Release Documentation
For
Maple Grove Lewis Flax

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Common Garden Studies

Common gardens were established at two sites in the spring of 1989 with greenhouse-reared transplants of Lewis flax and the blue flax cultivar 'Appar' as part of cooperative research studies conducted by the USDA Forest Service, Intermountain Research Station, Shrub Sciences Laboratory and the USDI Bureau of Land Management, Idaho State Office. The primary objective was to evaluate drought tolerance. Lewis flax transplants were grown using seed collected from 14 native populations representing four western states (Table 1). A randomized block design was used with three replications (plots) for each accession planted at each site. Individual plots consisted of four rows of six plants each (24 total). Within and between row spacing was 60 and 120 cm, respectively.

Common garden sites were located near Orchard, ID and Nephi, UT. The Orchard site lies approximately 32 km southeast of Boise at an elevation of 970 m. The soil is a deep sandy loam with good to moderately good drainage and 0 to 2 percent slope. Mean annual precipitation is 280 mm occurring primarily during winter and spring. Native vegetation in the surrounding area is dominated by Wyoming big sagebrush. The second site is located 13 km southwest of Nephi, Utah on the Utah State University Agricultural Station farm. Elevation is 1,590 m. The soil is a deep, loamy clay on a 0 to 2 percent slope. Mean annual precipitation is 340 mm. Native vegetation is dominated by basin big sagebrush. Both sites had been in cultivation and were fallowed prior to planting.

Plants were rated annually for survival and vigor from 1989 to 1992. Individual vigor scores on a scale of 1 (low) to 5 (high) were assigned subjectively to each surviving plant based on abundance and condition of leaves and stems, flower production, and overall succulence. In the spring of 1990 a naturally occurring rust infestation developed in the Nephi plots. Plants were scored on a scale of 0 (no visible evidence of rust) to 5 (visible evidence of infection on more than 90 percent of plant parts). In May 1990 all plants at this site were treated with the systemic fungicide, Plantvax.

Mean transplant survival 5 months after planting at the Orchard site was 19.2 percent (Table 2). Survival of eight Lewis flax accessions was not significantly different than for 'Appar' blue flax. In 1990 mean survival had dropped to 15.7 percent. 'Appar' and five Lewis flax populations were not significantly different at this point. Mean survival after 2 years was less than 5 percent for all accessions. This site is clearly too droughty for long-term persistence of flax accessions tested. Although the Maple Grove accession had a

Table 1-Collection site information for 19 Lewis flax accessions. Studies are: common gardens (1), seed production (2), greenhouse emergence (3), and field seedings (4).

Collect Name	County	State	Elevation	Mean Annual Precip.	Vegetation Type	Studies
			m	*mm*		
Confusion Range	Millard	UT	1,870	220	Desert shrub-grass	1,2,3,4
Potosi	Clark	NV	1,850	250	Pinyon-juniper	1,2,3
Burr Trail	Garfield	UT	2,030	250	Pinyon-juniper	1,2,3,4
Yuba Dam	Juab	UT	1,630	330	Sagebrush-grass	1,3,4
Mona	Juab	UT	1,540	340	Sagebrush-grass	1,2,3
Cove Fort	Millard	UT	1,760	340	Sagebrush-grass	1,2,3
Maple Grove	**Millard**	**UT**	**1,920**	**350**	**Sagebrush-grass**	**1,2,3**
Lava Hot Springs	Bannock	ID	1,460	360	Sagebrush-grass	1,2,3,4
Little Antelope Summit	White Pine	NV	2,270	360	Pinyon-junper-Mtn. brush	3
Black Hills	Custer	SD	1,340	360	Ponderosa pine-Mtn. mahogany	3
Fort Collins	Larimer	CO	1,760	380	Ponderosa pine-Mtn. mahogany	3
Asotin	Asotin	WA	320	380	Palouse grassland	1,2,3,4
Provo Overlook	Utah	UT	1,970	430	Sagebrush-grass	1,2,3,4
Blue Springs Hill	Box Elder	UT	1,570	430	Sagebrush-grass	1,2,3
Hyde Park	Cache	UT	1,540	440	Sagebrush-grass	1,2,3
Richmond	Cache	UT	1,710	470	Sagebrush-grass	1,2,3
Parley's Summit	Summit	UT	2,060	580	Mountain brush	1,2,3
Panguitch Lake	Garfield	UT	2,580	580	Ponderosa pine-bitterbrush	3
Elk Knoll	Sanpete	UT	3,160	710	Subalpine herbland	3
'Appar'	--	--	--	--	--	1,2,3,4

Table 2-Survival and vigor of 14 Lewis flax accessions and 'Appar' blue flax at the Orchard, ID common garden planted March 1989. Survival for all accessions was less than 5 percent in 1991. Plant vigor is on a scale of 1 (low) to 5 (high). Within columns, means followed by the same letter are not significantly different at the $P < 0.05$ level (Student-Neuman-Keuls multiple range test).

