazing, invasive hawkweeds can spread rapidly, displacing most other vegetation (Rinella, Sheley, Mangold, & Kittle, 2017). The plant's short growth structure provides little useable forage for livestock or wildlife (DiTomaso, Kyser, & et al, 2013). Grazing opportunities are limited in urban areas due to municipal bylaws regulating agriculture animals, the high probability of interface with the public, and the damage animals could cause to riparian areas and other sensitive sites with multiple land uses.

BIOLOGICAL: NOT AVAILABLE

Due to the large number of native and invasive *Pilosella/ Hieracium* species, host specificity is a challenge in biocontrol research for individual species (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997). Since infestations are largely spread by vegetation reproduction, research is focusing on agents that target the stolons and roots versus the flowers/ fruits (Wilson, McCaffrey, Quimby, Jr., & Birdsall, 1997).

The following agents are being studied as potential biocontrol agents for several of the invasive hawkweed species in BC, including orange hawkweed (Ministry of Forests, Range Branch, Invasive Plant Program, 2022):

- Stolon-feeding gall forming wasp, *Aulacidea subterminalis*, was first released in BC in 2011 and is currently being considered for four species of invasive hawkweed in BC, including orange hawkweed, although this species is a less preferred host. Subsequent inspections revealed low levels of survival of the galls on orange hawkweed.
- Root-feeding hoverfly, *Cheilosia urbana*, was approved for import in the spring of 2016 and first released in BC in 2017 for meadow and orange hawkweeds as the primarily targets. Subsequent releases were made at the initial site, but no flies have been recovered from this site to date.
- Switzerland and Agriculture and Agri-Food Canada in Lethbridge, AB are researching two genetically distinct forms of another gall wasp, *Aulacidea pilosellae*, which show potential to target invasive hawkweeds.
- Research on additional insect and rust (fungal plant parasites) species have been unsuccessful or terminated due to the low likelihood of success.

Despite ongoing research, to date biocontrol agents for orange hawkweed have not established and are not available for general distribution in BC. For the current status and availability of these agents, please visit the BC Ministry of Forests Biological Control website.

CONTROL SUMMARY

The following table provides a summary and comparison of control methods for orange hawkweed.

CONTROL STRATEGY	TECHNIQUES	APPLICABLE SITE TYPE	PROS	CONS
Chemical	**Foliar application**	Roadsides, large landscape-scale sites	High success when combined with a cultural control method, less labour intensive, treat large areas, less disturbance of surrounding environment	Herbicide resistance, may require herbicide mixtures, unintended environmental/health impacts, high public concern, requires trained staff, specialty equipment and herbicide products, weather dependent, cannot treat within PFZ, less suitable for pastures
Manual	**Hand pulling, digging**	Small, isolated sites	Non-chemical, selective, low risk to environment	Creates disturbance, labour intensive, seeds can mature after plants are treated
Cultural	**Maintaining competitive vegetation**	All sites	Non-chemical	Use with other methods for greatest success, requires maintenance of other vegetation, long-term commitment
	Cultivating and rotating annual agricultural crops	Farmland	Non-chemical, high success when combined with chemical treatment	Labour intensive, requires a pasture management regime, long-term commitment
Manual	**Flower removal**	Gardens	Non-chemical, prevents release of seeds	Containment measure only, seeds can mature after flowers are removed, requires bagging and offsite disposal
Cultural	**Fertilizer application**	Pastures, rangeland	Encourages competition from other plants	Labour intensive, non selective, use with chemical control, will not eradicate the plants, limited seasons for application
	Soil irrigation	Turf grass, gardens	Non-chemical, encourages competition from other plants	Non-selective, will not eradicate the plants, local watering restrictions may impact effectiveness
Mechanical	**Mowing**	None	Non-chemical	Encourages vegetative growth, not effective
Cultural	**Grazing**	None	Non-chemical	Non-selective, may create disturbance and unintended environmental impacts, special permits may be required
Biological	**No biological control agents are currently available for distribution in British Columbia**			

CONTROL SUMMARY COLOUR LEGEND

GREEN: RECOMMENDED

ORANGE: CAUTION

RED: NOT RECOMMENDED OR NOT AVAILABLE

Disposal

ON SITE DISPOSAL

If manual control methods are used for orange hawkweed, it is best to remove the plants offsite due to the risk of vegetative spread and since immature flowers can still produce viable seed after removal.

OFF SITE DISPOSAL

Bag or contain the plants and remove them offsite for disposal. In the Metro Vancouver region, several facilities accept orange hawkweed plants and/or infested soil. Please consult this disposal facility list for current details.

PLEASE CONTACT ALL FACILITIES BEFOREHAND TO CONFIRM THEY CAN PROPERLY HANDLE THE MATERIAL.

