ALASKA NON-NATIVE PLANT INVASIVENESS RANKING FORM

Botanical name: Ranunculus acris L.
Common name: Tall buttercup
Date: 11/15/2018
Date of previous ranking, if any: 4/8/2011
Assessors:

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Alaska Invasive Species Partnership members (formerly Committee for Noxious and Invasive Pests Management)
Alaska Invasive Species Workshop 2018, Homer, Alaska
This species was collectively ranked and reviewed in a group setting of 20 AISP members on 15Nov2018.

OUTCOME SCORE: 60

CLIMATIC COMPARISON

This species is present or may potentially establish in the following eco-geographic regions:

Pacific Maritime	Yes
Interior-Boreal	Yes
Arctic-Alpine	Yes

INVASIVENESS RANKING	**Total** (total answered points possible[1])	**Total**
Ecological impact	40 (40)	16
Biological characteristics and dispersal ability	25 (23)	17
Ecological amplitude and distribution	25 (25)	19
Feasibility of control	10 (10)	7
Outcome score	100 (98)[b]	59[a]
Relative maximum score[2]		60

[1] For questions answered "unknown" do not include point value for the question in parentheses for "total answered points possible."
[2] Calculated as a/b × 100

Previous ranking information:

Date of previous ranking, if any: 4/8/2011
Previous score: 54 (*Ranunculus repens* was ranked with *R. acris* for a single rank for both species)

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A. CLIMATIC COMPARISON

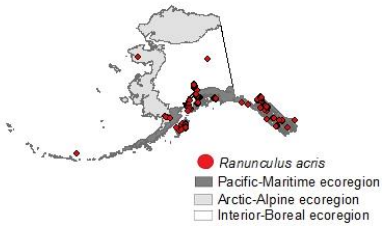
1.1. Has this species ever been collected or documented in Alaska?

- ☒ Yes - continue to 1.2
- ☐ No - continue to 2.1

1.2. From which eco-geographic region has it been collected or documented (see inset map)? Proceed to Section B. INVASIVNESS RANKING

- ☒ Pacific Maritime
- ☒ Interior-Boreal
- ☒ Arctic-Alpine

Documentation: Tall buttercup has been collected in the South Coastal, Interior-Boreal and Arctic-Alpine ecogeographic regions in Alaska (Hultén 1968, AKEPIC 2018, UAM 2018).



2.1. Is there a 40 percent or higher similarity (based on CLIMEX climate matching, see references) between climates where this species currently occurs and:

a. Juneau (Pacific Maritime region)?
- ☐ Yes – record locations and percent similarity; proceed to Section B.
- ☐ No

b. Eagle (Interior-Boreal region)?
- ☐ Yes – record locations and percent similarity; proceed to Section B.
- ☐ No

c. Nome (Arctic-Alpine region)?
- ☐ Yes – record locations and percent similarity; proceed to Section B.

☐ No

If "No" is answered for all regions; reject species from consideration

Documentation:

B. INVASIVENESS RANKING

1. Ecological Impact

1.1. Impact on Natural Ecosystem Processes

a.	No perceivable impact on ecosystem processes	0
b.	Has the potential to influence ecosystem processes to a minor degree (e.g., has a perceivable but mild influence on soil nutrient availability)	3
c.	Has the potential to cause significant alteration of ecosystem processes (e.g., increases sedimentation rates along streams or coastlines, degrades habitat important to waterfowl)	7
d.	Has the potential to cause major, possibly irreversible, alteration or disruption of ecosystem processes (e.g., the species alters geomorphology, hydrology, or affects fire frequency thereby altering community composition; species fixes substantial levels of nitrogen in the soil making soil unlikely to support certain native plants or more likely to favor non-native species)	10
e.	Unknown	U

Score **3**

Documentation:

Buttercup readily occupies open areas and may hinder colonization by native species (Harper 1957). Also, tall buttercup will regenerate from seeds and rhizomes following forest fire (Jacobs et al. 2010a). Tall buttercup grows in grasslands, wet meadows and woodlands, and can inhabit native plant communities when those areas are disturbed; however, the growth and reproduction of tall buttercup is reduced under plant competition (Jacobs et al. 2010a). The colonization and effects of tall buttercup in the native plant communities of Alaska is not well understood.