Collection	Transplant Survival		Vigor 1990
	1989	1990	
	--------- *percent* ----------		
Confusion Range	33a	31ab	4.1a
Potosi	31ab	28abc	3.4ab
Burr Trail	31ab	26abcd	3.4ab
Yuba Dam	10bcde	10cdef	3.0abc
Mona	26abc	24abcd	3.4ab
Cove Fort	2e	2f	4.0a
Maple Grove	**10bcde**	**8def**	**3.6ab**
Lava Hot Springs	13bcde	10cdef	2.6abcd
Asotin	8cde	7def	2.9abcd
Provo Overlook	25abc	22abcde	3.3ab
Blue Springs Hill	19abcd	15bcdef	1.5cd
Hyde Park	21abcd	9cdef	1.6cd
Richmond	17abcd	7def	1.3d
Parley's Summit	7de	2f	2.0bcd
'Appar'	35a	35a	3.8ab

relatively low 1989 survival rating at this site, its 1990 mean vigor rating (3.6) was greater than the overall mean (2.9) and not significantly lower than any other accession.

Transplant survival at the Nephi common garden during the second growing season (1990) was uniformly high with a mean of 95.3 percent. Considerable among-accession variation in mortality was observed from 1990 to 1992 (Figure 1). Maple Grove survival in 1992 (78 percent) was higher than all but the Asotin, WA accession (96 percent). Mortality was significantly correlated with 1990 mean rust index values ($r^2 = 0.52$) even though visible evidence of rust infection was absent in 1991 (possibly due to the fungicide treatment). Mean rust index varied among accessions from 0.0 ('Appar') to 4.6. Maple Grove mean rust index was 0.4 and was among the lowest for the native Lewis flax accessions. Although mean vigor ratings varied annually reflecting variation in environmental conditions, the four-year mean for Maple Grove germplasm (2.88) was the highest of all flax accessions, 'Appar' included (Table 3).

Individual Plant Seed Production

Flower, fruit, and seed production were determined on an individual plant basis at the Nephi common garden in 1990 and repeated in 1991. Two weeks before flowering, eight

vigorous, non-border plants were selected from the three plots representing each accession. Flower bearing stems were counted after flowering had ceased. Estimates of

Figure 1-Survival of eight representative Lewis flax accessions and 'Appar' blue flax at the Nephi common garden. Greenhouse-reared seedlings were planted in April 1989. Mortality from 1989 to 1992 was significantly correlated with severity of rust infection ($P < 0.05$, $r^2 = 0.52$).

