## WEED RISK ASSESSMENT FORM

<table>
<thead>
<tr>
<th>Botanical name:</th>
<th>Euphorbia esula L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common name:</td>
<td>Leafy spurge</td>
</tr>
<tr>
<td>Assessors:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Irina Lapina</td>
</tr>
<tr>
<td></td>
<td>Matthew L. Carlson, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>Botanist, Alaska Natural Heritage</td>
</tr>
<tr>
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<td>Program, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska 99501</td>
</tr>
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<td></td>
<td>tel: (907) 257-2710; fax (907) 257-2789</td>
</tr>
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<td>Matthew L. Carlson, Ph.D.</td>
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<td></td>
<td>Assistant Professor, Alaska Natural Heritage</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>Reviewers:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jeff Conn, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>Jeff Heys</td>
</tr>
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<td>Weed Scientist, USDA Agricultural Research Service</td>
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<td>Exotic Plant Management Program</td>
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<td></td>
<td>PO Box 757200 Fairbanks, Alaska 99775</td>
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<td>tel: (907) 474-7652; fax (907) 474-6184</td>
</tr>
<tr>
<td></td>
<td>Jamie M. Snyder</td>
</tr>
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<td>Julie Riley</td>
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<td></td>
<td>Horticulture Agent, UAF Cooperative Extension Service</td>
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<td>Extension Service</td>
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<tr>
<td></td>
<td>PO Box 757200 Fairbanks, Alaska 99775</td>
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<td>tel: (907) 474-7652; fax (907) 474-6184</td>
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<tr>
<td></td>
<td>Erin Uloth</td>
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<td>Roseann Densmore, Ph.D.</td>
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<tr>
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<td>Forest Health Protection State and Private Forestry, 3301 C Street Suite 202 Anchorage, AK 99503</td>
</tr>
<tr>
<td></td>
<td>tel: (907) 743-9459, fax (907) 743-9479</td>
</tr>
<tr>
<td></td>
<td>Research Ecologist, US Geological Survey, Alaska Biological Science Center, 1101 East Tudor Road Anchorage, AK 99503</td>
</tr>
<tr>
<td></td>
<td>tel: (907) 786-3916, fax (907) 786-3636</td>
</tr>
</tbody>
</table>

### Outcome score:

#### A. Climatic Comparison

<table>
<thead>
<tr>
<th>Eco-geographic region</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Coastal</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Interior-Boreal</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Arctic-Alpine</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

#### B. Invasiveness Ranking

<table>
<thead>
<tr>
<th>Category</th>
<th>Total (Total Answered*)</th>
<th>Total Possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological impact</td>
<td>40 (40)</td>
<td>31</td>
</tr>
<tr>
<td>Biological characteristic and dispersal ability</td>
<td>25 (25)</td>
<td>21</td>
</tr>
<tr>
<td>Ecological amplitude and distribution</td>
<td>25 (25)</td>
<td>23</td>
</tr>
<tr>
<td>Feasibility of control</td>
<td>10 (10)</td>
<td>9</td>
</tr>
<tr>
<td>Outcome score</td>
<td>100 (100)</td>
<td>84 a</td>
</tr>
<tr>
<td>Relative maximum score†</td>
<td>0.84</td>
<td></td>
</tr>
</tbody>
</table>

* For questions answered “unknown” do not include point value for the question in parentheses for “Total Answered Points Possible.”

† Calculated as $\frac{a}{b}$.

### A. CLIMATIC COMPARISON:

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

<table>
<thead>
<tr>
<th>Yes – continue to 1.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No – continue to 2.1</td>
</tr>
</tbody>
</table>

1.2. Which eco-geographic region has it been collected or documented (see inset map)?

*Proceed to Section B. Invasiveness Ranking.*

Sources of information:


2.1. Is there a 40% or higher similarity (based on CLIMEX climate matching) between climates any where the species currently occurs and

- a. Juneau (South Coastal Region)?
  
  **Yes**
  
  Yes – record locations and similarity; proceed to Section B.

  Invasiveness Ranking

  **No**

- b. Fairbanks (Interior-Boreal)?
  
  **Yes**
  
  Yes – record locations and similarity; proceed to Section B.

