THE SELECTION OF NATIVE PLANTS FOR USE IN THE MONTANA LANDSCAPE: SELECTION CRITERIA, AESTHETIC, CULTURAL AND ENVIRONMENTAL EVALUATION.

By

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of the requirements for the degree

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VITA

Shelly Marie Engler Bruce, daughter of George and Laurene Engler, was born September 29, 1959 in Red Lodge, Montana. She received her elementary and secondary education in Great Falls, Montana where she graduated from high school in June, 1977.

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ABSTRACT

During the past 15 years the landscape industry has experienced increased pressure to use native plants as ornamentals. Although a demand for natives in general exists there has been a reluctance on the part of the industry to offer native species because of the economic risks involved. An ornamental scorecard was developed as an evaluation tool for comparing native plant species with plant species currently available on the ornamental market. The scorecard evaluated 24 native Montana plant species and 20 exotic ornamentals commonly used in the landscape industry in Montana. The aesthetic scorecard rated six visual characteristics using color photographs. Scored were form/habit, flower, fruit, bark, leaf, and seasonal characteristics. The thirteen environmental factors evaluated by the environmental scorecard were transplantability, lifespan, propagation, maintenance cleanlines, soil texture and pH, moisture regime adaptability (both drought and flood tolerance), exposure tolerances (temperature, light, and wind), insect resistance, and disease resistance. Species were scored by a panel of professional evaluators in the botany, horticulture, nursery and landscape design/architecture fields. These scores allow selection of native plant species with visual and or functional qualities that are of equal or greater value than those exhibited by plants already available on the retail market, and thus exhibit competitive marketing potential.

CHAPTER 1

PROBLEM STATEMENT

Of all the native plant species found in the diverse flora of the western United States, few are being used as ornamentals by members of the landscaping industry (Blaisdell, 1971; Box, 1974; Stark, 1971; Van Dersal, 1938; Van Dersal, 1971). Several reasons for this lack of recognition have been proposed. Sutton (1974) outlined four obstacles preventing the specification of natives in landscape plans: (1) a lack of information regarding the benefits of using native plants available to the landscape profession; (2) the lack of factual information available on individual native species; (3) the lack of case studies and landscape plans utilizing native plants to act as a reference for comparing and critiquing a designer's own work; and (4) the fact that retail nurseries have not found it necessary or profitable to carry native plant materials. Pesman (1961) agrees with this fourth reason and adds two more of his own: (1) the public's perception of natives as weeds, and (2) the difficulty of transplanting native shrubs.

The lack of availability of native plants lies primarily with the wholesale and retail nursery trade, because a nurseryman cannot afford to market a new species until a demand for that species exists and propagation and production methods have been established (McWilliams and Welch, 1975; Tipton and McWilliams, 1979).

With the demand for native plants on the rise (Dickerson and Hadle, 1977; Jewett et al, 1980; Martin, 1974; Steger and Beck, 1973), there are currently available references containing: (1) factual information on various species (Anderson, 1969; Arno et al, 1980; Hightshoe, 1978; Hitchcock and Cronquist, 1981; Huddleston and Hussey, 1975; Johnson, 1970; Kelly, 1970; Kruckeberg, 1982; Stark, 1966; Sutton, 1974; U.S.D.A. 1981; Van Dersal, 1938; Wasser, 1982); (2) information on the benefits of using native plants (Burdick, 1975; Diekelmann and Schuster, 1982; Dorney, 1975; Jewett, 1980; McKell et al, 1971; McWilliams and Welch, 1975; Morrison, 1975; Smyser, 1982; Sutton, 1974; Tipton and McWilliams, 1979; Van Dersal, 1938; Walters et al, 1977; Wilson, 1984); and (3) case studies for professionals to study and compare (Dorney, 1975; Morrison, 1975; Sutton, 1974; White, 1982).

But there is still a lack of information on the criteria and process for selecting natives for the ornamental trade.

OBJECTIVES

The objectives of this thesis are to:

1) summarize current information available on the use and merits of native species;
2) establish criteria for selecting native plants for use as ornamentals in the nursery trade;
3) establish a method of scoring plant species for use by nurserymen

in determining which natives exhibit high potential as competitive retail ornamentals;

4) provide information on propagation techniques and cultural requirements for selected native species that exhibit this potential and thus, further their transition from the wilds to the retail marketplace.

CHAPTER 2

LITERATURE REVIEW

Introduction

Historically, plant species exotic to the western United States have been the primary ornamental plants available for landscaping. The extensive use of exotic ornamentals is a result of several factors. First, introduced species are readily available on the commercial market. Historically, these exotic ornamentals have been planted successfully in European landscapes, and last is the ancestral influence of European gardening on American landscapes. Exotic species continue to be introduced to the built environment as soil stabilizers, reclamation species, and ornamentals. These species are valuable contributions to the plant palette available to the landscaping industry (Jones, 1980; Mortenson, 1979; Mulford, 1981).