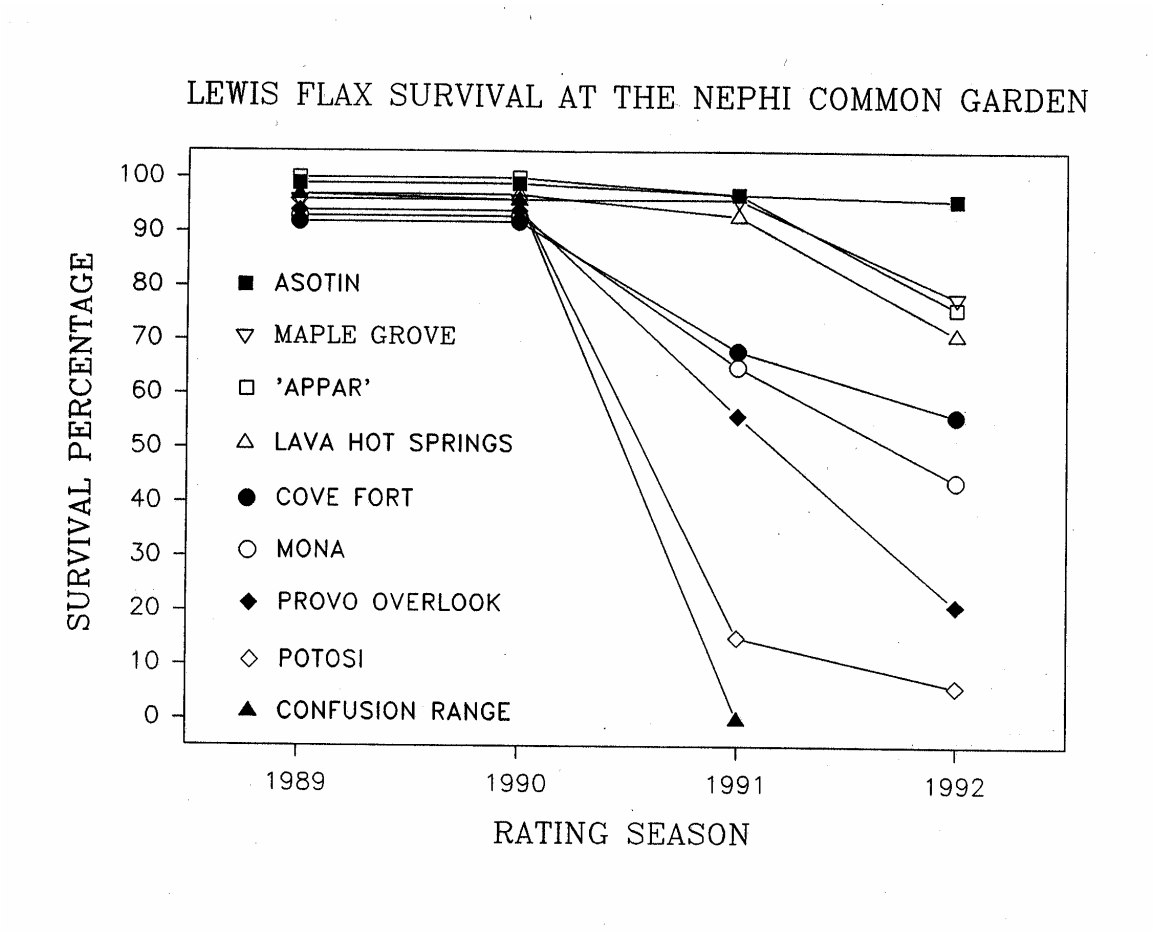

Table 3-Mean vigor ratings and rust indices for transplants of 14 Lewis flax accessions and 'Appar' blue flax at the Nephi common garden. Plant vigor is on a scale of 1 (low) to 5 (high). Rust index values were scored from 0 (no infection) to 5 (visible evidence of infection on more than 90 percent of the plant). Within columns, means followed by the same letter are not significantly different at the $P < 0.05$ level (Student-Newman-Keuls multiple range test).

Collection	Mean Vigor				Mean Rust
	1989	1990	1991	1992	Index (1990)
Confusion Range	2.9a	2.3b	--	--	4.6a
Potosi	2.6abcd	2.2bc	1.4c	2.5abc	1.0d
Burr Trail	2.7abcd	2.0cd	1.6e	2.2abc	1.4c
Yuba Dam	2.9a	2.1cd	1.8e	2.2abc	1.8b
Mona	2.4dce	2.4abc	2.9bcd	2.5abc	1.2c
Cove Fort	2.7abc	2.0cd	2.8cd	2.4abc	1.0d
Maple Grove	**2.9a**	**2.6a**	**3.4abc**	**2.6abc**	**0.4f**
Lava Hot Springs	2.5bcde	2.4ab	2.9cd	2.1abc	0.6e
Asotin	2.2	1.9de	3.3abc	2.9a	0.3f
Provo	2.8ab	2.1cd	2.4d	2.3abc	1.7b
Overlook Blue Springs Hill	2.6abcd	2.0cd	3.1bc	1.8bc	1.0d
Hyde Park	2.4de	2.1cd	3.5abc	2.0bc	0.6e
Richmond	2.9a	1.9de	2.9bcd	1.7c	1.0d
Parley's Summit	2.1e	1.7e	3.6ab	2.2abc	0.1g
'Appar'	2.9a	2.1cd	3.9a	2.5abc	0.0g

the mean number of flowers and fruits per stem were determined by counting fruits and aborted flowers on a sub-sample of 20 (1990) or 10 (1991) stems for each study plant. Twenty fruits were harvested from each plant (1990 only) just prior to ripening and harvested seeds were used to estimate mean fruit fill for each plant. Seed weight was determined using four replications of 100 seeds. Estimates of the total number and weight of seeds produced by each plant were calculated from these data. Four accessions of Lewis flax with the highest levels of mortality (apparently related to high rust infection during the previous year) were not samples in 1991.

For both study years, "Appar' blue flax plants produced more flowers and fruits per plant than all Lewis flax accessions tested (Table 4). The number of flower bearing stems per plant and the number of flowers per stem varied considerably among Lewis flax

accessions and between study years. Further studies of the mechanisms that control these variables and the relative importance of these variables in determining whole plant fecundity may provide valuable insight both for agronomic seed production and in understanding the ecology of this species in its varied natural environments. Variation in fruit set percentage was primarily associated with differences in the two study years. The Maple Grove 2-year mean for fruits per plant (2,687) was a close second among Lewis flax accessions.

Table 4-Stem, Flower, and fruit production for 13 Lewis flax collections and 'Appar' blue flax at the Nephi common garden in 1990 and 1991.

