# Hieracium aurantiacum



# INTRODUCTORY




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FEIS ABBREVIATION:
HIEAUR

NRCS PLANT CODE [95]:
HIAU

COMMON NAMES:
orange hawkweed
devil's-paintbrush
king devil
missionary weed

orange paintbrush
red daisy

TAXONOMY:
The scientific name of orange hawkweed is *Hieracium aurantiacum* L. (Asteraceae) [24,26,38,46,51,60,72,76,85,102,110].

Orange hawkweed may hybridize with other hawkweeds (*Hieracium)* [79], most notably tall hawkweed (*H. piloselloides*) [56,102].

In this report, the term "invasive hawkweeds" refers to species in the subgenus *Pilosella* that are nonnative to North America, including meadow hawkweed (*H. caespitosum*) and tall hawkweed.

SYNONYMS:
None

LIFE FORM:
Forb

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# DISTRIBUTION AND OCCURRENCE

SPECIES: Hieracium aurantiacum

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GENERAL DISTRIBUTION:
Orange hawkweed is native to northern and central Europe, occurring primarily in mountain meadows and hillsides [108]. It was introduced in Vermont by 1875 as a garden ornamental [102] and has been planted many times subsequently. Orange hawkweed has repeatedly escaped cultivation [108].

As of this writing (2010), orange hawkweed has a wide but discontinuous distribution in North America. Its distribution is most continuous from southern Canada and New England south to the mid-Atlantic states and west through the Great Lakes region to the Pacific Northwest. Its native distribution in Europe and current distribution in the United States suggest that orange hawkweed has the greatest potential for establishment in cool, subhumid to humid sites in the northern regions of the United States [108]. Orange hawkweed is also invasive in Australia [105] and New Zealand [48,51]. Plants Database provides a distributional map of orange hawkweed.

HABITAT TYPES AND PLANT COMMUNITIES:
Orange hawkweed occurs in a variety of plant communities within its North American distribution, including grasslands and other open areas, forests, and wetlands. A management guide suggests that sites most vulnerable to orange hawkweed establishment in the Pacific Northwest are disturbed areas, including roadsides, pastures, hay fields, abandoned farmland, mountain meadows, logged areas, and forest clearings [108].

**Open plant communities:** Floras commonly report orange hawkweed occurring in fields [24,26,27,60,67,76,79,85,102,110], pastures [76,102], meadows [26,67], and open hillsides [67]. On Prince Edward Island, orange hawkweed occurred in old fields regenerating into red spruce (*Picea rubens*) forest and was not found in forest interiors [14]. An extension service publication from Montana reports that orange hawkweed is closely associated with habitats that support oxeye daisy (*Leucanthemum vulgare*), sulfur cinquefoil (*Potentilla recta*) and spotted knapweed (*Centaurea maculosa*) [75]. Distribution records from Washington document orange hawkweed occurring on a dry gravel roadside with common St Johnswort (*Hypericum perforatum*), red alder (*Alnus rubra*), broom (*Cytisus*), pearly everlasting (*Anaphalis*), and field horsetail (*Equisetum arvense*) [74].

As of this writing (2010), there were few descriptions of open, native plant communities with orange hawkweed. On Nantucket Island, Connecticut, orange hawkweed was found on sand dunes [4]. It occurred infrequently in sand barren plant communities in southeastern Ontario. Sand barrens were dry openings surrounded by and interspersed with jack pine (*Pinus banksiana*) forest [13]. Orange hawkweed was one of several nonnative species to dominate upland bracken-grasslands in northern Wisconsin. Bracken-grasslands contained western bracken fern (*Pteridium aquilinum*), slender wheatgrass (*Elymus trachycaulus* subsp. *subsecundus*), arctic brome (*Bromus kalmii*), poverty oatgrass (*Danthonia spicata*), and roughleaf ricegrass (*Oryzopsis asperifolia*) [15]. In another Wisconsin upland bracken-grassland on ridges and hillsides, orange hawkweed, poverty oatgrass, and lichens dominated the understory [100]. Orange hawkweed was infrequently encountered in heavily grazed pastures and ungrazed, native tallgrass prairie in north-central Oklahoma. Native tallgrass prairie contained indiangrass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), paintbrush bluestem (*Andropogon ternarius*), and silver bluestem (*Bothriochloa saccharoides*) [52]. Orange hawkweed was also documented in the Palouse Prairie region of western Idaho [5]. A nonnative species guide to Alaska reported that orange hawkweed was rapidly expanding within a native forb and fern meadow on Camp Island in the Kodiak National Wildlife Refuge [35].

**Forested plant communities:** Orange hawkweed occurs in forested plant communities throughout its North American distribution. Forested plant community descriptions below are organized by forests that are primarily coniferous, primarily deciduous, or mixed coniferous-deciduous.

Coniferous forests: Orange hawkweed occurs in coniferous forests in the Northeast, Great Lakes region, and Northwest.

In southeastern New Brunswick, orange hawkweed was found in 3- to 8-year-old black spruce (*Picea mariana*) plantations (25% frequency). Surrounding forest contained red spruce, white spruce (*P. glauca*), balsam fir (*Abies balsamea*), sugar maple (*Acer saccharum*), red maple (*A. rubrum*), yellow birch (*Betula alleghaniensis*), and paper birch (*B. papyrifera*) [99]. In Maine, orange hawkweed occurred in large, recent (<15-year-old) clearcuts in red spruce forests [17]. In the southern Adirondack Mountains of New York, orange hawkweed occurred in forest openings in old-growth eastern white pine-eastern hemlock (*Pinus strobus-Tsuga canadensis*) forest [65]. In southeastern Ontario, orange hawkweed occurred at 10% to 45% frequency in approximately 70-year-old coniferous forests containing white spruce, eastern white pine, balsam fir, and black spruce [61].

In northern Michigan, orange hawkweed was detected infrequently in mesic forests dominated by white spruce and balsam fir [62]. It was common 2 years after prescribed fire in a 35-year-old jack pine forest in northern Lower Michigan [1]. In northern Wisconsin, orange hawkweed was found along the edges and in the interior of jack pine and red pine (*P. resinosa*) plantations [21]. In northern Wisconsin, orange hawkweed was detected with low frequency (5%) in jack pine barrens consisting of open, shrubby areas with scattered young jack pine and infrequent older red pine. Scattered patches of regenerating or mature aspen (*Populus* spp.), oak (*Quercus* spp.), and maple (*Acer* spp.) were also present [8].

Distribution records from Montana documented orange hawkweed occurring in subalpine fir/dwarf huckleberry (*A. lasiocarpa*/*Vaccinium caespitosum*), grand fir/queencup beadlily (*Abies grandis-Clintonia uniflora*), and subalpine fir/queencup beadlily-beargrass (*Xerophyllum tenax*) plant communities [74]. It was detected in successional lodgepole pine (*Pinus contorta*) forests in northwestern Montana [43]. In British Columbia, orange hawkweed occurred at low levels in mixed Douglas-fir (*Pseudotsuga menziesii*)-lodgepole pine forests that had undergone single seed-tree retention harvests 5 to 8 years prior to sampling [87]. Orange hawkweed was scarce in 6- to 10-year-old Engelmann spruce (*Picea engelmannii*)-subalpine fir plantations in southeastern British Columbia. [50].

Deciduous forests: Orange hawkweed occurs in deciduous forests in the Southeast, Northeast, Great Lakes region, and the Northwest.

A flora reports orange hawkweed occurring in openings in oak-hickory (*Quercus-Carya*) forests in North and South Carolina [72].

On Prince Edward Island, orange hawkweed occurred in interior upland hardwood forests, forest edge, and adjacent

developed communities. Hardwood forests were dominated by yellow birch, sugar maple, and American beech (*Fagus grandifolia*) [59]. In northeastern New Brunswick, orange hawkweed occurred in the understory of 7- to 25 -year-old mixed-hardwood forests. Orange hawkweed cover ranged from 2% to 14%, with no clear pattern of cover relative to stand age. Mixed-hardwood forests contained a mixture of pin cherry (*Prunus pensylvanica*), red maple, quaking aspen (*Populus tremuloides*), and paper birch [58]. In central New York, orange hawkweed occurred in the interior of sugar maple forests adjacent to residential areas. American beech, basswood (*Tilia americana*), eastern hemlock, and white ash (*Fraxinus americana*) were other common overstory trees [68].

Orange hawkweed occurred in several aspen (*Populus*) plant associations in northern Lower Michigan. It occurred in seral forests dominated by bigtooth aspen (*P. grandidentata*), paper birch, and quaking aspen; hardwood forests with pin cherry, paper birch, red maple, American beech, sugar maple, and bigtooth aspen; and lowland or bog forests containing quaking aspen and bigtooth aspen [25]. In northern Michigan, orange hawkweed occurred on a sandy ridge in a pin cherry plant association. The forest was dominated by short (<33 feet (10 m) in height) pin cherry trees but also contained red maple and small amounts of black spruce [20]. On the Upper Peninsula of Michigan, orange hawkweed occurred in northern hardwood forests dominated by sugar maple, with lesser amounts of yellow birch, basswood, eastern hemlock, red maple, and eastern hophornbeam (*Ostrya virginiana*) [10]. In the same region, orange hawkweed dominated the understory of a dry, open area near a quaking aspen forest. It also occurred in the understory of a floodplain with speckled alder (*Alnus incana* subsp. *rugosa*), black ash (*F. nigra*), balsam poplar (*P. balsamifera*), and quaking aspen [86].

Distribution records from Idaho document orange hawkweed occurring in a "weedy aspen grove" [74].

Mixed coniferous-deciduous forests: In a beach-dune complex on the shores of Lake Michigan in eastern Wisconsin, orange hawkweed was infrequent in ridge forests codominated by red maple, northern whitecedar (*Thuja occidentalis*), eastern white pine, red pine, eastern hemlock, and paper birch [97]. In northern Wisconsin and the Upper Peninsula of Michigan, orange hawkweed was detected frequently in upland forests dominated by eastern white pine, eastern hemlock, and/or sugar maple [104].