1.2. Impact on Natural Community Structure

a.	No perceived impact; establishes in an existing layer without influencing its structure	0
b.	Has the potential to influence structure in one layer (e.g., changes the density of one layer)	3
c.	Has the potential to cause significant impact in at least one layer (e.g., creation of a new layer or elimination of an existing layer)	7
d.	Likely to cause major alteration of structure (e.g., covers canopy, eliminating most or all lower layers)	10
e.	Unknown	U

Score **3**

Documentation:

Buttercup establishment may increase the density of vegetation through rhizome reproduction, however regeneration from rhizomes is reduced in species-rich plant communities (Jacobs et al. 2010a).

1.3. Impact on Natural Community Composition

a.	No perceived impact; causes no apparent change in native populations	0

b.	Has the potential to influence community composition (e.g., reduces the population size of one or more native species in the community)	3
c.	Has the potential to significantly alter community composition (e.g., significantly reduces the population size of one or more native species in the community)	7
d.	Likely to cause major alteration in community composition (e.g., results in the extirpation of one or more native species, thereby reducing local biodiversity and/or shifting the community composition towards exotic species)	10
e.	Unknown	U

Score **5**

Documentation:

Tall buttercup is known to reduce perennial grass biomass, and in some cases has a negative association with native forb cover and biomass (Strevey 2014). Tall buttercup produces the glycoside ranunculin (Jacobs et al. 2010a). Many glycosides are allelochemicals that interact with neighboring vegetation, insects, and microorganisms (Rhoades 1979). In New Zealand, tall buttercup reduces forage productivity by excluding palatable pasture plants (Lamoureaux and Bourdôt 2007).

1.4. Impact on associated trophic levels (cumulative impact of this species on the animals, fungi, microbes, and other organisms in the community it invades)

a.	Negligible perceived impact	0
b.	Has the potential to cause minor alteration (e.g., causes a minor reduction in nesting or foraging sites)	3
c.	Has the potential to cause moderate alteration (e.g., causes a moderate reduction in habitat connectivity, interferes with native pollinators, or introduces injurious components such as spines, toxins)	7
d.	Likely to cause severe alteration of associated trophic populations (e.g., extirpation or endangerment of an existing native species or population, or significant reduction in nesting or foraging sites)	10
e.	Unknown	U

Score **5**

Documentation:

The protoanemonin released in the sap of tall buttercup is poisonous. When ingested by grazing animals it results in intestinal disorders and blistering of tongue and lips, and can cause fatality due to respiratory failure or ventricular fibrillation (Jacobs et al. 2010b). Tall buttercup is typically avoided by livestock due to its toxic effects (Jacobs et al. 2010b), which could also potentially impact Alaskan wildlife. Geese and other birds readily eat leaves and seeds of a similar buttercup species (*Ranunculus repens*) (Lovett-Doust et al. 1990). The flowers are visited by honey bees, butterflies, moths, bugs, and beetles for pollen or nectar (Steinbach and Gottsberger 1994). However, the pollen of *Ranunculus acris* is lethal to pollinators if consumed >50% of the diet (Eckhardt et al. 2014). Buttercups host microorganisms, viruses, insects, and nematodes (Harper 1957, Lovett-Doust et al. 1990, Royer and Dickinson 1999). Apparently *Ranunculus acris* and *R. uncinatus* hybridize in Alaska (Welsh 1974). However, no hybrids have been recorded in Britain and Canada and experimental crosses between *Ranunculus* species have been unsuccessful (Harper 1957, Lovett-Doust et al. 1990).