Accession	Year	Stems per plant	Flowers per stem	Flowers per plant	Fruit set	Fruits per plant
					%	
Confusion	1990	80	26	2,029	.81	1,644
Range	1991	--	--	--	--	--
Potosi	1990	50	31	1,467	.75	1,072
	1991	--	--	--	--	--
Burr Trail	1990	85	21	1,790	88	1,601
	1991	--	--	--	--	--
Mona	1990	86	29	2,420	67	1,621
	1991	53	25	1,386	51	712
Cove Fort	1990	83	34	2,745	80	2,194
	1991	32	37	1,184	48	563
Maple	**1990**	**65**	**36**	**2,309**	**79**	**1,845**
Grove	**1991**	**56**	**30**	**1,692**	**50**	**842**
Lava Hot	1990	61	34	2,018	76	1,576
Springs	1991	25	38	1,051	50	527
Asotin	1990	36	37	1,293	88	1,125
	1991	45	22	1,192	34	403
Provo	1990	124	20	2,562	62	1,686
Overlook	1991	--	--	--	--	--
Blue	1990	63	36	2,256	86	1,927
Springs	1991	71	31	2,052	39	805
Hill						
Hyde Park	1990	45	33	1,467	79	1,175
	1991	57	37	2,006	49	987
Richmond	1990	51	33	1,601	75	1,193
	1991	40	25	1,043	57	594
Parley's	1990	26	46	1,150	87	1,006
Summit	1991	44	38	1,690	34	581
'Appar'	1990	92	60	5,678	67	3,859
	1991	84	48	4,060	57	2,313

As was expected (due to the high number of fruits produced), per plant seed production for 'Appar' blue flax exceeded that of all Lewis flax accessions in 1990 and 1991, both in terms of seed number and seed weight (Table 5). Estimates of fruit fill (mean of 87.5 percent; 1990 only) were similar for all accessions. Lewis flax seed size varied from 343 to 527 seeds per gram. 'Appar' blue flax seeds were smallest at 641 per gram. At 452 seeds per gram, Maple Grove seed size was intermediate for that observed for Lewis flax accessions that were tested. The 2-year estimate of total per-plant seed weight produced by the Maple Grove plants (57 g) was 64 percent of that yielded by 'Appar' plants (89g) and among the highest observed for the Lewis flax accessions.

Table 5- Seed production per plant for 13 accessions of Lewis flax and 'Appar' at the Nephi common garden. Within columns, means followed by the same letter are not significantly different at the *P* < 0.05 level (Student-Newman-Keuls multiple range test).

Accession	Mean seed number per plant		Seeds per	Mean seed weight per plant	
	1990	1991	gram	1990	1991
Confusion Range	15,114b	--	465	33abc	--
Potosi	9,548b	--	343	28bc	--
Burr Trail	14,784b	--	428	35abc	--
Mona	14,466b	7,122b	360	40ab	20b
Cove Fort	18,820b	5,626b	474	40ab	12b
Maple Grove	**17323b**	**8,418b**	**452**	**38ab**	**19b**
Lava Hot Springs	13,788b	5,266b	392	35abc	13b
Asotin	7,544b	4,031b	513	15c	8b
Provo Overlook	14,781b	--	365	40ab	--
Blue Springs Hill	16,865b	8,046b	481	35abc	17b
Hyde Park	10,375b	9,871b	362	29bc	27ab
Richmond	10,582b	5,939b	381	28bc	16b
Parley's Summit	8,988b	5,805b	527	17bc	11b
'Appar'	34,012a	23,126a	641	53a	36a

Seedling Emergence and Vigor

Seedling vigor was evaluated for 19 Lewis flax accessions and 'Appar' by means of greenhouse seedling emergence trials. A randomized block design was used to partition

variation due to greenhouse position. For each accession, three 70-cm rows of 50 seeds each were planted at a depth of 3.2 cm in a well-drained loamy sand. Row spacing was 6 cm. Water was added periodically so as to not be limiting. Seedling emergence and growth were evaluated weekly for 6 weeks after planting. Emergence percentages were adjusted based upon the results of laboratory germination percentages. Successful emergence varied from 89 to 18 percent. Maple Grove emergence (68 percent) was not significantly different than the highest values observed. Emergence and growth rates were similar for all intermountain collections from semi-arid environments.

Field seedings of 'Appar' blue flax and six Lewis flax accessions were established in the fall of 1991 at both common garden sites and at a third site 13 km north of Dugway, UT. Seeds were planted using a modified garden planter into sets of four parallel furrows 2.5 m in length. Seeding rate was approximately 67 seeds per m of row and seeding depth was 1 to 2 cm. Three of these plots were planted for each accession at each site in a randomized complete block design.