**Wetland plant communities**: Orange hawkweed occurs in wetland plant communities with variable tree canopy cover. In north-central Massachusetts, orange hawkweed occurred in a small (500 feet (150 m) in diameter), herbaceous wetland adjacent to mixed-mesophytic forests of red maple, American beech, paper birch, gray birch (*B. populifolia*), white ash, northern red oak (*Q. rubra*), eastern white pine, and eastern hemlock [63]. Orange hawkweed occurred with high cover in a rich fen in southwestern New York [23]. Orange hawkweed was found in a bog mined for peat in southern Ontario. Quaking aspen and birch (*Betula* spp.) dominated disturbed areas, while open stands of birch were found on relatively undisturbed areas [44]. On the Upper Peninsula of Michigan, orange hawkweed occurred in a sedge (Cyperaceae) fen. Broadleaf deciduous forests dominated upland areas, while a mixture of sedges, grasses, and low shrubs dominated low wetland areas [49]. In Wisconsin, orange hawkweed occurred in sedge meadows used for commercial cranberry production. Sedge meadows were dominated by sedges, asters (Asteraceae), knotweeds (Polygonaceae), ferns (Osmundaceae, Polypodiaceae), and roses (Rosaceae) [45].

Orange hawkweed is described as a dominant groundlayer species in the following vegetation classification from Wisconsin:

- upland western bracken fern-grasslands; slender wheatgrass, arctic brome, poverty oatgrass, and roughleaf ricegrass are characteristic grass dominants [15]

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# BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Hieracium aurantiacum

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GENERAL BOTANICAL CHARACTERISTICS:



**Botanical description:** This description covers characteristics that may be relevant to fire ecology and is not meant for identification. Keys for identification are available (e.g., [26,51,60,66,72,102,110,111]).

Orange hawkweed is a rhizomatous [12,16,26,51,107,108], and/or stoloniferous perennial herb [107] that exudes a milky sap [108]. Plants have a basal rosette of leaves covered in trichomes. Each rosette produces 10 to 30 flowering stems that are 10 to 36 inches (25-91 cm) tall. Each inflorescence consists of 5 to 39 orange flower heads. The seeds are tiny, with a tawny tuft of barbs at one end [108].


Photo by Michael Shephard, USDA Forest Service, Bugwood.org

Flowering stems may also arise from spreading stolons [16,26,72,85]. Plants produce from 4 to 12 leafy stolons that can reach a length of 4 to 12 inches (10-30 cm) [108]. Stolons have been described as slender [26,108] or stout [16].

Orange hawkweed roots are shallow and fibrous [12,51,107,108]. A fact sheet from the Pacific Northwest describes orange hawkweed rhizomes as short, resembling a root crown [12].

Orange hawkweed may be allelopathic. Laboratory studies suggest that orange hawkweed is pollen-allelopathic, limiting the sexual reproduction of other plants by inhibiting pollination, germination of seeds, or seedling growth [69]. In western bracken fern-grasslands in northern Wisconsin, one author observed that orange hawkweed produced a "potent antibiotic" that was detrimental to other plants except western bracken fern [15]. One weed management guide reported that orange hawkweed may have allelopathic tendencies [35].

**Raunkiaer** [73] **life form:**
Hemicryptophyte
Geophyte

SEASONAL DEVELOPMENT: Orange hawkweed seedlings establish in the spring [12]. On the Upper Peninsula of Michigan, orange hawkweed flowering was influenced by precipitation [86]. Flowering dates range from May to

October in different parts of its North American range.

| Month of flowering for orange hawkweed in different parts of its North American range | |
|---|---|
| Location | Month |
| Alaska | mid-July to October [35] |
| Connecticut | June [4] |
| Illinois | June to July [66] |
| Maine | August to mid-September [33] |
| Michigan | June [86] |
| Minnesota | May to August; peak in June [37] |
| New England | June to August [60] |
| North and South Carolina | May to July [72] |
| Virginia | May to July [110] |
| West Virginia | June to July [85] |
| Nova Scotia | June to July [76] |

A weed management guide reports that orange hawkweed seeds lack an after-ripening period and may germinate as soon as they are released from the parent plant [108] (see Germination). Stolons elongate through the summer, forming daughter rosettes at their tips. The stolons die as roots anchor daughter rosettes, and the young plants become independent of the mother plant [12]. After flowering, the supporting rosette dies [82]. New plants sprout each year from rhizomes [12].

REGENERATION PROCESSES:

- **Pollination and breeding system**
- **Seed production**
- **Seed dispersal**
- **Seed banking**
- **Germination**
- **Seedling establishment and plant growth**
- **Vegetative regeneration**

Orange hawkweed reproduces by seeds and spreads vegetatively via stolons and rhizomes [12].

**Pollination and breeding system:** Orange hawkweed is mostly apomictic. In New Zealand, most (93.8%) orange hawkweed seed was produced without fertilization [48]. It occasionally produces seed through pollination [12]. Orange hawkweed is pollinated by wind [33] and is visited by insects. On the Upper Peninsula of Michigan, orange hawkweed was an important source of pollen for bees (*Megachile relativa* and *M. inermis*) [86]. In Maine, orange hawkweed was visited by bumblebees *(Bombus* spp.), though the author noted that orange hawkweed offered minute quantities of nectar [34]. It was visited by nectar-collecting yellowbanded bumble bees (*B. terricola*) in old fields in eastern Ontario [71]. Orange hawkweed was visited by several butterfly species in Michigan [101], and was identified as a nectar species for the Karner blue butterfly in Wisconsin [47].

**Seed production:** Orange hawkweed may produce many seeds. An extension service publication reported that a single orange hawkweed flower can produce 12 to 50 tiny black seeds [75]. A nonnative species guide from Alaska reported that flowering stems produce hundreds of seeds [35]. An Australian government publication reports that an 11-foot² (1 m²) mat of orange hawkweed may produce up to 40,000 seeds per year [105].

An extension service publication suggests that seed production is density dependent, with production decreasing as population density increases. Most seed production occurs on the periphery of orange hawkweed populations, where plant density is typically lower than in population interiors [75].

In successional old fields in southern Michigan, daughter rosettes usually did not flower the year of establishment but flowered the spring of the following year [82]. In greenhouse experiments in east-central Minnesota, 35% of 3-month-old orange hawkweed seedlings flowered [37].

**Seed dispersal:** Orange hawkweed seeds mostly disperse over short distances, though long-distance dispersal may occur. In successional old fields in southern Michigan, most orange hawkweed seeds (94.9% and 82.7% in 2 different years) fell within 3 feet (1 m) of the parent plant [82]. However, several sources report that orange hawkweed seed may be dispersed long distances. A fact sheet from the Pacific Northwest reports that minute barbs along the seeds' ribs enable seeds to stick to hair, fur, feathers, clothing, and vehicles [12]. An Australian government publication reported that road maintenance equipment, hikers, and ski equipment have been implicated in long-distance orange hawkweed dispersal [105]. An extension service publication suggests that seeds may be transported in contaminated landscaping soil [75]. Orange hawkweed seeds and plant fragments may also be transported downslope by water [105].

**Seed banking:** Orange hawkweed apparently maintains a persistent seed bank, though the longevity of orange hawkweed seeds is not clear. Several secondary sources [32,35,75,105] report that orange hawkweed seeds may survive for up to 7 years in the soil seed bank, but a primary reference for this information was not identified.

Soil seed bank studies detected few or no orange hawkweed seedlings emerging from soil samples. Orange hawkweed seeds were found at a density of 34.8 seeds/m² in soil samples from a mixed-hardwood woodlot in southern Ontario. Two months after collection, orange hawkweed seedlings had not emerged from soil samples placed in a greenhouse [9]. One orange hawkweed seedling emerged from near-surface (1 to 2 inches (2-4 cm)) soil samples taken in mid-June from a jack pine community in eastern Ontario [103]. In mowed and undisturbed successional old fields in Germany, orange hawkweed was present at low levels in the extant vegetation, but seedlings did not emerge from soil samples [18].

**Germination:** Orange hawkweed seeds do not have an after-ripening period and can germinate immediately after dropping from the plant. Fall-germinated seedlings usually do not survive [12]. In germination trials, orange hawkweed seeds were gathered from successional old fields in southern Michigan and were not exposed to cold stratification. Germination rates declined through the season; for seeds gathered in June, July, August, and September, total germination was 66%, 28%, 18.5%, and 13% respectively. Cold stratification improved germination of late-season seeds but had little effect on early-season seeds. Small seeds had lower germinability than large seeds [82]. Orange hawkweed plants collected in New Zealand had high seed set (91%), and most seeds (71%) germinated on nutrient agar within 4 days. A few seeds produced multiple seedlings from individual seeds [48].

**Seedling establishment and plant growth:** A fact sheet from the Pacific Northwest suggests that most new populations of orange hawkweed establish via seed and then expand vegetatively [12]. In successional old fields in southern Michigan, few orange hawkweed seedlings established within patches of orange hawkweed, and those that established outside of patches did not survive their first winter [82].

The ability of orange hawkweed seedlings to establish may be limited by the presence of other vegetation. In Japan, the presence of other vegetation seemed to be the most important factor inhibiting establishment; it was difficult for orange hawkweed seedlings to establish in pastures with dense vegetation [88]. In experiments in old fields in east-central Minnesota, legume, moss, and leaf litter cover was negatively correlated with the size of orange hawkweed plants ($P$=0.001), while graminoid, forb, and bare ground cover was not [37]. In northern Wisconsin, shading by western bracken fern was reported as detrimental to orange hawkweed plants [15].