Native plant species have also been used for soil stabilization, erosion control and reclamation (Badger, 1976; Burdick, 1975; Edmunson, 1975; USDA, 1981; Van Dersal, 1938a; Van Dersal, 1938b; Van Dersal, 1971; Wasser, 1982). They are also important in the establishment and maintenance of good wildlife habitat (Croeni and McKibben, 1975; Monsen and Christensen, 1975; Robinette, 1971).

Although the concept of using natives in the built landscape is not new (Tipton and McWilliams, 1979), the past decade has shown an increasing awareness of and demand for a wide variety of native species (Dickenson and Hadle, 1977; Havlik, 1975; Jewett et al, 1980; Martin, 1974; Steger and Beck, 1973). This interest has risen primarily due to the hardiness, tolerance, water conserving, and low maintenance qualities of many native plants (Folkner, 1964; Pesman, 1961; Randon, 1980; Witt and Witt, 1978). Along with this interest in natives there has arisen an interest in re-creating ecotypes typical of a given locale, and in preserving historic landscapes (Dorney, 1975; Diekelmann and Schuster, 1982; Hardesty and Whitenberg, 1976; Moore and Bell, 1974; Morrison, 1975; White, 1982).

Another valuable aspect of native landscaping is the aesthetic blending of a manmade environment with its rural surroundings. By using native plants in the man-made landscape the character of the surrounding landscape can be brought into the built environment, blending the two into a single harmonious design preserving the landscape character of the region (Simonds, 1983).

Naturally, this increased interest in native plants has given rise to numerous publications on gardening with natives (Diekelmann and Schuster, 1982; Everett, 1965; Folkner, 1964; Huddleston and Hussey, 1975; Kelly, 1979; Kelly, 1980; Kruckberg, 1982; Labadie, 1978;Mc Williams and Welch, 1975; Smith and Smith, 1980; Smyser, 1982; Spurr, 1978). This interest and the increased exposure of native plants has created a demand for natives at the retail level. In Montana, certain species have become very popular and are commonly

available, often in horticulturally modified forms such as, Green Ash (Fraxinus pennsylvanica Marsh.) Shrubby Cinquefoil (Potentilla fruticosa L.) and Redtwig Dogwood (Cornus stolonifera L.). But the selection of other native species for exposure seems to be a very arbitrary and subjective process.

The following review will explore the aforementioned uses of native plants, document the case for and against using natives as ornamentals, and review criteria neccessary for selecting ornamental plant species.

Uses, Merits and Disadvantages of Native Plants

Land resource managers have been using native species to preserve and restore natural resources for many years. The importance of native vegetation in wildlife habitat has long been recognized (Robinette, 1971; Van Dersal, 1938). Van Dersal (1938) in his work Native Woody Plants of the United States concentrates on the value of woody plants, native to the United States, as soil stabilizers and wildlife food and cover providers. Van Dersal states "...our first choice of species for planting on a given site should be those that have already been tested for such a site; that is, species native to the region in question." (Van Dersal, 1938, p. 13-14). One of the first recognized uses for native shrubs was for game and livestock forage (Blaisdell, 1971). A cooperative effort between the Soil Conservation Service and the California Department of Fish and Game has been ongoing since 1966 (Croeni and McKibben, 1975). The project

is designed to select various native shrub species suitable for providing food and cover for wildlife.

Monsen and Christensen (1975) outline the importance of shrubs for rehabilitating range lands. One of their selection criteria is that a species must provide forage, groundcover and protection for animals. A second is that the plants be adapted to the planting sites. Both introduced and native species that satisfy these criteria are being studied. Much of the research that has been done on shrubs has been limited to browse species (Blaisdell, 1971; Monsen and Christensen, 1975). There remains much research to be done in other areas (Blaisdell, 1971; Monsen and Christensen, 1975).