Mean seedling emergence in the spring of 1992 was 18, 23, and 63 percent at the Orchard, Nephi, and Dugway sites, respectively. Among-accession variation was relatively low and not predictable based on performance at any other site or on the greenhouse emergence trial results. Seedlings at the Orchard and Dugway sites failed to survive to the summer of 1993 while plants at the Nephi site were generally vigorous, producing flowers and seed in the second year of growth. Although the Maple Grove accession was not included in these trials, those that were demonstrated the ability of Lewis flax accessions from a variety of semi-arid sites to establish from seed with success similar to that experienced by 'Appar' blue flax.

Cultivated Seed Production

The selection of the Maple Grove germplasm for potential release over other possible Lewis flax accessions was made in 1997 after a review of the data presented above and after verification of the distinct taxonomies and reproductive isolation of 'Appar' blue flax and native Lewis flax (see Note 1). At that time questions remained regarding the establishment, growth, and seed production of Maple Grove germplasm using established agronomic practices. In addition there was essentially no seed available for increase. Consequently, approximately 200 container stock plants were green-house reared from G0 seed (1988 original collection) during the winter of 1997-1998. These seedlings were transplanted to the Snow Field Station in Ephraim, UT in May 1998. No other native flax was in cultivation at this site insuring proper isolation. Seed (G1) was collected from these transplants in 1998 and 1999. Seed of both years was combined and used for establishing drilled seeding trials in 2000 at the Aberdeen Plant Materials Center (PMC) and the Snow Field Station. The transplants have subsequently been removed.

On May 24, 2000 two 26 m (84 ft) rows each of 'Appar' blue flax and Maple Grove Lewis flax G1 were seeded side by side in field 15 at the Aberdeen PMC home farm. No other native flax accessions were in cultivation at the PMC. Seed was planted with a Planet Junior seeder pulled by a tractor. The seeding rate was 82-98 pure live seeds

(PLS) per m (25-30 PLS per ft) and rows were spaced 91 cm (36 in) apart. During the establishment year, the Maple Grove accession had the best stand. On September 8, 2000 the plots were evaluated for percent stand, plant height, and vigor. Percent cover for 'Appar' ranged from 40 – 45 percent and plants were 6 – 10 cm tall. The Maple Grove accession had a 65 – 75 percent stand and plants were 8 – 12 cm tall. Vigor for both accessions was good but the Maple Grove accession clearly had the best vigor.

Observations during the 2001 growing season indicated that the Maple Grove accession appeared to have a slightly better stand than 'Appar' but overall plant health and vigor were equal. On June 1, both accessions were flowering. On July 2, the plots were observed for seed ripeness and both accessions were in the late milk to early dough stage. On July 24, three randomly located 3 m (10 ft) plots were harvested from both accessions for seed yield comparison. All remaining Maple Grove plants were harvested for seed increase. Seed was bagged, allowed to dry, and cleaned.

On May 8, 2002 the trial was evaluated for basal cover and plant height. Maple Grove had 67 percent basal cover and averaged 28 cm tall. 'Appar' had 44 percent basal cover and averaged 31 cm tall. Plots were harvested for seed yield comparison a second time on July 19, 2002 using 2001 protocols. All Maple Grove plants were again harvested for seed increase.

Data in Table 6 show Maple Grove yielded 92 and 119 percent of what 'Appar' produced in 2001 and 2002, respectively. This difference in seed production must be qualified due to the substandard stand of 'Appar' as evidenced by basal cover data. Long-term yield data for Appar is 806 kg per ha (720 lbs per acre). By comparing these yield data for the Maple Grove germplasm (mean 632 kg per ha) to the long-term data of 'Appar', it is estimated that Maple Grove may produce seed yields of 70 to 90 percent of that of 'Appar'.

Table 6-Two-year comparative seed yields for Maple Grove Lewis flax and "Appar' blue flax at the Aberdeen PMC.

	Maple Grove		Appar	
Sample	2001	2002	2001	2002
	---------- kg/ha ----------			
1	636	422	472	162
2	632	504	744	781
3	640	960	852	796
Mean	636 (568 lb/a)	628 (561 lb/a)	689 (615 lb/a)	580 (518 lb/a)

The total 2001 harvest for Maple Grove germplasm at the Aberdeen PMC (including the sample data) was 1.89 kg of seed. This is equivalent to 404 kg per ha (361 lbs per a), which is 50 percent of the long-term yield of 'Appar'. In 2002, the total seed harvest was 2.18 kg or 465 kg per ha (415 lbs per acre), which is 57 percent of the long-term yield of 'Appar'.