One study from Canada found that increased light and nutrients promoted orange hawkweed growth. In growth chamber experiments, orange hawkweed plants showed improved growth and net assimilation rates when grown in high (1,100 $\mu$mol/m²/s PAR) versus low (200 $\mu$mol/m²/s PAR) light conditions. An increase in nutrients also improved

growth and net assimilation rates [64].

Once established, orange hawkweed populations are persistent [76] and may occur at high density or in a monoculture [74,82,88,105]. Orange hawkweed occurred in pastures in Japan at a density of > 1,000 plants/m² [88]. Distribution records from Montana document orange hawkweed populations occurring as both scattered plants and as monocultures [74]. In jack pine barrens in northern Wisconsin, orange hawkweed cover averaged 4.2% but ranged from 0.1% to 30%. [8].

Patches of orange hawkweed may cover extensive areas. An Australian government publication suggests that under ideal conditions, an orange hawkweed plant can form a 5-foot² (0.5 m²) mat in its first year. One population in Australia consisted of 20 to 50 plants covering 160 feet² (15 m²) [105]. In Maine, orange hawkweed covered a 915-foot² (85 m²) area [34]. In Washington, an orange hawkweed patch covered 200 feet² (20 m²) [74].

**Vegetative regeneration:** Orange hawkweed spreads vegetatively via stolons [16,26,38,51,72,85,108] and rhizomes [16,26,51,107,108]. Orange hawkweed sprouted following herbicide application in Japan [88].

In greenhouse experiments in east-central Minnesota, 91% of 3-month-old orange hawkweed seedlings produced stolons [37].

A fact sheet from the Pacific Northwest suggests that most orange hawkweed spread is accomplished vegetatively once a population is established [12]. An extension service publication suggests that stolon production is density dependent; thus, most vegetative spread occurs on the periphery of established populations where plant density is typically low [75].

SITE CHARACTERISTICS:

Orange hawkweed establishes on sites with a range of soil and climate conditions and does not appear to have specific elevation requirements. It commonly establishes on disturbed sites, though it may also occur in intact native plant communities. A summary of invasive hawkweeds reports that in the Pacific Northwest, sites most vulnerable to establishment includes roadsides, mountain meadows, forest clearings, cleared timber units, permanent pastures, hayfields, and abandoned farmland at elevations of 2,100 to 5,400 ft (600-1,600 m) [19]. Floras report orange hawkweed occurring in disturbed areas [24,66,111], including roadsides [24,26,60,102,110], meadows [26,67], open hillsides [67], clearings [79], logged areas [102], fields [24,26,27,60,67,76,79,85,102,110], pastures [76,102], and lawns [24]. Floras also report orange hawkweed establishing in bogs [24], woods, shores, marshy ground, and northern whitecedar swamps [102]. See Habitat Types and Plant Communities for detailed descriptions of plant communities where orange hawkweed occurs.

**Soil:** Several weed management summaries report that soils that are well drained, textured, and moderately low in organic matter are most susceptible to establishment by invasive hawkweeds [12,19,75].

Orange hawkweed occurs on a variety of soil textures. In New Brunswick, orange hawkweed occurred on gravelly silt loam with large shale fragments [29]. On Nantucket Island, it occurred on sand dunes [4]. In central New York, orange hawkweed was abundant on fine sandy loam, silt loam, and silt clay loam, and scarce on marly silt [92]. Herbarium records from Wisconsin document orange hawkweed occurring on sand, sandy loam, and mixed sand and gravel [96]. An invasive plant guide for the Upper Midwest states that invasive hawkweeds prefer sandy or gravelly soil [16]. Distribution records from Montana document orange hawkweed occurring on silt loam amongst scree [74].

Several sources report that orange hawkweed occurs on well-drained soil [12,19,35,75,76]. In old fields in east-central Minnesota, soil moisture had a significant negative effect on size of orange hawkweed ($P$=0.013) [37]. Herbarium records from Wisconsin document orange hawkweed occurring on dry and moist soils [96]. Orange hawkweed occurs in several wetland plant communities. See Habitat Types and Plant Communities for detailed descriptions of wetland plant communities where orange hawkweed occurs.

Orange hawkweed may tolerate low-nutrient, acidic, or disturbed soils. In Japan, it usually establishes on "poor" soils [88]. A weed management guide suggests that invasive hawkweeds tolerate low-productivity soils [108]. An invasive

plant guide for the Upper Midwest states that invasive hawkweeds prefer slightly acidic conditions [16]. In Japan, orange hawkweed was usually found on acidic soils, but acidic soils were not always "preferred" [88]. One flora reports that orange hawkweed occurs on disturbed soil [66].

Researchers in Japan suggested that the presence of other vegetation was more important than soil characteristics in determining orange hawkweed establishment [88].

**Climate:** In North America, orange hawkweed occurs in climates ranging from the humid, continental climate of central New York [68] to the subboreal climate of southeastern British Columbia [50]. Orange hawkweed's distribution in Europe and current distribution in the United States suggest that it is of greatest threat in cool, subhumid to humid sites in the northern regions of the United States [108]. However, one study found that nonnative populations of orange hawkweed occupied different climatic niches than native populations. Populations in eastern North America occurred in warmer, wetter conditions than those of the native range. Populations in western North America also had a broad climatic niche, generally occurring in warmer conditions than native populations [3].

| Average annual precipitation of sites with orange hawkweed within its North American distribution | |
|---|---|
| Location | Precipitation (mm) |
| New York | 940 [68] |
| Oklahoma | 810 [52] |
| Wisconsin | 762-813 [8] |
| British Columbia | 1,200 [50] |
| Ontario | 770 [61], 784 [39] |

**Elevation:** Orange hawkweed occurs at a wide range of elevations in North America.

| Elevation of sites with orange hawkweed within its North American distribution | |
|---|---|
| Location | Elevation (feet) |
| Idaho | 2,400 [74] |
| Massachusetts | 1,440 [63] |
| Montana | 3,050-7,580 [74] |
| New York | 240-300 [27] |
| Washington | 2,700-4,000 [74] |
| Wisconsin | 760-1,500 [21] |
| Pacific Northwest | 2,100-5,400 [12] |
| New Brunswick | 500 [29] |
| Ontario | 575 [44] |

SUCCESSIONAL STATUS:
In its native range, orange hawkweed generally achieves its highest densities in disturbed areas and does not persist past early succession [108]. In its North American range, it is frequently documented in early-successional plant communities or disturbed areas. In northern Ontario, orange hawkweed was detected at a mean relative frequency of 6% in initial surveys of young (11- to 33-year-old) upland jack pine and black spruce plantations, but it was not detected in the same plantations after 20 years of successional development [39]. In southeastern New Brunswick, orange hawkweed was found in 3- to 8-year-old black spruce plantations [99] and 7- to 25-year-old mixed-hardwood forests [58]. In Maine, orange hawkweed occurred in large, recent (<15-year-old) clearcuts in red spruce forests [17].

It was detected at a low abundance in 6- to 10-year-old Engelmann spruce-subalpine fir forests planted after clearcutting in southeastern British Columbia. [50]. However, orange hawkweed is also documented in many plant communities not described as early-successional (see Habitat Types and Plant Communities). In Michigan, it was abundant in a midsuccessional old field that was undisturbed for approximately 50 years [22].

Disturbance appears to favor orange hawkweed. An Australian government publication reports that orange hawkweed is most likely to establish along roads, hiking trails, and other areas experiencing human disturbances [105]. A weed management guide reports that orange hawkweed spread is enhanced by mechanical disturbances—including control efforts and machinery use—as well as local disturbances such as livestock, wild ungulate, or rodent activity [108]. In west-central Wisconsin, orange hawkweed established in high abundance on heavily disturbed construction remediation sites [47]. In a study examining the effects of disturbance created by commercial cranberry (*Vaccinium macrocarpon*) production on wetland plant communities in Wisconsin, the importance value of orange hawkweed occurring in sedge meadow communities decreased with distance from disturbance ($P$=0.007) [45]. Orange hawkweed also occurs in areas that have been mowed [84], grazed [52], logged [17,39,43,50,87,99], burned [1,29,43,70], logged and burned [1,30,43,80], and mined for peat [44].

Orange hawkweed may be favored by high-light conditions. A fact sheet from the Pacific Northwest reports that orange hawkweed is shade-intolerant [12]. In northern Wisconsin, shading by western bracken fern was considered detrimental to orange hawkweed [15]. In growth chamber experiments in Canada, orange hawkweed plants showed improved growth and net assimilation rates when grown in high (1,100 $\mu$mol/m²/s PAR) versus low (200 $\mu$mol/m²/s PAR) light conditions [64]. Orange hawkweed occurs in forest openings in North and South Carolina [72], New York [65], and Wisconsin [55]. It is also found in shaded areas, like forest interiors. In northern Wisconsin, orange hawkweed was found in both the interior and edges of jack pine and red pine plantations [21]. Herbarium records from Wisconsin document orange hawkweed as occurring in full shade, partial sun, and full sunlight [96]. On Prince Edward Island, orange hawkweed occurred both outside of upland hardwood forests and up to 1,000 feet (300 m) into the interior of these forests [59]. See Habitat Types and Plant Communities for detailed descriptions of other forested plant communities where orange hawkweed occurs.

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# FIRE EFFECTS AND MANAGEMENT

SPECIES: Hieracium aurantiacum

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FIRE EFFECTS:



**Immediate fire effect on plant:** As of this writing (2010), there was no published information on the immediate effects of fire on orange hawkweed. Orange hawkweed is likely top-killed by fire; belowground rhizomes may survive. As of 2010, no information was available regarding fire effects on or heat tolerance of orange hawkweed seeds.