CLEANING AND DISINFECTION[5]

Before leaving a site, all visible plant parts and soil from vehicles, equipment, and gear should be removed and rinsed if possible. When back at a works yard or wash station, vehicles should be cleaned and disinfected using the following steps:

- Wash with 180 °F (82 °C) water at 6 gpm, 2000 psi*, with a contact time of ≥ 10 seconds on all surfaces to remove dirt and organic matter such as vegetation parts or seeds. Pay special attention to undercarriages, chassis, wheel-wells, radiators, grills, tracks, buckets, chip-boxes, blades, and flail-mowing chains.
- Use compressed air to remove vegetation from grills and radiators.
- Sweep/vacuum interior of vehicles paying special attention to floor mats, pedals, and seats.
- Steam clean poor access areas (e.g., inside trailer tubes) – 200 psi @ 300 °F (149 °C).
- Fully rinse detergent residue from equipment before leaving the facility.

* Appropriate self-serve and mobile hot power-wash companies in the Metro Vancouver area include: Omega Power Washing, Eco Klean Truck Wash, RG Truck Wash, Ravens Mobile Pressure Washing, Hydrotech Powerwashing, Platinum Pressure Washing Inc, and Alblaster Pressure Washing. Wash stations should be monitored regularly for orange hawkweed growth.

5 Adapted from Metro Vancouver 2017 Water Services Equipment Cleaning Procedures and Inspection Protocols.

Follow-up Monitoring

Whatever control method is used, follow-up monitoring and maintenance treatments are components of an integrated management plan or approach. Orange hawkweed sites should be monitored during the same season as treatment and for several years after treatment. Since orange hawkweed plants flower for many months, the City of Burnaby conducts monitoring of treated sites two times per month during the growing season (monthly is not frequent enough) (Yong, 2023).

After manual control, monitoring is important to detect plants arising from seeds or root fragments missed during treatment (King County Noxious Weed Control Program, 2010). After herbicide treatment, monitoring is important to detect new plants germinating from the seed bank. Orange hawkweed infestations typically have a substantial seed bank.

In agricultural settings, pasture edges, fences, and watering holes should be monitored thoroughly (King County Noxious Weed Control Program, 2010).

CREDIT: ISCMV

Restoration

Re-seed or plant sites with grasses, native forbs grass and other competitive vegetation following orange hawkweed control efforts (King County Noxious Weed Control Program, 2010) (Wilson, 2007).

Examples of common competitive native species prescribed in Metro Vancouver sites are summarized in the table below based on site moisture.

WET SITES	MOIST SITES	DRY SITES
SHRUBS		
Salmonberry	Salmonberry	Thimbleberry
Hardhack	Willow	Nootka rose
Willow	Red osier dogwood	Red flowering currant
Red osier dogwood	Red elderberry	Snowberry
Pacific ninebark	Vine maple	Tall Oregon grape
	Indian plum	Oceanspray
TREES		
Western red cedar	Western red cedar	Douglas-fir
Red alder	Red alder	Red alder

Replacement species should be chosen based on the ecology of the site by a qualified environmental professional. Local biologists, environmental professionals, agronomists, agrologists, native and domestic forage specialists, seed companies, and plant nurseries are all good sources for localized recommendations for regional native species and regionally adapted domestic species, based on site usage. Native grass seed mixes are also available. There are several science-based resources available to guide restoration efforts, such as the South Coast Conservation Program's Diversity by Design restoration planning toolkit.

Revegetation of the site to a domestic or cultured non-native plant species composition may be considered in some circumstances. Often domestic species establish faster and grow more prolifically, which aids in resisting orange hawkweed re-invasion.

Orange hawkweed sites may be found in areas with existing, or potential, wildlife populations (e.g., deer, beaver, muskrat, vole, etc.) that can damage restoration plantings. Therefore, any revegetation plan must consider impacts from wildlife and utilize appropriate mitigation measures to protect the restoration and existing native plantings (e.g., tree wrapping, exclusion caging/fencing, vole guards, etc.).

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Additional Resources

For more information please refer to the following resources.

- BC Ministry of Forests, Lands, and Natural Resource Operations, Invasive Alien Plant Program (IAPP). www.gov.bc.ca/invasive-species
- Grow Green Guide. www.growgreenguide.ca
- Grow Me Instead. http://bcinvasives.ca/resources/programs/plant-wise/
- Key to Identification of Invasive and Native Hawkweeds (*Hieracium spp.*) in the Pacific Northwest (Revised March 2007) https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/publications/key_to_identification_of_invasive_and_native_hawkweeds_in_the_pacific_northwest.pdf
- Pesticides and Pest Management. Province of British Columbia https://www2.gov.bc.ca/gov/content/environment/pesticides-pest-management

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