Seed was not harvested from these plots in 2003 (to prevent contamination) because the Maple Grove plants had begun to die out and 'Appar' volunteer plants (from un-harvested seeds on neighboring rows) were becoming established in their place.

Drill rows of Maple Grove and 'Appar' were also planted at the Snow Field Station in 2000. As was the case at the Aberdeen PMC, Maple Grove produced a better stand than did 'Appar' at this site. Seed yields were compared by harvesting four replications of 10 plants from both flaxes for 2 years. Using these sampling protocols, we found that Maple Grove seed yield was 62 percent that of 'Appar' across 2 years. Approximately 8 kg (18 lbs) of Maple Grove Lewis flax G2 seed produced from this planting (3-year total) is in cold storage at the USDA Forest Service, Shrub Sciences Lab, Provo, UT. Seed was harvested 2 to 3 weeks earlier at this site than at the Aberdeen PMC.

Based on these data, we estimate that seed yield for Maple Grove germplasm will vary from 50 to 75 percent of what 'Appar' might yield when comparing similar stands.

Bushel weight of the Maple Grove seed harvested at the Aberdeen PMC in 2001 and 2002 was 18.6 and 18.1 kg (41 and 40 lbs) per bushel, respectively. Long-term bushel weight of Appar is 19.2 kg (47.5 lbs).

Maple Grove seed that was harvested in 2001 at the Aberdeen PMC was seeded on 0.7 ha (1.8 a) in field 3 of the same on May 31, 2002 and has been entered into certification with the Idaho Crop Improvement Association. A good stand was established. Seed yield in 2003 was 279 kg (615 lbs) or 383 kg per ha (342 lb per a). Test results indicate a purity of 99.2 percent and germ of 89 percent resulting in an inventory of 246 kg (542 lbs) pure live seed. Bushel weight was 17.6 kg (38.8 lbs).

Field longevity (sustained productivity) for Maple Grove Lewis flax will be evaluated at the Aberdeen PMC in coming years. The production field at Aberdeen will be replaced as needed using G2 seed currently in cold storage (USDA Forest Service, Shrub Sciences Lab) or G1 seed if available. The Forest Service will attempt to recollect seed from the original collection site to facilitate long-term maintenance of the germplasm.

Note 1-Reciprocal crossing trials using 10 North American Lewis flax, 10 European flax, and three 'Appar' flax (certified seed and two putative original collections) accessions were conducted in 1992 as part of a study to determine taxonomic affinities for these flax taxa. Cross-pollination of Lewis flax plants with 'Appar' and European plants produced essentially no viable seeds (high levels of fruit and seed abortion) while 'Appar' and European crosses yielded good levels of fruit set (92 to 100 percent) and fill (65 to 74 percent). An absence of off-types among regenerating seedlings in common garden and

seed production sites supports the conclusion that ‘Appar’ blue flax and North American Lewis flax populations have natural reproductive barriers that insure genetic isolation.

Environmental Evaluation of Plant Materials Releases

Name of person scoring: L. St. John **Date of scoring:** 2/27/03

Scientific Name: Linum lewisii **Common Name:** Lewis flax

Release Name: Maple Grove (proposed)

Is the plant native to the US? **Yes**

Is the plant native to the area of intended use? **Yes**

Authority used to determine native status: **USFS Shrub Sciences Lab**

What is the intended area of use for this plant? **Intermountain west**

What is the intended use for this plant? **Erosion control, biodiversity, beauty**

Areas in which the release is known to be invasive or has a high probability of being invasive:

Summary of Criteria from Section A	**Score**
Part 1. Impact on Habitats, Ecosystems, and Land Use	**3**
Part 2. Ease of Management	**17**
Part 3. Conservation Need and Plant Use	**6**
Part 4. Biological Characteristics	**39**

Final Determination of Release Based on the Environmental Evaluation:

X---- ☐ **OK to Release**

☐ **OK to Release but qualify use and intended area of use***

☐ **Do Not Release - NPL determines if release is made***

☐ **Do Not Release - document and destroy materials**

I certify that this Environmental Evaluation was conducted with the most accurate and current information possible.

/s/ Loren St. John 2/27/03

Signature of Person Scoring Date

Signature of NPL indicating that it is OK to make the release:

National Program Leader, PM **Date**

Section A. Scoring of Criteria for Impact, Management, Need and Biological Characteristics

Circle the appropriate number for each of the following criteria. Add up the scores for each part and record at the end of each part. Comments which clarify answers or provide supporting information may be included in the right margin of the worksheet or attached on a separate sheet of paper.

Part 1: Impact on Habitats, Ecosystems, and Land Use

This section assesses the ability of the species or release to adversely affect habitats, ecosystems, and agricultural areas.