**Postfire regeneration strategy** [83]:
Surface rhizome and/or a chamaephytic root crown in organic soil or on soil surface
Rhizomatous herb, rhizome in soil
Geophyte, growing points deep in soil
Ground residual colonizer (on site, initial community)

Initial off-site colonizer (off site, initial community)
Secondary colonizer (on- or off-site seed sources)

### Fire adaptations and plant response to fire:

Fire adaptations: Orange hawkweed exhibits some characteristics that make it adapted to surviving and establishing after fire. It is rhizomatous [16,26,51,107,108], and it is likely that rhizomes below the soil surface survive fire. It reportedly sprouts from stolons and rhizomes after mechanical disturbance [105], and sprouted following herbicide application in Japan [88]. Orange hawkweed seeds have the potential for long-distance seed dispersal, and seeds reportedly persist in the seed bank for at least 7 years. Seedling establishment and plant growth seem to be favored by disturbance and high-light conditions (see Successional Status).

Plant response to fire: Several studies document orange hawkweed occurring in areas burned by wildfire [43,80,107] or prescribed fire [1,29,30,70,90], but to date (2010), a lack of details about fire characteristics, pre- and postfire vegetation, and orange hawkweed response limit the inferences that can be made from these studies. The limited information available suggests that fire may facilitate orange hawkweed establishment and spread.

It is not clear whether fire increases the abundance of orange hawkweed. An Australian government publication reports that existing orange hawkweed populations spread following a January wildfire [105]. Two years after prescribed fire in logged jack pine-red pine forest in northern Lower Michigan, orange hawkweed was one of several forbs commonly found in the understory [1], but its abundance prior to the fire was not reported.

Some studies have documented orange hawkweed establishing after fire in sites where it was not found previously. In eastern Ontario, orange hawkweed was found in a jack pine clearcut within 2 years of prescribed burning. It was not detected in the stands prior to fire [90]. In New Brunswick, a mixed deciduous-coniferous woodlot was clearcut, left untreated for a year, then burned in April for 2 consecutive years to encourage low sweet blueberry (*Vaccinium angustifolium*) and velvetleaf blueberry (*V. myrtilloides*) production. June vegetation surveys showed that orange hawkweed was not present prior to treatments, in the year between clearcutting and burning, or in the 1st year after fire. Four orange hawkweed stems were detected 2 months after the 2nd fire. The author suggested that orange hawkweed established via wind-dispersed seed [29].

Orange hawkweed was detected in surveys of 3 managed coniferous forest stands in British Columbia. Prior to treatment, the forests largely contained hybrid spruce (*P. engelmannii* × *P. glauca*). Stands were clearcut in the winter and burned the following autumn. Fire was of moderate severity and generally consumed all fine fuels but exposed little mineral soil. Stands were planted with lodgepole pine and/or hybrid spruce the year after fire. Vegetation was sampled prior to treatments and for 10 years afterward. Orange hawkweed was not detected prior to burning or in surveys 1, 2, 3, and 5 years after fire, but it was detected at low levels (0.02% mean cover) 10 years after fire on all 3 sites [30].

One study documented orange hawkweed in burned areas but not in unburned plots. It was detected after both single and multiple low-severity spring prescribed fires in a red pine and eastern white pine plantation in Michigan's southwestern Lower Peninsula. Fire conditions are available in the Research Project Summary of this study. In study plots burned once, the average cover of orange hawkweed 4 growing seasons after fire was 0.33%. In study plots burned biennially, its average cover 2 growing seasons after the 2nd fire was 0.07%, and it did not occur the first growing season after the 3rd fire. It was not present in unburned plots [70].

The combination of fire and other disturbances may increase the potential for orange hawkweed establishment. In northwestern Montana, orange hawkweed was studied in mountain meadows and 3 types of successional lodgepole pine forests: 1) logged, 2) burned by wildfire [43] 12 years previously, and 3) burned by wildfire 12 years previously [42] and then salvage-logged. Descriptions of the wildfire or logging treatments were not reported. Orange hawkweed had the highest probability of detection on burned and salvage-logged sites ($P$=0.002), which the authors attributed to relatively low levels of "competitive" interactions with other plants and high levels of sunlight and disturbance. However, it was not clear that disturbance was the only factor influencing orange hawkweed establishment, because orange hawkweed had a higher likelihood of establishment in mountain meadows than the 2 other disturbed cover types [43].

FUELS AND FIRE REGIMES:

**Fuels:** As of this writing (2010) there was no information available regarding the fuels characteristics of orange hawkweed.

**Fire regimes:** It is not known what fire regime orange hawkweed is best adapted to. In North America, orange hawkweed occurs in a wide variety of plant communities, and consequently, a range of fire regimes. See the Fire Regime Table for further information on fire regimes of vegetation communities in which orange hawkweed may occur.

FIRE MANAGEMENT CONSIDERATIONS:

**Potential for postfire establishment and spread:** Orange hawkweed possesses several traits that make it adapted to surviving and establishing after fire (see Fire adaptations). The available literature suggests that orange hawkweed may establish after fire; it was documented in areas following both wildfire [43,80,107] and prescribed fire [1,29,30,70,90], and in some of these cases, it was not detected prior to fire [29,30,90] (see Plant response to fire).

**Preventing postfire establishment and spread:** Because of its potential for long-distance seed dispersal and the suggestion that orange hawkweed established on burned sites via wind-dispersed seed [29], monitoring areas in close proximity to known populations of orange hawkweed for potential establishment is advised. Orange hawkweed establishment may occur soon after fire (e.g., 1 year after wildfire in British Columbia [80], 2 years after prescribed fire in Ontario [90] and New Brunswick [29], 2 and 4 growing seasons after prescribed fire in Michigan [70], and 4 years after wildfire in Australia [105]), or may be delayed (e.g., 10 years after wildfire in British Columbia [30]). These observations, combined with orange hawkweed's persistence in the seed bank, suggest that long-term monitoring may be necessary to limit orange hawkweed's establishment in burned areas.

Preventing invasive plants from establishing in weed-free burned areas is the most effective and least costly management method. This may be accomplished through early detection and eradication, careful monitoring and follow-up, and limiting dispersal of invasive plant seed into burned areas. General recommendations for preventing postfire establishment and spread of invasive plants include:

- Incorporate cost of weed prevention and management into fire rehabilitation plans
- Acquire restoration funding
- Include weed prevention education in fire training
- Minimize soil disturbance and vegetation removal during fire suppression and rehabilitation activities
- Minimize the use of retardants that may alter soil nutrient availability, such as those containing nitrogen and phosphorus
- Avoid areas dominated by high priority invasive plants when locating firelines, monitoring camps, staging areas, and helibases
- Clean equipment and vehicles prior to entering burned areas
- Regulate or prevent human and livestock entry into burned areas until desirable site vegetation has recovered sufficiently to resist invasion by undesirable vegetation
- Monitor burned areas and areas of significant disturbance or traffic from management activity
- Detect weeds early and eradicate before vegetative spread and/or seed dispersal
- Eradicate small patches and contain or control large infestations within or adjacent to the burned area
- Reestablish vegetation on bare ground as soon as possible
- Avoid use of fertilizers in postfire rehabilitation and restoration
- Use only certified weed-free seed mixes when revegetation is necessary

For more detailed information on these topics, see the following publications: [2,6,27,94].

**Use of prescribed fire as a control agent:** Prescribed fire does not appear to be an effective method for controlling orange hawkweed. Though no studies have used prescribed fire specifically to control orange hawkweed, its establishment following prescribed fire in New Brunswick [29], Ontario [90], and British Columbia [30], and its

presence in burned but not unburned sites in Michigan [70], suggest that prescribed fire may encourage orange hawkweed establishment.

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# MANAGEMENT CONSIDERATIONS

SPECIES: Hieracium aurantiacum

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FEDERAL LEGAL STATUS:
None

OTHER STATUS:
Information on state-level noxious weed status of orange hawkweed in the United States is available at Plants Database.

IMPORTANCE TO WILDLIFE AND LIVESTOCK:
**Palatability and/or nutritional value:** An extension service publication suggests that invasive hawkweeds have moderate to high nutritive value. Deer, elk, and domestic livestock eat invasive hawkweeds [75]. Domestic cattle grazed orange hawkweed flowers and stems in pastures in Japan [88], and white-tailed deer consumed orange hawkweed in old fields in east-central Minnesota [37]. Orange hawkweed was listed as frequently eaten by woodchucks [89].

Orange hawkweed flowers are visited by a variety of insects, including bees [22,34,86,101] and butterflies [47,101]. Though leaves are high in nutrients, trichomes limit insect herbivory [78]. Orange hawkweed was damaged by meadow spittle bugs (*Philaenus spumarius*) in old fields in east-central Minnesota [37].

**Cover value:** No information is available on this topic.

OTHER USES:
No information is available on this topic.

IMPACTS AND CONTROL:


**Impacts:** A variety of fact sheets, government publications, and weed management guides suggest that orange hawkweed populations form dense mats that exclude other plants [35,75], including native plants [3,12,75,105] and economically valuable forage species [12,40,75,108]. A 2007 Australian government publication reported that orange hawkweed could cause an estimated $48 million in agricultural production losses [105]. Orange hawkweed may also be a problem in

lawns and gardens [75].

Photo by Richard Old, XID Services, Inc., Bugwood.org

Orange hawkweed's ability to dominate an area is attributed to fast vegetative spread [12,75,108], allelopathy [15,35,69], and tolerance of low-nutrient sites [35,75].

**Control:** Control of orange hawkweed is complicated by its ability to sprout from stolons [12,108] and rhizomes [12] following control treatments. An extension service publication suggests control efforts should concentrate on the periphery of established populations, where most sexual and vegetative reproduction occurs [75]. Control effectiveness may depend on a program that integrates multiple management procedures such as fertilizers, herbicides, seeding, and other techniques that decrease orange hawkweed spread and favor desired species [35].