The work by Van Dersal (1938) cited earlier also recognizes the importance of native woody plants in soil stabilization. This role goes hand in hand with the more recent concern about revegetation of disturbed lands and mining sites (Weddle, 1984). Burdick (1975) stresses the need for commercial sources of native plants. In order to restore the environment to its natural state, native plant communities must be re-established to provide for wildlife habitat, seasonal grazing use, and acceptable aesthetic levels. The Upper Colorado Environmental Plant Center was created to develop native plant varieties and assure their commercial availability for reclamation of mined areas (Burdick, 1975). The Soil Conservation Service Plant Materials Center in Manhattan, Kansas was founded to select plant materials for reclaiming coal surface mines (Badger, 1976). A similar program at the Soil Conservation Service Plant Materials Center in Tuscon, Arizona selects plants for range improvement, soil

stability, salinity control, shelterbelts and Christmas trees (Holzworth, 1979). Although there is a general lack of research and information available on species suitable for revegetation (Burdick, 1975; Stark, 1976; USDA, 1981), the recent thrust in this direction has produced several good resources on species, both exotic and native, suitable for revegetating disturbed lands in the west (Stark, 1966; USDA, 1981; Wasser, 1982).

Another key factor which has brought the subject of native plants visibility is that of drought tolerance. All native plants are not drought tolerant, different native species have different moisture requirements, as do exotics (Hildreth, 1977). But whether it be highway right-of-way plantings, mining revegetation or residential landscape plantings, the concern over water availability in the arid and semi-arid regions of the West is making the selection of drought tolerant plants critical (Edmunson, 1975; Riley, 1977; Rodiek, 1984; Rondon, 1980; Rooke, 1974; Starr, 1983; Texas, 1984). Several western cities have enacted programs stressing water conservation through landscaping with low-water-requiring and native plants: Sacramento, California (Riley, 1977); Aurora, Colorado (Rondon, 1980); and, Austin, Texas (Texas, 1984). The program in Austin is a part of the larger "Go Native-Plant Texas" program which is encouraging the research, preservation and use of native Texan plants in general.

More water can be saved by a well-managed landscape than by savings inside the home (Rondon, 1980). The use of drought tolerant plants may be part of this well-managed landscape (Rooke, 1974). Species that are indigenous to an area are adapted to that moisture

regime. So, if drought tolerant plants are being sought in a xeric climate the plants native to that environment should be explored (Rondon, 1980). "It appears then that, in the arid west, one solution to the water shortage (and distinctively picturesque landscaping, with a minimum of frustrating struggle) lies in the use of materials naturally available" (Rooke, 1974, p. 21). This concept is probably applicable throughout the west. Exotic plants adapted to similar climates should also be explored (Starr, 1983).

As with moisture adaptation, native plants are adapted to other climatic factors of their native ranges. Native plants often survive extreme weather conditions that kill introduced species (Folkner, 1964; McWilliams and Welch, 1975). In addition, native plants are usually resistant to the insects and diseases of their native range. This is not to say that native plants are free from insects and disease; they are not; but few suffer devastating damage from native pathogens (Steger and Beck, 1973; Wilson, 1984). However, natives may be susceptible to severe damage from introduced insects or diseases in cultivated situations, while introduced plants are adapted to these pests. Also, native plants may host insects and pathogens that are detrimental to nearby exotics.

An additional adaptation of natives favoring their selection as ornamentals is the ability to reproduce themselves in their native environment where introduced species often have their life-cycles interrupted by adverse conditions (McWilliams and Welch, 1975).

The low maintenance benefits of using native plants are only benefits if the species being planted are properly selected, provided

with the proper environment, and properly cared for. When selecting species for a given location care must be taken to select plants that are indigenous to similar environments (Conner, 1977; Finch, 1977; Sutton, 1975; USDA, 1981; Van Dersal, 1971). If environment is not considered, the desirable qualities of a plant may be negatively affected (Conner, 1977; Finch, 1971; Stark, 1971; Sutton, 1975; USDA, 1981). "Whenever a low-maintenance shrub is moved from its native habitat to one with different diseases, insects, and environmental stresses, there is no assurance that it will be 'low-maintenance' in the new habitat" (Stark, 1971, p. 80).

Any wild species must adjust to cultivation practices (Warner, 1977). When cultivating native plants traditionally proper care may be improper. Native plants, when moved and placed under cultivation, are stressed and predisposed to disease by tender care and other detrimental environment modifications (Finch, 1977). Giffen (1979) outlines four frequent problems occuring with cultivated natives: (1) leaf sunburn or leaf drop due to an increase or decrease in light; (2) unseasonal and potentially vulnerable growth due to increased and untimely fertilization and irrigation; (3) adverse effects on beneficial soil microorganisms due to fertilization and irrigation, which often disrupts the natural balance between the plant and these organisms; and (4) other dramatic stress factors of the urban environment.

Sutton (1975) cautions further on landscaping with native plants: (1) the interaction of climate, soil, topography, location and biota should not be ignored when dealing with native landscapes;

(2) maintenance is necessary to keep the proper successional species in tune with the ecologic niche of the planting site, and to preserve design continuity; (3) present quality and quantity of native plant stock is not equal to standard nursery stock. Neither is the information available on propagation, culture and use of natives equal to that available on common ornamental materials. Often plants or seed collected from the wild is used and results in failure due to disease or weakened collected plants or seed untested for germination or origin.