  Invasiveness Ranking

  **No**

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

  Invasiveness Ranking

**No**

- If “No” is answered for all regions, reject species from consideration

Documentation: The CLIMEX matching program indicates the climatic similarity between Anchorage and areas where this species is documented is high. Leafy spurge is well established in Lillehammer, Dalen, and Oslo, Norway (Lid and Lid 1994), which have 61%, 54% and 53% climatic matches with Anchorage, Alaska. The climatic similarity between Fairbanks and Nome with the native or introduced range of leafy spurge is low. Temperature and the number of frost-free days may be a limiting factor for seed germination and seedling establishment in Interior or Artic-Alpine ecogeographic regions (Selleck et al. 1962). It should be noted that once established a population is capable of maintaining itself vegetatively over a broad range of environmental conditions (Butterfield et al. 1996, Kreps 2000, Selleck et al. 1962). The establishment of *Euphorbia esula* in South-Central Alaska and southern portion of interior Alaska may be possible.

Sources of information:


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**B. INVASIVENESS RANKING**

1. ECOLOGICAL IMPACT

1.1. Impact on Natural Ecosystem Processes

A. No perceivable impact on ecosystem processes

B. Influences ecosystem processes to a minor degree (e.g., has a perceivable but mild influence on soil nutrient availability) 3

C. Significant alteration of ecosystem processes (e.g., increases sedimentation rates along 7
D. Major, possibly irreversible, alteration or disruption of ecosystem processes (e.g., the species alters geomorphology, hydrology; or affects fire frequency, 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)

U. Unknown

Documentation:
Identify ecosystem processes impacted:
Leafy spurge infestations may promote the establishment of other weeds, particularly smooth brome and Kentucky bluegrass (Belcher and Wilson 1989). It likely has soil impact due to allelopathy (Butterfield et al. 1996, Royer and Dickinson 1999, Steenhagen and Zimdahl 1979).

Rational:
Sources of information:

1.2. Impact on Natural Community Structure
A. No perceived impact; establishes in an existing layer without influencing its structure 0
B. Influences structure in one layer (e.g., changes the density of one layer) 3
C. Significant impact in at least one layer (e.g., creation of a new layer or elimination of an existing layer) 7
D. Major alteration of structure (e.g., covers canopy, eradicating most or all layers below) 10
U. Unknown

Documentation:
Identify type of impact or alteration:
Leafy spurge is capable of forming dense stands in natural communities and reducing native plant diversity. Almost complete exclusion of native forbs and grasses may result from the allelopathic chemicals (Kreps 2000, Butterfield and Stubbendieck 1999, Selleck et al. 1962).

Rational:
Sources of information:

1.3. Impact on Natural Community Composition
A. No perceived impact; causes no apparent change in native populations 0
B. Influences community composition (e.g., reduces the number of individuals in one or more native species in the community) 3
C. Significantly alters community composition (e.g., produces a significant reduction in the population size of one or more native species in the community) 7
D. Causes major alteration in community composition (e.g., results in the extirpation of one or several native species, reducing biodiversity or change the community composition towards species exotic to the natural community) 10
U. Unknown

**Documentation:**
Identify type of impact or alteration:
Leafy spurge can reduce species richness and even exclude native forbs and grasses. Displacement of native species in undisturbed areas can occur in a few years if the infestation is unchecked (Biesboer 1996, Kreps 2000).

**Rational:**
Leafy spurge reduced native plant species by 51% in woodland, 36% in grassland, 28% in floodplain, and 21% in shrubland (Butler and Cogan 2004). In experiments in Saskatchewan, all annual species disappeared at all study sites (Selleck et al. 1962). In Manitoba the frequency of 5 common native species decreased significantly with introduction of leafy spurge. The only species that were positively correlated with leafy spurge establishment were smooth brome and Kentucky bluegrass (Belcher and Wilson 1989).

**Sources of information:**

**1.4. Impact on higher 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. Minor alteration 3
C. Moderate alteration (minor reduction in nesting/foraging sites, reduction in habitat connectivity, interference with native pollinators, injurious components such as spines, toxins) 7
D. Severe alteration of higher trophic populations (extirpation or endangerment of an existing native species/population, or significant reduction in nesting or foraging sites) 10
U. Unknown