In all cases where invasive species are targeted for control, no matter what method is employed, the potential for other invasive species to fill their void must be considered [7]. Control of biotic invasions is most effective when it employs a long-term, ecosystem-wide strategy rather than a tactical approach focused on battling individual invaders [57].

Fire: For information on the use of prescribed fire to control this species, see Fire Management Considerations.

Prevention: A fact sheet from British Columbia suggests orange hawkweed establishment may be prevented by minimizing soil disturbance and promptly revegetating disturbed areas. Consumers should avoid purchasing wildflower seed mixes that contain invasive hawkweeds [40].

It is commonly argued that the most cost-efficient and effective method of managing invasive species is to prevent their establishment and spread by maintaining "healthy" natural communities [57,81] (e.g., avoid road building in wildlands [93]) and by monitoring several times each year [41]. Managing to maintain the integrity of the native plant community and mitigate the factors enhancing ecosystem invasibility is likely to be more effective than managing solely to control the invader [36].

Weed prevention and control can be incorporated into many types of management plans, including those for logging and site preparation, grazing allotments, recreation management, research projects, road building and maintenance, and fire management [95]. See the Guide to noxious weed prevention practices [95] for specific guidelines in preventing the spread of weed seeds and propagules under different management conditions.

Cultural control: In Japan, orange hawkweed establishment and persistence were limited by other vegetation and it was not able to establish via seed in pastures with dense vegetation [88]. A weed management guide suggests that cultural methods are useful for controlling orange hawkweed in pastures or rangelands. Where perennial grasses, legumes, or other preferred forbs are present, fertilizers may be applied to increase nutrient availability to the desired species [75,108]. A fact sheet from the Pacific Northwest reports that, depending on soil productivity and grass condition, a single nitrogen application may be sufficient for grasses to suppress invasive hawkweed growth for 3 to 5 years. Good grazing management may extend this period. Integrated management techniques may increase the effectiveness of cultural methods in controlling orange hawkweed.

Physical or mechanical control: A weed management guide from Australia reports that any activities that disturb orange hawkweed plants, such as digging or grazing, can stimulate the growth of new plants from fragmented roots, stolons and rhizomes [105]. Physical disturbance by machinery may spread orange hawkweed across fields, and local disturbances such as activity by livestock, wild ungulates, or rodents may enhance its spread [108].

A fact sheet from the Pacific Northwest suggests that small infestations of orange hawkweed may be eradicated by carefully digging out rosettes; for this technique to be effective, all stolons, rhizomes, and roots must be collected to prevent on-site sprouting [12]. A nonnative species guide from Alaska also reports that hand-removal of plants may be effective if all parts are removed. Hand removal from lawns is more effective if used in conjunction with fertilizer [35].

Several sources report that mowing does not control orange hawkweed because basal rosettes are too low to be

impacted by mowing blades [12,35,105,108]. Mowing may prevent or limit seed production, but it may also encourage vegetative spread [12,105,108]. In northeastern Georgia, dozens of orange hawkweed plants were reported from a frequently mowed, grassy area. [84]. Livestock consume orange hawkweed, but grazing encourages vegetative spread just as mowing does [75].

A weed management guide states that orange hawkweed does not appear to survive in annually tilled cropland [108]. A summary of invasive hawkweeds reports that they do not persist with tillage, particularly where herbicide use and tillage are combined [19].

Biological control: Both insects [106,108] and fungi [108] were being evaluated for use in controlling orange hawkweed and other invasive hawkweeds as of 2010.

Biological control of invasive species has a long history that indicates many factors must be considered before using biological controls. Refer to these sources: [98,109] and the Weed control methods handbook [91] for background information and important considerations for developing and implementing biological control programs.

Chemical control: Herbicides may control orange hawkweed [12,35,40,75,108], though orange hawkweed sprouted following herbicide application in Japan [88]. An invasive plant guide for the Upper Midwest states that herbicides have effectively controlled orange hawkweed while in the rosette stage, though a surfactant may be needed to enhance contact with hairy leaves [16]. Integrated management techniques may increase the effectiveness of herbicide application in controlling orange hawkweed. See the following weed management guides for information about using herbicides to control orange hawkweed: [12,16,35,40,75].

Herbicides are effective in gaining initial control of a new invasion or a severe infestation, but they are rarely a complete or long-term solution to weed management [11]. See the Weed control methods handbook [91] for considerations on the use of herbicides in natural areas and detailed information on specific chemicals.

Integrated management: Integrated management techniques may be more effective than individual methods at controlling orange hawkweed. A nonnative species guide to Alaska reported that no single management practice can be implemented just once to manage invasive hawkweeds. Successful programs combine multiple management procedures such as fertilizers, herbicides, seeding, and other techniques to decrease orange hawkweed spread and favor desired species [35]. Herbicide use [12] or tilling [19,108] may increase the effectiveness of cultural methods in controlling orange hawkweed. One source recommends combining herbicide application with fertilizer applications geared towards improving the growth of preferred species [12]. A summary of invasive hawkweeds reports that orange hawkweed does not persist when herbicide use and tillage are combined [19].

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# APPENDIX: FIRE REGIME TABLE

SPECIES: Hieracium aurantiacum

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The following table provides fire regime information that may be relevant to orange hawkweed habitats. Follow the links in the table to documents that provide more detailed information on these fire regimes.

| |
|---|
| Fire regime information on vegetation communities in which orange hawkweed may occur. This information is taken from the LANDFIRE Rapid Assessment Vegetation Models [54], which were developed by local experts using available literature, local data, and/or expert opinion. This table summarizes fire regime characteristics for each plant community listed. The PDF file linked from each plant community name describes the model and synthesizes the knowledge available on vegetation composition, structure, and dynamics in that community. Cells are blank where information is not available in the Rapid Assessment Vegetation Model. |
| Pacific |

Northwest | Northern and Central Rockies | Northern Great Plains | Great Lakes
Northeast | South-central US | Southern Appalachians

## Pacific Northwest

- Northwest Grassland
- Northwest Forested

| Vegetation Community (Potential Natural Vegetation Group) | Fire severity* | Fire regime characteristics | | | |
|---|---|---|---|---|---|
| | | Percent of fires | Mean interval (years) | Minimum interval (years) | Maximum interval (years) |
| Northwest Grassland | | | | | |
| Bluebunch wheatgrass | Replacement | 47% | 18 | 5 | 20 |
| | Mixed | 53% | 16 | 5 | 20 |
| Northwest Forested | | | | | |
| Sitka spruce-western hemlock | Replacement | 100% | 700 | 300 | >1,000 |
| Douglas-fir-western hemlock (dry mesic) | Replacement | 25% | 300 | 250 | 500 |
| | Mixed | 75% | 100 | 50 | 150 |
| Spruce-fir | Replacement | 84% | 135 | 80 | 270 |
| | Mixed | 16% | 700 | 285 | >1,000 |

## Northern and Central Rockies

- Northern and Central Rockies Grassland
- Northern and Central Rockies Forested

| Vegetation Community (Potential Natural Vegetation Group) | Fire severity* | Fire regime characteristics | | | |
|---|---|---|---|---|---|
| | | Percent of fires | Mean interval (years) | Minimum interval (years) | Maximum interval (years) |
| Northern and Central Rockies Grassland | | | | | |
| Mountain grassland | Replacement | 60% | 20 | 10 | |
| | Mixed | 40% | 30 | | |
| Northern and Central Rockies Forested | | | | | |
| Grand fir-Douglas-fir-western larch mix | Replacement | 29% | 150 | 100 | 200 |
| | Mixed | 71% | 60 | 3 | 75 |
| | Replacement | 31% | 220 | 50 | 250 |

| | | | | | |
|---|---|---|---|---|---|
| Grand fir-lodgepole pine-larch-Douglas-fir | Mixed | 69% | 100 | 35 | 150 |
| Lower subalpine lodgepole pine | Replacement | 73% | 170 | 50 | 200 |
| | Mixed | 27% | 450 | 40 | 500 |
| Upper subalpine spruce-fir (Central Rockies) | Replacement | 100% | 300 | 100 | 600 |

**Northern Great Plains**

- Northern Plains Grassland

| Vegetation Community (Potential Natural Vegetation Group) | Fire severity* | Fire regime characteristics | | | |
|---|---|---|---|---|---|
| | | Percent of fires | Mean interval (years) | Minimum interval (years) | Maximum interval (years) |
| Northern Plains Grassland | | | | | |
| Southern mixed-grass prairie | Replacement | 100% | 9 | 1 | 10 |

**Great Lakes**

- Great Lakes Woodland
- Great Lakes Forested

| Vegetation Community (Potential Natural Vegetation Group) | Fire severity* | Fire regime characteristics | | | |
|---|---|---|---|---|---|
| | | Percent of fires | Mean interval (years) | Minimum interval (years) | Maximum interval (years) |
| Great Lakes Woodland | | | | | |
| Great Lakes pine barrens | Replacement | 8% | 41 | 10 | 80 |
| | Mixed | 9% | 36 | 10 | 80 |
| | Surface or low | 83% | 4 | 1 | 20 |
| Jack pine-open lands (frequent fire-return interval) | Replacement | 83% | 26 | 10 | 100 |
| | Mixed | 17% | 125 | 10 | |
| Great Lakes Forested | | | | | |
| Northern hardwood maple-beech-eastern hemlock | Replacement | 60% | >1,000 | | |
| | Mixed | 40% | >1,000 | | |
| | Replacement | 36% | 540 | 220 | ≥1,000 |

| | | | | | |
|---|---|---|---|---|---|
| Conifer lowland (embedded in fire-resistant ecosystem) | Mixed | 64% | 300 | | |
| Great Lakes spruce-fir | Replacement | 100% | 85 | 50 | 200 |
| Great Lakes pine forest, jack pine | Replacement | 67% | 50 | | |
| | Mixed | 23% | 143 | | |
| | Surface or low | 10% | 333 | | |
| Maple-basswood | Replacement | 33% | ≥1,000 | | |
| | Surface or low | 67% | 500 | | |
| Northern hardwood-eastern hemlock forest (Great Lakes) | Replacement | 99% | >1,000 | | |