Total Possible	40
Total	**16**

2. Biological Characteristics and Dispersal Ability

2.1. Mode of reproduction

a.	Not aggressive (produces few seeds per plant [0-10/m^2] and not able to reproduce vegetatively).	0
b.	Somewhat aggressive (reproduces by seed only [11-1,000/m^2])	1
c.	Moderately aggressive (reproduces vegetatively and/or by a moderate amount of seed [<1,000/m^2])	2
d.	Highly aggressive (extensive vegetative spread and/or many seeded [>1,000/m^2])	3
e.	Unknown	U

Score **2**

Documentation:

Tall buttercup is a perennial with a lifespan of 4-14 years that reproduces by both seeds and rhizomes (Jacobs et al. 2010b). Tall buttercups are capable of producing up to 240 seeds per plant (Sarukhan 1974). However, it typically has fewer than four flowers per plant, it may not flower every year, and it often does not flower its first year or for as many as 10 years. Tall buttercup is likely to flower more at sites with high soil fertility or low species diversity or density. It requires cross-pollination, and if pollinators are lacking it may not produce viable seed (Jacobs et al. 2010a). Also, many seeds germinate their first year but less than 1% survive. Rhizomes reproduce after the plant is defoliated, trampled, or subjected to other disturbance; or after flowering or removal of the flowering stem. Lateral buds of rhizomes form new rhizomes that subsequently separate from the parent plant. Apical dominance of new shoots maintains upward growth while ensuring a continuing supply of lateral buds that can regenerate new shoots. As with seeds, rhizome survival rate is also less than 1%. Survival rates increase where disturbance removes surrounding vegetation (Jacobs et al. 2010a).

2.2. Innate potential for long-distance dispersal (wind-, water- or animal-dispersal)

a.	Does not occur (no long-distance dispersal mechanisms)	0
b.	Infrequent or inefficient long-distance dispersal (occurs occasionally despite lack of adaptations)	2
c.	Numerous opportunities for long-distance dispersal (species has adaptations such as pappus, hooked fruit coats, etc.)	3
d.	Unknown	U

Score **3**

Documentation:

Seeds have a short hook at the tip of the achene that helps them attached to animal fur for long-distance dispersal (Jacobs et al. 2010a). They can also pass through an animal's digestive tract intact, allowing them to be distributed by birds and mammals (Harper 1957, Jacobs et al. 2010b, Lovett-Doust et al. 1990). One study found a high rate of viability after passing through a cow, with the potential for one cow to disperse 9400 seeds in a grazing period of 165 days. Propagules can also be moved in mud attached to animal hooves, and seeds can be transported by water. Otherwise, plants have no long distance dispersal mechanism and seeds and rhizomes remain within a few feet of the parent plant (Jacobs et al. 2010, Strevey 2014).

2.3. Potential to be spread by human activities (both directly and indirectly – possible mechanisms include: commercial sale of species, use as forage or for revegetation, dispersal along highways, transport on boats, common contaminant of landscape materials, etc.).

a.	Does not occur	0
b.	Low (human dispersal is infrequent or inefficient)	1
c.	Moderate (human dispersal occurs regularly)	2
d.	High (there are numerous opportunities for dispersal to new areas)	3
e.	Unknown	U

Score **3**

Documentation:

Seeds can be dispersed by attachment to clothes, shoes, and tires of farm equipment or other vehicles (USDA, NRCS 2010). They can also be spread through contaminated hay (Jacobs et al. 2010a). Garden varieties have been grown and escaped from gardens in Alaska (J. Riley – pers. obs.). Seen spread on ATV trails in Kodiak and associated with horses in Klondike National Park (AISP members).

2.4. Allelopathic

a.	No	0
b.	Yes	2
c.	Unknown	U

Score **U**

Documentation:

There is an unconfirmed hypothesis that buttercups' toxic root secretions are detrimental to neighboring plants (Lovett-Doust et al. 1990). This is probably attributable to the glycoside ranunculin produced by tall buttercups. Many glycosides are allelochemicals that interact with neighboring vegetation, insects, and microorganisms (Rhoades 1979).