**Documentation:**
Identify type of impact or alteration:
Leafy spurge is unpalatable and often toxic to herbivores such as deer, elk, and antelope. Infestations of leafy spurge reduce the availability of forage for these species (Kreps 2000, Masters and Kappler 2002). Most North American insects avoid leafy spurge. Alteration of grassland vegetation structure by leafy spurge may degrade nesting habitat of breeding birds. In North Dakota, study densities, breeding, nest-site selection, and nest success of Savannah sparrow was lower on sites infested by leafy spurge (Scheiman et al. 2003).The milky sap contained in leafy spurge tissue may cause severe skin rashes in humans (Royer and Dickinson 1999). Bees, flies, ants, and mosquitoes feed on the nectar of leafy spurge flowers (Messersmith et al. 1985, Fowler 1983, Selleck et al. 1962). Over sixty species of insects have been recorded visiting leafy spurge flowers (Butterfield et al. 1999). Decomposing plant tissues release allelopathic chemicals that suppress the growth of other plant species (Steenhagen and Zimdahl 1979, Royer and Dickinson 1999).

**Rational:**
Sources of information:

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

2.1. Mode of reproduction

A. Not aggressive reproduction (few [0-10] seeds per plant and no vegetative reproduction) 0
B. Somewhat aggressive (reproduces only by seeds (11-1,000/m²)) 1
C. Moderately aggressive (reproduces vegetatively and/or by a moderate amount of seed, <1,000/m²) 2
D. Highly aggressive reproduction (extensive vegetative spread and/or many seeded, >1,000/m²) 3
U. Unknown 0

Score 3

Documentation:
Describe key reproductive characteristics (including seeds per plant):
Leafy spurge can spread by seed, rhizome, or root fragment. Root buds can regenerate new shoots if the stems are destroyed. Each stem of leafy spurge can produce up to 250 seeds and dense infestations can produce over 8,000 seeds per square meter (Royer and Dickinson 1999, Selleck et al. 1962).

Rational:

Sources of information:

2.2. Innate potential for long-distance dispersal (bird dispersal, sticks to animal hair, buoyant fruits, wind-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
U. Unknown 0

Score 3
Identify dispersal mechanisms:

Fruits open explosively and can scatter seeds up to 15 ft from the parent plant. Long-distance dispersal by animals is also suspected (Best et al. 1980, Butterfield et al. 1996) and the seeds can float and germinate in water (Masters and Kappler 2002). Leafy spurge seeds contain fat and protein which make them a desirable food source for ants who act as dispersal agents (Remberton 1988).

Sources of information:


2.3. Potential to be spread by human activities (both directly and indirectly – possible mechanisms include: commercial sales, use as forage/revegetation, spread along highways, transport on boats, contamination, etc.)

<table>
<thead>
<tr>
<th></th>
<th>Potential to be spread by human activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Does not occur</td>
</tr>
<tr>
<td>B.</td>
<td>Low (human dispersal is infrequent or inefficient)</td>
</tr>
<tr>
<td>C.</td>
<td>Moderate (human dispersal occurs)</td>
</tr>
<tr>
<td>D.</td>
<td>High (there are numerous opportunities for dispersal to new areas)</td>
</tr>
<tr>
<td>U.</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

Score 3

Identify dispersal mechanisms:

It is likely that the first introduction of leafy spurge to North America was in contaminated oats from Russia. Leafy spurge is known to contaminating commercial seed, grain, and hay. Fragments of roots and rhizomes can be carried on road maintenance or farm equipment (Kreps 2000, Butterfield et al.1996, Dunn 1985, Selleck et al. 1962).

Sources of information:


2.4. Allelopathic

<table>
<thead>
<tr>
<th></th>
<th>Allelopathic</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>No</td>
</tr>
<tr>
<td>B.</td>
<td>Yes</td>
</tr>
<tr>
<td>U.</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

Score 2
### 2.5. Competitive ability

<table>
<thead>
<tr>
<th></th>
<th>Poor competitor for limiting factors</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Moderately competitive for limiting factors</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Highly competitive for limiting factors and/or nitrogen fixing ability</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>Unknown</td>
<td></td>
</tr>
</tbody>
</table>

**Score** 3

**Documentation:**

Evidence of competitive ability:
Leafy spurge outcompetes native forbs and grasses (Masters and Kappler 2002), and is allelopathic toward associated species (Steenhagen and Zimdahl 1979).

**Rational:**
Leafy spurge has extensive vegetative reproduction, effective seed dispersal, high seed viability, and very rapid development of seedlings (Masters and Kappler 2002). In a detailed study of *Euphorbia esula* growing with smooth brome and crested wheatgrass neither species was successful in competition with leafy spurge (Selleck et al. 1962).