**Northeast**

- Northeast Forested

| Vegetation Community (Potential Natural Vegetation Group) | Fire severity* | Fire regime characteristics | | | |
|---|---|---|---|---|---|
| | | Percent of fires | Mean interval (years) | Minimum interval (years) | Maximum interval (years) |
| Northeast Forested | | | | | |
| Northern hardwoods (Northeast) | Replacement | 39% | ≥1,000 | | |
| | Mixed | 61% | 650 | | |
| Eastern white pine-northern hardwoods | Replacement | 72% | 475 | | |
| | Surface or low | 28% | >1,000 | | |
| Northern hardwoods-eastern hemlock | Replacement | 50% | ≥1,000 | | |
| | Surface or low | 50% | ≥1,000 | | |
| Beech-maple | Replacement | 100% | >1,000 | | |
| Northeast spruce-fir forest | Replacement | 100% | 265 | 150 | 300 |

**South-central US**

- South-central US Grassland

| Vegetation Community (Potential Natural Vegetation Group) | Fire severity* | Fire regime characteristics | | | |
|---|---|---|---|---|---|
| | | Percent of fires | Mean interval (years) | Minimum interval (years) | Maximum interval (years) |
| South-central US Grassland | | | | | |
| Southern tallgrass prairie | Replacement | 91% | 5 | | |
| | Mixed | 9% | 50 | | |
| **Southern Appalachians** | | | | | |
| Vegetation Community (Potential Natural Vegetation Group) | Fire severity* | Fire regime characteristics | | | |
| | | Percent of fires | Mean interval (years) | Minimum interval (years) | Maximum interval (years) |
| Southern Appalachians Forested | | | | | |
| Appalachian oak-hickory-pine | Replacement | 3% | 180 | 30 | 500 |
| | Mixed | 8% | 65 | 15 | 150 |
| | Surface or low | 89% | 6 | 3 | 10 |

*Fire Severities—
**Replacement:** Any fire that causes greater than 75% top removal of a vegetation-fuel type, resulting in general replacement of existing vegetation; may or may not cause a lethal effect on the plants.
**Mixed:** Any fire burning more than 5% of an area that does not qualify as a replacement, surface, or low-severity fire; includes mosaic and other fires that are intermediate in effects.
**Surface or low:** Any fire that causes less than 25% upper layer replacement and/or removal in a vegetation-fuel class but burns 5% or more of the area [31,53].

# REFERENCES

SPECIES: Hieracium aurantiacum

1. Abrams, Marc D.; Dickmann, Donald I. 1983. Response of understory vegetation to fertilization on mature and clear-cut jack pine sites in northern Lower Michigan. The American Midland Naturalist. 110(1): 194-200. [80251]

2. Asher, Jerry; Dewey, Steven; Olivarez, Jim; Johnson, Curt. 1998. Minimizing weed spread following wildland fires. Proceedings, Western Society of Weed Science. 51: 49. Abstract. [40409]

3. Beaumont, Linda J.; Gallagher, Rachael V.; Thuiller, Wilfried; Downey, Paul O.; Leishman, Michelle R.; Hughes, Lesley. 2009. Different climatic envelopes among invasive populations may lead to underestimations of current and future biological invasions. Diversity and Distributions. 15: 409-420. [80254]

4. Bicknell, Eugene P. 1915. Ferns and flowering plants of Nantucket--XVI. Bulletin of the Torrey Botanical Club. 42(10): 549-570. [80256]

5. Black, Anne E.; Stand, Eva; Wright, R. Gerald; Scott, J. Michael; Morgan, Penelope; Watson, Cortney.

1998. Land use history at multiple scales: implications for conservation planning. Landscape and Urban Planning. 43: 49-63. [80257]

6. Brooks, Matthew L. 2008. Effects of fire suppression and postfire management activities on plant invasions. In: Zouhar, Kristin; Smith, Jane Kapler; Sutherland, Steve; Brooks, Matthew L., eds. Wildland fire in ecosystems: Fire and nonnative invasive plants. Gen. Tech. Rep. RMRS-GTR-42-vol. 6. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 269-280. [70909]

7. Brooks, Matthew L.; Pyke, David A. 2001. Invasive plants and fire in the deserts of North America. In: Galley, Krista E. M.; Wilson, Tyrone P., eds. Proceedings of the invasive species workshop: The role of fire in the control and spread of invasive species; Fire conference 2000: 1st national congress on fire ecology, prevention, and management; 2000 November 27 - December 1; San Diego, CA. Misc. Publ. No. 11. Tallahassee, FL: Tall Timbers Research Station: 1-14. [40491]

8. Brosofske, K. D.; Chen, J.; Crow, T. R.; Saunders, S. C. 1999. Vegetation responses to landscape structure at multiple scales across a northern Wisconsin, USA, pine barrens landscape. Plant Ecology. 143(2): 203-218. [74417]

9. Brown, Doug. 1992. Estimating the composition of a forest seed bank: a comparison of the seed extraction and seedling emergence methods. Canadian Journal of Botany. 70(8): 1603-1612. [69376]

10. Buckley, David S.; Crow, Thomas R.; Nauertz, Elizabeth A.; Schulz, Kurt E. 2003. Influence of skid trails and haul roads on understory plant richness and composition in managed forest landscapes in Upper Michigan, USA. Forest Ecology and Management. 175: 509-520. [80261]

11. Bussan, Alvin J.; Dyer, William E. 1999. Herbicides and rangeland. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 116-132. [35716]

12. Callihan, Robert H.; Wilson, Linda M.; McCaffrey, Joseph P.; Miller, Timothy W. 1997. Hawkweeds: Hieracium aurantiacum, H. pilosella, H. pratense, H. floribundum, H. piloselloides. Pacific Northwest Extension Publication PNW 499. Corvallis, OR: Oregon State University, Cooperative Extension Service; Pullman, WA: Washington State University, Cooperative Extension Service; Moscow, ID: Idaho University, Cooperative Extension Service. 4 p. Available online: http://www.cals.uidaho.edu/edcomm/pdf/PNW/PNW0499.pdf [2010, October 5]. [80263]

13. Carbyn, Susan E.; Catling, Paul M. 1995 . Vascular flora of sand barrens in the middle Ottawa valley. Canadian Field Naturalist. 109(2): 242-250. [60022]

14. Cavallin, N.; Vasseur, L. 2009. Red spruce forest regeneration dynamics across a gradient from Acadian forest to old field in Greenwich, Prince Edward Island National Park, Canada. Plant Ecology. 201: 169-180. [80266]

15. Curtis, John T. 1959. Sand barrens and bracken-grassland. In: The vegetation of Wisconsin. Madison, WI: The University of Wisconsin Press: 308-321. [60527]

16. Czarapata, Elizabeth J. 2005. Invasive plants of the Upper Midwest: An illustrated guide to their identification and control. Madison, WI: The University of Wisconsin Press. 215 p. [71442]

17. Dibble, Alison C.; Brissette, John C.; Hunter, Malcolm L., Jr. 1999. Putting community data to work: some understory plants indicate red spruce regeneration habitat. Forest Ecology and Management. 114: 275-291. [80269]

18. Dolle, Michaela; Schmidt, Wolfgang. 2009. The relationship between soil seed bank, above-ground vegetation and disturbance intensity on old-field successional permanent plots. Applied Vegetation

Science. 12: 415-428. [80280]

19. Duncan, Celestine A. 2005. Hawkweeds--Hieracium caespitosum Dumort. and Hieracium aurantiacum L. In: Duncan, Celestine L.; Clark, Janet K., eds. Invasive plants of range and wildlands and their environmental, economic, and societal impacts. WSSA Special Publication. Lawrence, KS: Weed Science Society of America: 84-90. [60235]

20. Dutro, Ruth; Cohoe, Edith. 1938. An ecological study of Wolf's Bog, Cheboygan County, Michigan. Transactions of the Kansas Academy of Science. 41(4): 87-95. [80285]

21. Euskirchen, Eugenie S.; Chen, Jiquan; Bi, Runcheng. 2001. Effects of edges on plant communities in a managed landscape in northern Wisconsin. Forest Ecology and Management. 148: 93-108. [47031]

22. Evans, Francis C. 1986. Bee-flower interactions on an old field in southeastern Michigan. In: Clambey, Gary K.; Pemble, Richard H., eds. The prairie: past, present and future: Proceedings of the 9th North American Prairie Conference; 1984 July 29 - August 1; Moorhead, MN. Fargo, ND: Tri-College University Center for Environmental Studies: 103-109. [3538]

23. Falb, Diana L.; Leopold, Donald J. 1993. Population dynamics of Cypripedium candidum Muhl. ex Willd., small white ladyslipper, in a western New York fen. Natural Areas Journal. 13(2): 76-86. [21444]

24. Flora of North America Association. 2010. Flora of North America: The flora, [Online]. Flora of North America Association (Producer). Available: http://www.fna.org/FNA. [36990]

25. Gates, Frank C. 1930. Aspen association in northern Lower Michigan. Botanical Gazette. 40(3): 233-259. [16933]

26. Gleason, Henry A.; Cronquist, Arthur. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. 2nd ed. New York: New York Botanical Garden. 910 p. [20329]

27. Goodwin, Kim; Sheley, Roger; Clark, Janet. 2002. Integrated noxious weed management after wildfires. EB-160. Bozeman, MT: Montana State University, Extension Service. 46 p. Available online: http://www.montana.edu/wwwpb/pubs/eb160.html [2003, October 1]. [45303]

28. Greller, Andrew M. 1989. Vascular flora of the Kalbfleisch Field Research Station of the American Museum of Natural History, Suffolk County, Long Island, New York. Bulletin of the Torrey Botanical Club. 116(2): 174-181. [80248]