2.5. Competitive ability

a.	Poor competitor for limiting factors	0
b.	Moderately competitive for limiting factors	1
c.	Highly competitive for limiting factors and/or able to fix nitrogen	3
d.	Unknown	U

Score **2**

Documentation:

Tall buttercup is not highly competitive. Diverse vegetation can outcompete and suppress tall buttercup, likely due to its low stature, as the basal leaves are not capable of overtopping neighboring plants (Jacobs et al. 2010a). Species-rich communities limit rhizome regeneration, and it has little to no drought tolerance (Sarukhan 1974, Harper 1953, Jacobs et al. 2010a). To its advantage, where soil nitrogen is sufficient, buttercup can adapt to low light by increasing its light-harvesting efficiency (Jacobs et al. 2010a). Tall buttercup's stout rhizomes may make them more resilient to environmental conditions and better at regenerating relative to other species (Lamoureaux and Bourdôt 2007).

2.6. Forms dense thickets, has a climbing or smothering growth habit, or is otherwise taller than the surrounding vegetation.

a.	Does not grow densely or above surrounding vegetation	0
b.	Forms dense thickets	1
c.	Has a climbing or smothering growth habit, or is otherwise taller than the surrounding vegetation	2
d.	Unknown	U

Score **0**

Documentation: Tall buttercup grows as a perennial with no documented tendency to smother, form thickets, or climb (USDA, NRCS 2010).

2.7. Germination requirements

a.	Requires sparsely vegetated soil and disturbance to germinate	0
b.	Can germinate in vegetated areas, but in a narrow range of or in special conditions	2
c.	Can germinate in existing vegetation in a wide range of conditions	3
d.	Unknown	U

Score **2**

Documentation:

Studies in Canada and New Zealand have shown that seedling recruitment in pastures is highest on bare ground created by mole hills, dung pats, and trampled soils (Parish and Turkington 1990, Lusk 2009). Seedling recruitment is reduced in waterlogged and well-drained soils (Jacobs et al. 2010a). Observed in vegetated areas in Alaska (AISP members).

2.8. Other species in the genus invasive in Alaska or elsewhere

a.	No	0
b.	Yes	3
c.	Unknown	U

Score **3**

Documentation:

Ranunculus repens is also invasive in Alaska (AKEPIC 2018). *Ranunculus abortivus*, *R. arvensis*, *R. bulbosus*, and *R. sardous* are invasive in other areas of the United States (USDA, NRCS 2018).

2.9. Aquatic, wetland, or riparian species

a.	Not invasive in wetland communities	0
b.	Invasive in riparian communities	1
c.	Invasive in wetland communities	3
d.	Unknown	U

Score **2**

Documentation:

Buttercups occur in damp meadows, pastures, fields, grasslands, woodlands, and rock ledges, as well as semi-aquatic communities, such as swamps, margins of lakes, ponds, rivers, streams, gullies, and floodplains (Jacobs et al. 2010a). They thrive in disturbed soils including gardens, croplands, irrigated areas and ditches, borrow pits, gravel pits, parking lots, and along roads with gravely substrates (Jacobs et al. 2010a). Plants are able to tolerate some salinity and are sometimes found on beaches, margins of tidal estuaries, and in salt marshes (Harper 1957). Tall buttercup also tolerates soils with low oxygen and can withstand flooding for up to a month. It prefers neutral to calcareous substrates and has been observed at up to 8400 feet elevation (in Montana; Jacobs et al. 2010). In Southeast Alaska it is a weed of wet, but not flooded sites along the road (T. Heutte – pers. obs.). Tall buttercup is listed as a facultative wetland plant for Alaska (Lichvar et al. 2014).