**Sources of information:**

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

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Forms dense thickets</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Has climbing or smothering growth habit, or otherwise taller than the surrounding vegetation</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Unknown</td>
<td></td>
</tr>
</tbody>
</table>

**Score** 1

**Documentation:**

Describe grow form:
Leafy spurge is capable of creating dense monocultures. A density of 200 shoots per square meter was recorded in Saskatchewan (Selleck et al. 1962). Stem densities of 1,000 per square yard are not uncommon (Kreps 2000).

**Rational:**

**Sources of information:**
Kreps, L.B. *Euphorbia esula* L. In: Bossard, C.C., J.M. Randall, and M.C. Hoshovsky,
2.7. Germination requirements

A. Requires open soil and disturbance to germinate
B. Can germinate in vegetated areas but in a narrow range or in special conditions
C. Can germinate in existing vegetation in a wide range of conditions
U. Unknown

Score: 2

Documentation:
Describe germination requirements:
Leafy spurge requires anthropogenic or natural disturbances for germination (Belcher and Wilson 1989, Selleck et al. 1962).

Rational:

Sources of information:

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

A. No
B. Yes
U. Unknown

Score: 3

Documentation:
Species:
*Euphorbia cyparissias*, *E. myrsinites*, *E. oblongata*, *E. serrata*, *E. terracina* have State Noxious Status in various American states (USDA 2002).

Sources of information:

2.9. Aquatic, wetland, or riparian species

A. Not invasive in wetland communities
B. Invasive in riparian communities
C. Invasive in wetland communities
U. Unknown

Score: 1

Documentation:
Describe type of habitat:
Although leafy spurge prefers dry sandy soils, it is able to establish in irrigated meadows and along riparian areas (Masters and Kappler 2002). Leafy spurge is known from riverbanks in central Europe, Sweden, and Western Asia. In Saskatchewan infestations often follow drain channel contours (Selleck et al. 1962).

Rational:

Sources of information:
3. DISTRIBUTION

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

<table>
<thead>
<tr>
<th>Option</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. No</td>
<td>0</td>
</tr>
<tr>
<td>B. Is occasionally an agricultural pest</td>
<td>2</td>
</tr>
<tr>
<td>C. Has been grown deliberately, bred, or is known as a significant agricultural pest</td>
<td>4</td>
</tr>
<tr>
<td>U. Unknown</td>
<td></td>
</tr>
</tbody>
</table>

Documentation:
Identify reason for selection, or evidence of weedy history:
Leafy spurge is a successful weed in untilled fields (Kreps 2000).
Rational:

Sources of information:

3.2. Known level of ecological impact in natural areas

<table>
<thead>
<tr>
<th>Option</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Not known to cause impact in any other natural area</td>
<td>0</td>
</tr>
<tr>
<td>B. Known to cause impacts in natural areas, but in dissimilar habitats and climate zones than exist in regions of Alaska</td>
<td>1</td>
</tr>
<tr>
<td>C. Known to cause low impact in natural areas in similar habitats and climate zones to those present in Alaska – or high impacts in weakly similar habitats</td>
<td>3</td>
</tr>
<tr>
<td>D. Known to cause moderate impact in natural areas in similar habitat and climate zones – or high impacts in moderately similar habitats</td>
<td>4</td>
</tr>
<tr>
<td>E. Known to cause high impact in natural areas in similar habitat and climate zones</td>
<td>6</td>
</tr>
<tr>
<td>U. Unknown</td>
<td></td>
</tr>
</tbody>
</table>

Documentation:
Identify type of habitat and states or provinces where it occurs:
Leafy spurge has invaded prairies, pine savannahs, and riparian areas in Minnesota, North and South Dakota, Idaho, Oregon, Colorado, and California (Kreps 2000, Dunn 1979). It is known to invade native grassland in Ontario, Quebec, and Saskatchewan (Selleck et al. 1962). Leafy spurge is spreading rapidly into native rangeland in Western Canada (Frankton and Mulligan 1970).