29. Hall, I. V. 1955. Floristic changes following the cutting and burning of a woodlot for blueberry production. Canadian Journal of Agricultural Science. 35: 143-152. [9012]

30. Hamilton, Evelyn H. 2007. Post-fire vegetation development and fire effects in the SBS zone: Haggen Creek, Francis Lake, Genevieve Lake, Brink, and Indianpoint sites. Technical Report 041. Victoria, BC: Ministry of Forests and Range, Forest Science Program. 74 p. [71203]

31. Hann, Wendel; Havlina, Doug; Shlisky, Ayn; [and others]. 2008. Interagency fire regime condition class guidebook. Version 1.3, [Online]. In: Interagency fire regime condition class website. U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior; The Nature Conservancy; Systems for Environmental Management (Producer). 119 p. Available: http://frames.nbii.gov/frcc/documents/FRCC_Guidebook_2008.07.10.pdf [2010, 3 May]. [70966]

32. Hauser, Cindy E.; McCarthy, Michael A. 2009. Streamlining 'search and destroy': cost-effective surveillance for invasive species management. Ecology Letters. 12: 683-692. [80287]

33. Heinrich, Bernd. 1976. Flowering phenologies: bog, woodland, and disturbed habitats. Ecology. 57(5):

890-899. [80431]

34. Heinrich, Bernd. 1976. The foraging specializations of individual bumblebees. Ecological Monographs. 46(2): 105-128. [80430]

35. Heutte, Tom; Bella, Elizabeth; Snyder, Jamie; Shephard, Michael. 2003. Invasive plants and exotic weeds of southeast Alaska, [Online]. In: Forest health protection--Alaska Region. In: Invasive plants. Anchorage, AK: U.S. Department of Agriculture, Forest Service, Alaska Region, State and Private Forestry, Forest Health Protection (Producer). Available: www.invasive.org/weedcd/pdfs/se_inv_plnt_guide1.pdf [2010, March 1]. [78986]

36. Hobbs, Richard J.; Humphries, Stella E. 1995. An integrated approach to the ecology and management of plant invasions. Conservation Biology. 9(4): 761-770. [44463]

37. Howe, Katherine Mitchell. 2002. The ecology of invasions in a Minnesota grassland: characteristics of invasive species and invaded communities and the effects of global change. Seattle, WA: University of Washington. 186 p. Dissertation. [80500]

38. Hulten, Eric. 1968. Flora of Alaska and neighboring territories. Stanford, CA: Stanford University Press. 1008 p. [13403]

39. Hunt, Shelley L.; Gordon, Andrew M.; Morris, Dave M.; Marek, George T. 2003. Understory vegetation in northern Ontario jack pine and black spruce plantations: 20-year successional changes. Canadian Journal of Forest Research. 33(9): 1791-1803. [65102]

40. Invasive Plant Council of British Columbia. 2008. Targeted Invasive Plant Solutions (T.I.P.S.)--Invasive hawkweeds, [Online]. In: Invasive plant watch--Hawkweeds (Hieracium spp.). In: Invasive plants. Williams Lake, BC: Invasive Plant Council of British Columbia (Producer). Available: http://www.invasiveplantcouncilbc.ca/images/stories/documents/tips/Invasive_Hawkweeds_TIPS.pdf [2010, October 6]. [80501]

41. Johnson, Douglas E. 1999. Surveying, mapping, and monitoring noxious weeds on rangelands. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 19-36. [35707]

42. Jones, Alexis. 2010. [Email to Katharine Stone]. September 21. Regarding year of orange hawkweed study. Missoula, MT: University of Montana, College of Forestry and Conservation. On file with: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT; FEIS files. [80517]

43. Jones, Alexis; Crone, Elizabeth. 2009. The effect of disturbance history on hawkweek invasion (Montana). Ecological Restoration. 27(2): 139-141. [75415]

44. Jonsson-Ninniss, Susan; Middleton, John. 1991. Effect of peat extraction on the vegetation in Wainfleet Bog, Ontario. The Canadian Field-Naturalist. 105(4): 505-511. [19716]

45. Jorgensen, Eric E.; Nauman, Lyle E. 1994. Disturbance in wetlands associated with commercial cranberry (Vaccinium macrocarpon) production. The American Midland Naturalist. 132: 152-158. [24099]

46. Kartesz, John T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. 1st ed. In: Kartesz, John T.; Meacham, Christopher A. Synthesis of the North American flora (Windows Version 1.0), [CD-ROM]. Chapel Hill, NC: North Carolina Botanical Garden (Producer). In cooperation with: The Nature Conservancy; U.S. Department of Agriculture, Natural Resources Conservation Service; U.S. Department of the Interior, Fish and Wildlife Service. [36715]

47. Kleintjes, Paula K.; Sporrong, Jill M.; Raebel, Christopher A.; Thon, Stephen F. 2003. Habitat type conservation and restoration for the Karner blue butterfly: A case study from Wisconsin. Ecological Restoration. 21(2): 107-115. [80288]

48. Koltunow, Anna M.; Johnson, Susan D.; Bicknell, Ross A. 1998. Sexual and apomictic development in Hieracium. Sexual Plant Reproduction. 11: 213-230. [80298]

49. Kowalski, Kurt P.; Wilcox, Douglas A. 2003. Differences in sedge fen vegetation upstream and downstream from a managed impoundment. The American Midland Naturalist. 150(2): 199-220. [80289]

50. Kreyling, Juergen; Schmiedinger, Andreas; Macdonald, Ellen; Baiekuhnlein, Carl. 2008. Potentials of natural tree regeneration after clearcutting in subalpine forests. Western Journal of Applied Forestry. 23(1): 46-52. [74396]

51. Lackschewitz, Klaus. 1991. Vascular plants of west-central Montana--identification guidebook. Gen. Tech. Rep. INT-227. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 648 p. [13798]

52. Lambert, Raymond A.; Barclay, John S. 1976. Woodcock singing grounds and diurnal habitat in north central Oklahoma. Proceedings, Annual Conference of the Southeastern Association of Fish and Wildlife Agencies. 29: 617-630. [76507]

53. LANDFIRE Rapid Assessment. 2005. Reference condition modeling manual (Version 2.1), [Online]. In: LANDFIRE. Cooperative Agreement 04-CA-11132543-189. Boulder, CO: The Nature Conservancy; U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior (Producers). 72 p. Available: http://www.landfire.gov/downloadfile.php?file=RA_Modeling_Manual_v2_1.pdf [2007, May 24]. [66741]

54. LANDFIRE Rapid Assessment. 2007. Rapid assessment reference condition models, [Online]. In: LANDFIRE. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Lab; U.S. Geological Survey; The Nature Conservancy (Producers). Available: http://www.landfire.gov/models_EW.php [2008, April 18] [66533]

55. Levy, Gerald F. 1970. The phytosociology of northern Wisconsin upland openings. The American Midland Naturalist. 83: 213-237. [9986]

56. Loomis, Eli S.; Fishman, Lila. 2009. A continent-wide clone: population genetic variation of the invasive plant Hieracium aurantiacum (orange hawkweed; Asteraceae) in North America. International Journal of Plant Sciences. 170(6): 759-765. [80294]

57. Mack, Richard N.; Simberloff, Daniel; Lonsdale, W. Mark; Evans, Harry; Clout, Michael; Bazzaz, Fakhri A. 2000. Biotic invasions: causes, epidemiology, global consequences, and control. Ecological Applications. 10(3): 689-710. [48324]

58. MacLean, David A.; Wein, Ross W. 1977. Changes in understory vegetation with increasing stand age in New Brunswick forests: species composition, cover, biomass, and nutrients. Canadian Journal of Botany. 55: 2818-2831. [10106]

59. MacQuarrie, Kate; Lacroix, Christian. 2003. The upland hardwood component of Prince Edward Island's remnant Acadian forest: determination of depth of edge and patterns of exotic invasion. Canadian Journal of Botany. 81: 1113-1128. [47131]

60. Magee, Dennis W.; Ahles, Harry E. 2007. Flora of the Northeast: A manual of the vascular flora of New England and adjacent New York. 2nd ed. Amherst, MA: University of Massachusetts Press. 1214 p. [74293]

61. Maycock, P. F. 1956. Composition of an upland conifer community in Ontario. Ecology. 37(4): 846-848. [80300]

62. Maycock, Paul F. 1961. The spruce-fir forests of the Keweenaw Peninsula, northern Michigan. Ecology. 42(2): 357-365. [62688]

63. McMaster, Robert T. 2001. The population biology of Liparis loeselii, Loesel's twayblade, in a Massachusetts wetland. Northeastern Naturalist. 8(2): 163-178. [80301]

64. Meziane, D.; Shipley, B. 1999. Interacting components of interspecific relative growth rate: constancy and change under differing conditions of light and nutrient supply. Functional Ecology. 13: 611-622. [80305]

65. Mitchell, Richard S.; Tucker, Gordon C. 1994. Flora of an unusually diverse virgin and old-growth forest area in the southern Adirondacks of New York. Bulletin of the Torrey Botanical Club. 121(1): 76-83. [80306]

66. Mohlenbrock, Robert H. 1986. [Revised edition]. Guide to the vascular flora of Illinois. Carbondale, IL: Southern Illinois University Press. 507 p. [17383]

67. Moldenke, Harold N. 1944. A Contribution to our knowledge of the wild and cultivated flora of Ohio--I. Castanea. 9(1-3): 1-80. [80312]

68. Moran, M. A. 1984. Influence of adjacent land use on understory vegetation of New York forests. Urban Ecology. 8: 329-340. [80313]