Total Possible 23
Total **17**

3. Ecological Amplitude and Distribution

3.1. Is the species highly domesticated or a weed of agriculture?

a.	Is not associated with agriculture	0
b.	Is occasionally an agricultural pest	2
c.	Has been grown deliberately, bred, or is known as a significant agricultural pest	4
d.	Unknown	U

Score **3**

Documentation:

Somewhat domesticated as a garden plant, tall buttercup is a common invasive plant in hay fields and pastures in other states (Strevey 2014). In New Zealand, tall buttercup reduces forage productivity by excluding palatable pasture plants (Lamoureaux and Bourdôt 2007).

3.2. Known level of ecological impact in natural areas

a.	Not known to impact other natural areas	0
b.	Known to impact other natural areas, but in habitats and climate zones dissimilar to those in Alaska	1
c.	Known to cause low impact in natural areas in habitats and climate zones similar to those in Alaska	3
d.	Known to cause moderate impact in natural areas in habitat and climate zones similar to those in Alaska	4
e.	Known to cause high impact in natural areas in habitat and climate zones similar to those in Alaska	6
f.	Unknown	U

Score **3**

Documentation:

Tall buttercup has become widespread in North America including marshes and meadows of Montana (Stevey and Mangold 2015). Tall buttercup is known to cause reduction in available pasture for livestock in New Zealand (Lamoureau and Bourdôt 2007) despite use of herbicides. Tall buttercup occurs as far north as 78° N latitude in Norway (GBIF 2018).

3.3. Role of anthropogenic and natural disturbance in establishment

a.	Requires anthropogenic disturbance to establish	0
b.	May occasionally establish in undisturbed areas, readily establishes in naturally disturbed areas	3
c.	Can establish independently of natural or anthropogenic disturbances	5
e.	Unknown	U

Score **3**

Documentation:

Seedlings establish readily in open ground and rapidly colonize bare areas in the year following germination (Harper 1957). Tall buttercup is favored by regular mowing and thrives on lawn (T. Heutte – pers. obs.). Occurrences in AKEPIC are associated with anthropogenic disturbances (AKEPIC 2018) but also observed in vegetated areas (AISP members).

3.4. Current global distribution

a.	Occurs in one or two continents or regions (e.g., Mediterranean region)	0
b.	Extends over three or more continents	3
c.	Extends over three or more continents, including successful introductions in arctic or subarctic regions	5
e.	Unknown	U

Score **5**

Documentation:

Tall buttercup is native to central and northern Europe (Jacobs et al. 2010, Bourdôt et al. 2013). In the northern hemisphere its northern limit is at 78° N on the Arctic Archipelago of Svalbard, Norway (GBIF 2018). Tall buttercup can be found in in North America, Asia, Morocco, Tasmania, and New Zealand (GBIF 2018).

3.5. Extent of the species' U.S. range and/or occurrence of formal state or provincial listing

a.	Occurs in 0-5 percent of the states	0
b.	Occurs in 6-20 percent of the states	2
c.	Occurs in 21-50 percent of the states and/or listed as a problem weed (e.g., "Noxious," or "Invasive") in one state or Canadian province	4
d.	Occurs in more than 50 percent of the states and/or listed as a problem weed in two or more states or Canadian provinces	5
e.	Unknown	U

Score **5**

Documentation:

Tall buttercup was introduced to North America in the early twentieth century and occurs in 42 US states and all but one Canadian Province (USDA, NRCS 2018). It is considered a weed in the western United States (Whitson et al. 2000) and Manitoba and Quebec (Royer and Dickinson 1999). In Montana, tall buttercup is on the noxious weed list (USDA, NRCS 2018).