Sources of information:

3.3. Role of anthropogenic and natural disturbance in establishment

<table>
<thead>
<tr>
<th>Option</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Requires anthropogenic disturbances to establish</td>
<td>0</td>
</tr>
<tr>
<td>B. May occasionally establish in undisturbed areas but can readily establish in areas with natural disturbances</td>
<td>3</td>
</tr>
<tr>
<td>C. Can establish independent of any known natural or anthropogenic disturbances</td>
<td>5</td>
</tr>
<tr>
<td>U. Unknown</td>
<td></td>
</tr>
</tbody>
</table>

Documentation:
Identify type of disturbance:
Leafy spurge requires anthropogenic or natural disturbances for initial establishment. It has been found to spread in native grassland, presumably after establishment from seed in a gopher mound (Selleck et al. 1962).
Rational:
Almost all (95%) of leafy spurge infestations are associated with anthropogenic disturbances such as vehicle tracks, road construction, and fire lines (Belcher and Wilson 1989).
Sources of information:

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
U. Unknown

Documentation:
Describe distribution:
Leafy spurge is native to Eurasia. It is presently found worldwide (including the boreal zone), except for Australia (Biesboer 1996, Butterfield et al. 1996).
Rational:
Sources of information:

3.5. Extent of the species U.S. range and/or occurrence of formal state or provincial listing
A. 0-5% of the states 0
B. 6-20% of the states 2
C. 21-50%, and/or state listed as a problem weed (e.g., “Noxious,” or “Invasive”) in 1 state or Canadian province 4
D. Greater than 50%, and/or identified as “Noxious” in 2 or more states or Canadian provinces 5
U. Unknown

Documentation:
Identify states invaded:
Leafy spurge has spread into 30 states and every Canadian province, except Newfoundland (Best et al. 1980, Butterfield et al. 1996, USDA 2002). All indications are that it will continue to expand its range in Canada (White et al. 1993). Leafy spurge is a noxious weed in 22 American states and 6 Canadian provinces (Invaders Database System 2003, Royer and Dickinson 1999). Leafy spurge is a prohibited noxious weed in Alaska (Alaska Administrative Code 1987).
Rational:
Sources of information:
Alaska Administrative Code. Title 11, Chapter 34. 1987. Alaska Department of Natural Resources. Division of Agriculture.
4. FEASIBILITY OF CONTROL

4.1. Seed banks

A. Seeds remain viable in the soil for less than 3 years  
B. Seeds remain viable in the soil for between 3 and 5 years  
C. Seeds remain viable in the soil for 5 years and more  
U. Unknown

Score 3

Documentation:
Identify longevity of seed bank:

Ninety-nine percent of viable seeds will germinate in the first 2 years. The rest of the seeds may be viable in the soil for up to 8 years. However, viability decreases by about 13% each year (Butterfield et al. 1996, Whitson et al. 2000). Selleck et al. (1962) reported seeds to remain viable no longer than five years.

Rational:

Sources of information:


4.2. Vegetative regeneration

A. No resprouting following removal of aboveground growth  
B. Resprouting from ground-level meristems  
C. Resprouting from extensive underground system  
D. Any plant part is a viable propagule  
U. Unknown

Score 2

Documentation:
Describe vegetative response:

Root buds give rise to new shoots after removal of aboveground parts. Root fragments buried 9 feet deep can produce new plants (Royer and Dickinson 1999).

Rational:
An experiment showed that tilling increased the density of leafy spurge from 134 shoots/m² in untilled area to 316 shoots/m² (Selleck et al. 1962).

Sources of information:

4.3. Level of effort required
A. Management is not required (e.g., species does not persist without repeated anthropogenic disturbance) 0
B. Management is relatively easy and inexpensive; requires a minor investment in human and financial resources 2
C. Management requires a major short-term investment of human and financial resources, or a moderate long-term investment 3
D. Management requires a major, long-term investment of human and financial resources 4
U. Unknown

Score 4

Documentation:
Identify types of control methods and time-term required:
Leafy spurge is extremely difficult to control, and the best approach is the early detection and elimination of new infestation. Mechanical, chemical, cultural, and biological control methods have all been used on leafy spurge with varying levels of success. Most control methods have a detrimental effect on other plant species, and they all constitute a disturbance that will promote the establishment of leafy spurge or other exotic species (Masters and Kappler 2002, Biesboer 1996, Lym 1998, Selleck et al. 1962). Treated sites require monitoring for 10 years after treatment.

Rational:
Sources of information:

Total Possible 10
Total 9

Total for 4 sections Possible 100
Total for 4 sections 84

References:
Alaska Administrative Code. Title 11, Chapter 34. 1987. Alaska Department of Natural Resources. Division of Agriculture.