1) **Ability to invade natural systems where the species does not naturally occur**
   a) Species not known to spread into natural areas on its own — 0
   b) Establishes only in areas where major disturbance has occurred in the last 20 years (e.g., natural disasters, highway corridors) — **3**
   c) Often establishes in mid- to late-successional natural areas where minor disturbances occur (e.g., tree falls, streambank erosion), but no major disturbance in last 20-75 years — 6
   d) Often establishes in intact or otherwise healthy natural areas with no major disturbance for at least 75 years — 10

2) **Negative impacts on ecosystem processes** (e.g., altering fire occurrence, rapid growth may alter hydrology)
   a) No perceivable negative impacts — **0**
   b) Minor negative impacts to ecosystem processes — 2
   c) Known significant negative impacts to ecosystems processes — 6
   d) Major, potentially irreversible, alteration or disruption of ecosystem processes — 10

3) **Impacts on the composition of plant communities where the species does not naturally occur**
   a) No negative impact; causes no perceivable changes in native populations — **0**
   b) Noticeable negative influences on community composition — 5
   c) Causes major negative alterations in community composition — 10

4) **Allelopathy**
   a) No known allelopathic effects on other plants — **0**
   b) Demonstrates allelopathic effects on seed germination of other plants — 3
   c) Demonstrates allelopathic effects to mature stages of other plants — 5

5) Impact on habitat for wildlife or domestic animals (aquatic and terrestrial), including threatened and endangered species (coordinate with USFWS and state Heritage Programs as appropriate)

a) No negative impact on habitat, or this criteria not applicable based on intended use for the plant **0**
b) Minor negative impact on habitat (e.g., decreased palatability; lower wildlife value; decreased value for undesirable animal species) 2
c) Significant negative impact on habitat (e.g., foliage toxic to animals; significantly lower value for wildlife; excludes desirable animal species from an area) 5

6) Impact on other land use

a) No negative impacts on other land uses **0**
b) Minor impacts (plant could invade adjacent areas and decrease its value) 3
c) Significant impacts (plant may alter the system or adjacent lands significantly enough to prevent certain uses) 5

Total Possible Points 45

Total Points for Part 1 3

Part 2. Ease of Management

This part evaluates the degree of management which might be needed to control the species or release if it becomes a problem, or eradicate the species or release if it is no longer desirable.

1) Level of effort required for control

a) Effective control can be achieved with mechanical treatment 0
b) Can be controlled with one chemical treatment 2
c) One or two chemical or mechanical treatments required or biological control is available or practical **5**
d) Repeated chemical or mechanical control measures required 10

2) Effectiveness of community management to potentially control the plant release

a) No management is needed, the plant release is short-lived and will significantly decrease or disappear within 5 years under normal conditions without human intervention 0
b) Routine management of a community or restoration/preservation practices (e.g., prescribed burning, flooding, controlled disturbance, pasture renovation) effectively controls the release **2**
c) Cultural techniques beyond routine management can be used to control the release 4
d) The previous options are not effective for managing or controlling the release 10

3) Side effects of chemical or mechanical control measures

a) Control measures used on release will have little or no effect on other plants — 0
b) Control measures used on release will cause moderate effects on other plants — **3**
c) Control measures used on release will cause major effects on other plants — 5

**If spreads by seed, or both seed and vegetative means, go to #4
**If spreads by vegetative means only, go to #5

4) Seed banks

a) Seeds viable in the soil for 1 year or less — 0
b) Seeds remain viable in the soil for 2-3 years — 1
c) Seeds remain viable in the soil for 4-5 years — **3**
d) Seeds remain viable in the soil for more than 5 years — 5

5) Vegetative regeneration under natural conditions

a) Regeneration from resprouting of cut stumps — **1**
b) Regeneration from pieces of the root left in the soil — 3
c) Regeneration from root or stem parts left in the soil — 5

6) Resprouts after cutting above-ground parts

a) Does not resprout or resprouts but the release is sterile and does not produce seed — 0
b) Resprouts and produces seed in future years — **3**
c) Resprouts and produces seed in same year — 5

Total Possible Points 40
Total Points for Part 2 17

Part 3. Conservation Need and Plant Use

This part evaluates the importance of the species or release to meet a conservation need.

1) Potential Use(s) of the Plant Release

a) Used for low-priority issues or single use — 1
b) Has several uses within conservation — **2**
c) Has many uses within conservation as well as outside of conservation — 4
d) Has high-priority use within conservation — 5

2) Availability of Other Plants to Solve the Same Need

a) Many other plants available — 1
b) Few other plants available — **3**
c) No other plants available — 5

3) Consequences of Not Releasing This Plant

a) No impact to conservation practices	0
b) Minor impact on one or more conservation practice	**1**
c) Serious impact on one conservation practice	3
d) Serious impact on more than one conservation practices	5
Total Possible Points	**15**
Total Points for Part 3	**6**

Part 4. Biological Characteristics

This part evaluates the biological properties which indicate the natural ability of the species or release to propagate and maintain itself under natural conditions. Note: these criteria relate to the species under natural conditions, as opposed to the species under managed conditions used to increase the species, i.e. seed increase programs, or specific propagation methods which do not normally occur in nature.