Total Possible 25

Total **19**

4. Feasibility of Control

4.1. Seed banks

a.	Seeds remain viable in the soil for less than three years	0
b.	Seeds remain viable in the soil for three to five years	2
c.	Seeds remain viable in the soil for five years or longer	3
e.	Unknown	U

Score **1**

Documentation:

Tall buttercup does not accumulate a long-lived seed bank (Champness and Morris 1948, Harper 1957, Sarukhan 1974). A depression of germination rate was not observed for tall buttercup seeds stored for 4 years under laboratory conditions (Harper 1957). Seed survival rate in the soil is generally less than two years (Jacobs et al. 2010a) however, seeds buried deeper than one inch can survive longer than two years. Seedling recruitment is reduced in waterlogged and well-drained soils. Rhizomes will decompose quickly in aerated soils and may persist two years or more in peaty soils (Harper 1957).

4.2. Vegetative regeneration

a.	No resprouting following removal of aboveground growth	0
b.	Resprouting from ground-level meristems	1
c.	Resprouting from extensive underground system	2
d.	Any plant part is a viable propagule	3
e.	Unknown	U

Score **3**

Documentation:

Buttercups are able to regrow after cutting or heavy grazing (Harper 1957). Small pieces of rhizome remain viable propagules after the aboveground portion of the plant is removed (Jacobs et al. 2010a) and can grow from seed and rhizomes following a forest fire. Regeneration from rhizomes is reduced in a species-rich plant community (Jacobs et al. 2010a).

4.3. Level of effort required

a.	Management is not required (e.g., species does not persist in the absence of repeated anthropogenic disturbance)	0
b.	Management is relatively easy and inexpensive; requires a minor investment of human and financial resources	2
c.	Management requires a major short-term or moderate long-term investment of human and financial resources	3
d.	Management requires a major, long-term investment of human and financial resources	4
e.	Unknown	U

Score **3**

Documentation:

Tall buttercup can typically be controlled with herbicides, including glyphosate, aminopyralid, and dicamba, although it has been known to develop resistance to herbicide, so a combination of management actions and/or rotation of herbicides may be needed. Small populations can be somewhat controlled by hand pulling, which will help limit seed set, but any rhizomes left behind will regrow. Consequently, hand pulling is best used in combination with another management action, or frequent manual follow up will be needed. Fertilization has mixed results, but can be effective in combination with herbicides and crop rotation, as it promotes growth of grasses that can out compete buttercup while having little to no effect on tall buttercup (Jacobs et al. 2010b). Mowing can reduce flowering and seed productions but may or may not be useful depending on the tolerance of surrounding native vegetation to mowing. For example, mowing was effective in a field trial in Russia dominated by red fescue but was ineffective in Slovenia where the surrounding vegetation consisted of tussock grasses (USDA, NRCS 2010). With mowing, proper frequency and timing are important in order to be effective and maintain native plant cover (Lamoureaux and Bourdôt 2007). Grazing, tilling, and plowing are not effective control methods and can actually promote buttercup growth (Jacobs et al. 2010a). Nutrient management combined with use of herbicides and crop rotation is recommended where tall buttercup invades non-native pastures and hay meadows (USDA, NRCS 2010).

Total Possible	10
Total	**7**
Total for four sections possible	98
Total for four sections	**59**

References:

AKEPIC database. Alaska Exotic Plant Information Clearinghouse Database. 2018. Available: http://accs.uaa.alaska.edu/

Bourdôt, G.W., S.L. Lamoureaux, M.S. Watt and D.J. Kriticos. 2013. The potential global distribution of tall buttercup (*Ranunculus acris* ssp. *acris*): Opposing effects of irrigation and climate change. Weed Science 61: 230-238.

Champness, S.S. and K. Morris. 1948. The population of buried viable seeds in relation to contrasting pasture and soil types. Journal of Ecology 36: 149-173.

Eckhardt, M., M. Haider, S. Dorn and A. Müller. 2014. Pollen mixing in pollen generalist solitary bees: a possible strategy to complement or mitigate unfavourable pollen properties? Journal of Animal Ecology 83 (3), 588-597.

GBIF (Global Biodiversity Information Facility). 2018. *Ranunculus acris* L. Available: https://www.gbif.org/species/3033363

Harper, J.L. 1957. Biological flora of the British Isles: *Ranunculus acris* L., *R. repens* L., *R. bulbosus* L. Journal of Ecology 45: 289-342.