69. Murphy, Stephen D. 2001. The role of pollen allelopathy in weed ecology. Weed Technology. 15(4): 867-872. [80316]

70. Neumann, David D.; Dickmann, Donald I. 2001. Surface burning in a mature stand of Pinus resinosa and Pinus strobus in Michigan: effects on understory vegetation. International Journal of Wildland Fire. 10: 91-101. [40201]

71. Plowright, R. C.; Galen, Candace. 1985. Landmarks or obstacles: the effects of spatial heterogeneity on bumble bee foraging behavior. Oikos. 44(3): 459-464. [80317]

72. Radford, Albert E.; Ahles, Harry E.; Bell, C. Ritchie. 1968. Manual of the vascular flora of the Carolinas. Chapel Hill, NC: The University of North Carolina Press. 1183 p. [7606]

73. Raunkiaer, C. 1934. The life forms of plants and statistical plant geography. Oxford: Clarendon Press. 632 p. [2843]

74. Rice, Peter M. 2010. INVADERS database system, [Online]. Missoula, MT: University of Montana, Division of Biological Sciences (Producer). Available: http://invader.dbs.umt.edu/ [2010, August 17]. [38172]

75. Rinella, Matthew J.; Sheley, Roger L.; Mangold, Jane; Kittle, Rene. 2009. [Revised]. Orange hawkweed and meadow hawkweed complex. MontGuide MT199816AG. Bozeman, MT: Montana State University Extension. 4 p. Available online: http://www.msuextension.org/store/Products/Orange-Hawkweed-and-Meadow-Hawkweed-Complex__MT199816AG.aspx [2010, October 6]. [80499]

76. Roland, A. E.; Smith, E. C. 1969. The flora of Nova Scotia. Halifax, NS: Nova Scotia Museum. 746 p. [13158]

77. Royal Botanic Garden Edinburgh. 2010. Flora Europaea, [Online]. Edinburgh, UK: Royal Botanic

Garden Edinburgh (Producer). Available: http://rbg-web2.rbge.org.uk/FE/fe.html. [41088]

78. Schmitz, Oswald J. 1994. Resource edibility and trophic exploitation in an old-field food web. Proceedings of the National Academy of Sciences of the United States of America. 91: 5364-5367. [80415]

79. Scoggan, H. J. 1978. The flora of Canada. Part 4: Dicotyledoneae (Dictoyledonceae to Compositae). National Museum of Natural Sciences: Publications in Botany, No. 7(4). Ottawa: National Museums of Canada. 1711 p. [78054]

80. Scott, Lisa K. 2007. Invasive plant management following the 2003 Okanagan Valley wildfires, British Columbia. In: Harrington, Timothy B.; Reichard, Sarah H., tech. eds. Meeting the challenge: invasive plants in Pacific Northwest ecosystems. Gen. Tech. Rep. PNW-GTR-694. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 73-76. [69628]

81. Sheley, Roger; Manoukian, Mark; Marks, Gerald. 1999. Preventing noxious weed invasion. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 69-72. [35711]

82. Stergios, Basil G. 1976. Achene production, dispersal, seed germination, and seedling establishment of Hieracium auranticum in an abandoned field community. Canadian Journal of Botany. 54: 1189-1197. [80318]

83. Stickney, Peter F. 1989. Seral origin of species comprising secondary plant succession in Northern Rocky Mountain forests. FEIS workshop: Postfire regeneration. Unpublished draft on file at: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT. 10 p. [20090]

84. Stiles, Billy J.; Howel, Carol L. 1998. Floristic survey of Rabun County, Georgia, Part II. Castanea. 63(2): 154-160. [80416]

85. Strausbaugh, P. D.; Core, Earl L. 1977. Flora of West Virginia. 2nd ed. Morgantown, WV: Seneca Books. 1079 p. [23213]

86. Strickler, Karen; Scott, Virginia L.; Rischer, Roland L. 1996. Comparative nesting ecology of two sympatric leafcutting bees that differ in body size (Hymenoptera: Megachilidae). Journal of the Kansas Entomological Society. 69(1): 26-44. [80418]

87. Sullivan, Thomas P.; Sullivan, Druscilla S.; Lindgren, Pontus M. F. 2008. Influence of variable retention harvests on forest ecosystems: plant and mammal responses up to 8 years post-harvest. Forest Ecology and Management. 254: 239-254. [80421]

88. Suzuki, Shinjiro; Narayama, Tadashi. 1977. Orange hawkweed (Hieracium aurantiacum L.) as an alien pasture weed in Hokkaido. Report of Hokkaido National Agricultural Experiment Station--Research Bulletin 117: 45-56. [English abstract]. [80491]

89. Swihart, Robert K. 1990. Common components of orchard ground cover selected as food by captive woodchucks. The Journal of Wildlife Management. 54(3): 412-417. [80420]

90. Tellier, Renee; Duchesne, Luc C.; Ruel, Jean-Claude; McAlpine, Robert S. 1994. Effects of the intensity of prescribed burning and scarification on the diversity of plant species in a jack pine stand. Ecoscience. 2: 159-167. [26971]

91. Tu, Mandy; Hurd, Callie; Randall, John M., eds. 2001. Weed control methods handbook: tools and techniques for use in natural areas. Davis, CA: The Nature Conservancy. 194 p. [37787]

92. Turner, J. Authur. 1928. Relation of the distribution of certain Compositae to the hydrogen-ion concentration of the soil. Bulletin of the Torrey Botanical Club. 55(4): 199-213. [73909]

93. Tyser, Robin W.; Worley, Christopher A. 1992. Alien flora in grasslands adjacent to road and trail corridors in Glacier National Park, Montana (U.S.A.). Conservation Biology. 6(2): 253-262. [19435]

94. U.S. Department of Agriculture, Forest Service. 2001. Guide to noxious weed prevention practices. Washington, DC: U.S. Department of Agriculture, Forest Service. 25 p. Available online: http://www.fs.fed.us/invasivespecies/documents/FS_WeedBMP_2001.pdf [2009, November 19]. [37889]

95. U.S. Department of Agriculture, Natural Resources Conservation Service. 2010. PLANTS Database, [Online]. Available: http://plants.usda.gov/. [34262]

96. University of Wisconsin-Madison. 1999. Wisflora - Vascular plant species, [Online]. In: Wisconsin Botanical Information System. Madison, WI: University of Wisconsin, State Herbarium (Producer). Available: http://www.botany.wisc.edu/wisflora/ [2005, January 29]. [51106]

97. van Denack, Julia Marie. 1961. An ecological analysis of the sand dune complex in Point Beach State Forest, Two Rivers, Wisconsin. Botanical Gazette. 122(3): 155-174. [49642]

98. Van Driesche, Roy; Lyon, Suzanne; Blossey, Bernd; Hoddle, Mark; Reardon, Richard, tech. coords. 2002. Biological control of invasive plants in the eastern United States. Publication FHTET-2002-04. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team. 413 p. Available online: http://www.invasive.org/eastern/biocontrol/index.html [2009, November 19]. [54194]

99. Veinotte, Cam; Freedman, Bill; Maass, Wolfgang; Kirstein, Friederike. 2003. Comparison of the ground vegetation in spruce plantations and natural forest in the Greater Fundy ecosystem. The Canadian Field-Naturalist. 117(4): 531-540. [50507]

100. Vogl, R. J. 1964. The effects of fire on the vegetational composition of bracken-grassland. Wisconsin Academy of Sciences, Arts and Letters. 53: 67-82. [9142]

101. Voss, Edward G. 1954. The butterflies of Emmet and Cheboygan counties, Michigan with other notes on northern Michigan butterflies. The American Midland Naturalist. 51(1): 87-104. [80435]

102. Voss, Edward G. 1996. Michigan flora. Part III: Dicots (Pyrolaceae--Compositae). Bulletin 61. Bloomfield Hills, MI: Cranbrook Institute of Science; Ann Arbor, MI: University of Michigan Herbarium. 622 p. [30401]

103. Whittle, C. A.; Duchesne, L. C.; Needham, T. 1998. Soil seed bank of a jack pine (Pinus banksiana) ecosystem. International Journal of Wildland Fire. 8(2): 67-71. [28985]

104. Wiegmann, Shannon M.; Waller, Donald M. 2006. Fifty years of change in northern upland forest understories: identity and traits of "winner" and "loser" plant species. Biological Conservation. 129: 109-123. [80436]

105. Williams, Nicholas; Hahs, Amy; Morgan, John; Holland, Kelly. 2007. A dispersal constrained habitat suitability model for orange hawkweed (Hieracium aurantiacum) on the Bogong High Plains, Victoria. Parks Victoria Technical Series No. 38. Melbourne, Australia: Parks Victoria. 57 p. [80440]

106. Wilson, L. M.; Schwarzlander, M. 2004. Hawkweeds. In: Coombs, Eric M.; Clark, Janet K.; Piper, Gary L.; Cofrancesco, Alfred F., Jr., eds. Biological control of invasive plants in the United States. Corvallis, OR: Oregon State University Press: 444. [53103]

107. Wilson, Linda M. 2007. Biology and management of invasive hawkweeds (Hieracium spp.) in the Pacific Northwest. In: Harrington, Timothy B.; Reichard, Sarah H., tech. eds. Meeting the challenge: invasive plants in Pacific Northwest ecosystems. Gen. Tech. Rep. PNW-GTR-694. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 43-46. [69621]

108. Wilson, Linda M.; Callihan, Robert H. 1999. Meadow and orange hawkweed. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 238-248. [35733]

109. Wilson, Linda M.; McCaffrey, Joseph P. 1999. Biological control of noxious rangeland weeds. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 97-115. [35715]

110. Wofford, B. Eugene. 1989. Guide to the vascular plants of the Blue Ridge. Athens, GA: The University of Georgia Press. 384 p. [12908]

111. Wunderlin, Richard P.; Hansen, Bruce F. 2003. Guide to the vascular plants of Florida. 2nd edition. Gainesville, FL: The University of Florida Press. 787 p. [69433]

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