1) Typical mode of reproduction under natural conditions

a) Plant does not increase by seed or vegetative means (skip to #11)	0
b) Reproduces almost entirely by vegetative means	1
c) Reproduces only by seeds	**3**
d) Reproduces vegetatively and by seed	5

2) Reproduction (by seed or vegetative) in geographic area of intended use

a) Reproduces only outside the geographic area of intended use	1
b) Reproduces within the geographic area of intended use	3
c) Reproduces in all areas of the United States where plant can be grown	**5**

3) Time required to reach reproductive maturity by seed or vegetative methods

a) Requires more than 10 years	1
b) Requires 5-10 years	2
c) Requires 2-5 years	3
d) Requires 1 year	**5**

** If reproduces only by seed, skip to #5

4) Vegetative reproduction (by rhizomes, suckering, or self-layering)

a) Vegetative reproduction rate maintains population (plant spreads but older parts die out)	1
b) Vegetative reproduction rate results in moderate increase in population size (plant spreads <3' per year)	3
c) Vegetative reproduction rate results in rapid increase in population size (plant spreads >3' per year)	5

** If reproduces only vegetatively, skip to #11

5) Ability to complete sexual reproductive cycle in area of intended use

a) Not observed to complete sexual reproductive cycle in the geographic area of intended use, but completes sexual reproduction in distant areas of the United States — 1

b) Not observed to complete sexual reproductive cycle in the geographic area of intended use, but completes sexual reproduction in adjoining geographic areas — 3

c) Observed to complete the sexual reproductive cycle in the geographic area of intended use — **5**

6) Frequency of sexual reproduction for mature plant

a) Almost never reproduces sexually — 0

b) Once every five or more years — 1

c) Every other year — 3

d) One or more times a year — **5**

7) Number of viable seeds per mature plant each reproductive cycle

a) None (does not produce viable seed) — 0

b) Few (1-10) — 1

c) Moderate (11-1,000) — **3**

d) Many-seeded (>1,000) — 5

8) Dispersal ability

a) Limited dispersal (<20') and few plants produced (<100) — 1

b) Limited dispersal (<20') and many plants produced (>100) — 3

c) Greater dispersal (>20') and few plants produced (<100) — **7**

d) Greater dispersal (>20') and many plants produced (>100) — 10

9) Germination requirements

a) Requires open soil and disturbance to germinate — **1**

b) Can germinate in vegetated areas but in a narrow range or in special conditions — 5

c) Can germinate in existing vegetation in a wide range of conditions — 10

10) Hybridization

a) Has not been observed to hybridize outside the species — **0**

b) Hybridizes with other species in the same genera — 3

c) Hybridizes with other genera — 5

11) Competitive ability (of established plants)

a) Poor competitor for limiting factors	0
b) Moderately competitive for limiting factors	**5**
c) Highly competitive for limiting factors	10
Total Possible Points	**70**
Total Points for Part 4	**39**

References

Many of the criteria used in this rating system were adapted from the following sources:

Hiebert, Ron D. and James Stubbendieck. 1993. Handbook for Ranking Exotic Plants for Management and Control. US Department of the Interior, National Park Service, Denver, CO.

Randall, John M., Nancy Benton, Larry E. Morse, and Gwendolyn A. Thornhurst. 1999. Criteria for Ranking Alien Wildland Weeds. The Nature Conservancy, Arlington, VA.

Section B. Scoring and Interpretation

Based on the scores from above, circle the points range you scored to determine the appropriate interpretation. The interpretation will be used to determine the course of action for the release.

Part	Points Scored	Interpretation
Part 1. Impacts on Habitats, Ecosystems, and Land Use	0-15	**Low** chance plant is going to affect the environment
	16-25	**Mod**erate chance plant is going to affect the environment
	26-45	**High** chance plant is going to affect the environment
Part 2. Ease of Management	0-20	**Easy** to control
	21-30	**Mod**erate to control
	31-40	**Diff**icult to control
Part 3. Conservation Need and Plant Use	0-5	**Low** need
	6-9	**Mod**erate need
	10-15	**High** need
Part 4. Biological Characteristics	0-25	**Low** chance plant is going to propagate and increase itself
	26-40	**Mod**erate chance plant is going to propagate and increase itself
	41-70	**High** chance plant is going to propagate and increase itself