Harper, J.L. and G.R. Sagar. 1953. Buttercups. Some aspects of the ecology of buttercups in permanent grassland. Pages 256-263 In: 1st British Weed Control Conference, Brighton, UK.

Heutte, Thomas. USDA Forest Service State & Private Forestry. Forest Health Protection Alaska Region, New Mexico Field Office 4331 The Lane @25NE (907) 723-1338. Pers. obs.

Hultén, E. 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA. 1008 p.

Jacobs, J., M. Graves and J. Mangold. 2010a. Ecology and management of tall buttercup (*Ranunculus acris* L.). US Department of Agriculture, Natural Resources Conservation Service, Invasive Species Technical Note No. MT-27 (April 2010). 8 pp.

Jacobs, J., M. Graves and J. Mangold. 2010b. Plant Guide – Tall Buttercup (*Ranunculus acris*). U.S. Department of Agriculture, Natural Resource Conservation Service. Montana State Office. Bozeman, Montana 59715.

Lamoureaux, S. and G.W. Bourdôt. 2007. A review of the ecology and management of *Ranunculus acris* L. in pasture. Weed Research 47: 461-471.

Lichvar, R.W., M. Butterwick, N.C. Melvin and W.N. Kirchner. 2014. Alaska 2014 Regional Wetland Plant List. Phytoneuron 41: 1-42. Engineer Research and Development Center), Cold Regions Research and Engineering Laboratory, U.S. Army Corps of Engineers. http://wetland_plants.usace.army.mil/

Lovett-Doust, J., L. Lovett-Doust and A.T. Groth. 1990. The biology of Canadian weeds. 95. Ranunculus repens. Canadian Journal of Plant Science 70: 1132-1141.

Lusk, C.S., S.L. Lamoureaux and G.W. Bourdôt. 2009. Giant buttercup (*Ranunculus acris* L.) seedling emergence and survival in Golden Bay dairy pastures. New Zealand Plant Protection 62: 222-227.

Parish, R. and R. Turkington. 1990. The colonization of dung pats and molehills in permanent pastures. Canadian Journal of Botany 68: 1706-1711.

Rhoades, D.F. 1979. Evolution of plant chemical defense against herbivores. Pages 3-54 In: Herbivores, their interaction with secondary plant metabolites. G.A. Rosenthal and D. H. Janzen (eds.). Academic Press, New York, N.Y.

Riley, J. Horticulture Agent, UAF Cooperative Extension Service 2221 E. Northern Lights Blvd. #118 Anchorage, AK 99508-4143 tel: (907) 786-6306. Pers. obs.

Royer, F. and R. Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

Sarukhan, J. 1974. Studies on plant demography: *Ranunculus repens* L., *R. bulbosus* L. and *R. acris* L. II. Reproductive strategies and seed population dynamics. Journal of Ecology 62: 151-177.

Steinbach, K. and G. Gottsberger. 1994. Phynology and pollination biology of five Ranunculus species in Giessen, Central Germany. Phyton 34 (2): 203-218.

Strevey, H.K. 2014. The ecology and integrated management of tall buttercup (*Ranunculus acris* L.). Thesis, Montana State University, Bozeman, Montana. 132 pp.

UAM (University of Alaska Museum), University of Alaska Fairbanks. 2018. Arctos database. Available: http://arctos.database.museum/SpecimenSearch.cfm

USDA, NRCS. 2010. The PLANTS Database. Plant Guide – Tall buttercup. Available: https://plants.sc.egov.usda.gov/core/profile?symbol=RAAC3

USDA, NRCS. 2018. The PLANTS Database (http://plants.usda.gov, 30 October 2018). National Plant Data Team, Greensboro, NC 27401-4901 USA.

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

Whitson, T.D., L.C. Burrill, S.A. Dewey, D.W. Cudney, B.E. Nelson, R.D. Lee and R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.