Hildreth (1977) reiterates some of Sutton's concerns, and has further concerns about misconceptions surrounding natives. First, is the myth that all natives are drought tolerant. Natives are as diverse in moisture requirements as the West is varied in environments. Second, are the statements that natives require no maintenance. Although many natives, if properly placed, are low-maintenance once established, the initial establishment period is maintenance intensive (Havlik, 1975; Hildreth, 1977; Wilson, 1984), and care of natives in the nursery is equal to that necessary for other nursery stock. Hildreth's final three concerns are widespread ones and will be discussed in detail.

The first is the popular mandate that only natives be planted. Although native plants can and do often offer ideal solutions to a difficult planting problem, the selection of native species for the sake of using natives is not a wise or acceptable practice (Conner, 1977; Hildreth, 1977; Warner, 1977; USDA, 1981). The pressure to plant native species sometimes results in the use of unadapted native

ecotypes instead of adapted introduced species (USDA, 1981). Neither is the selection of an introduced species justified simply because it has been the traditional ornamental commercially available. The historic mandate to plant and sell exotics has sometimes resulted in failure. Selection of a species should be determined by the planned use, intended function and specific site conditions, not on whether a plant is native or introduced (Warner et al, 1977; USDA, 1981). In urban/suburban gardens the luxury of choice is deserved (Hildreth, 1977).

A second widespread concern about native ornamentals is the lack of communication among professionals specifying, producing and planting native plants (Hildreth, 1977; Sutton, 1974). Information as to what native plants are available from wholesalers, planting techniques, culture, native range, and use is necesssary so natives are specified which are adapted to the site, planted correctly and maintained properly such that a successful landscape is realized (Sutton, 1974).

A final concern is the collecting of seed and plants from the wild, with resulting endangerment of native plant species (Hildreth, 1977; Steger and Beck, 1973; Walters, 1977). Steger and Beck (1973) summarize the problems of unauthorized removal of native plants from western U.S. rangelands. Not only may the existence of a particular species be threatened, but impacts on insects, wildlife and associated species may be devastating as well (Steger and Beck, 1973; Tipton and McWilliams, 1979; Wilson, 1984).

Collection from public and private lands is prohibited without special permission. Most States have passed legislation protecting native plant species from unlawful collection on public lands (Sacamano and Jones, 1975). Enforcement of these laws is difficult so further measures must be taken to preserve our native plant heritage. The State of Arizona is a front runner in legislative protection of its native flora (BLM, 1980; Countryman, 1979). Native plant societies can do much to create awareness of native plant issues. The California Native Plant Society has established a policy to reduce environmental impacts by their members (Hildreth, 1977).

Propagation instead of collection of native species assures their continued existence. Vegetative and seed propagation of natives to increase their availability on the market will reduce collection of plants from the wild (Countryman, 1979). Careful and intelligent research, propagation and culture will, in many cases, increase the population of a rare species (Countryman, 1979; Monsen, 1975). Such was the case with the Texas Madrone (Arbutus xalpanesis v. texana (Buckl.) A. Gray), for which successful propagation was reached only after years of research (Hardesty and Whitenberg, 1976), but numbers are now increasing as a result of this research.

Along with the preservation and propagation of native species, another valuable aspect of native landscaping is that of the creation and preservation of historic landscapes and community ecotypes (Diekelmann and Schuster, 1982; Dorney, 1975; Kropp, 1975; Martin, 1974; Morrison, 1975; Wilson, 1984). Diekelmann and Schuster (1982) wrote an entire volume on the concept of designing with native plant

communities. The value of plant community re-creation is four-fold. First, landscaping with native plant communities makes a regional statement (Morrison, 1975). By using locally native plants in the manmade landscape, in a natural setting, the character of the surrounding landscape can be brought into the built environment, blending them into a single harmonious design, preserving the landscape character (Simonds, 1983). It is this landscape character that reinstates differences between regions and between micro-habitats within regions (Morrison, 1975).

Second, is the addition of an historical element into the landscape (Diekelman and Schuster, 1982; Morrison, 1975; Wilson, 1984). Typical urban landscapes reflect linkage to our European heritage, they are not an expression of our natural landscape heritage (Dorney, 1975). The merits of historic community representation are: (1) visual and auditory continuity with previous plant communities; (2) visual reinforcemment of our native heritage; and (3) the addition of an educational element into the landscape (Diekelmann and Schuster, 1982; Dorney, 1975; Morrison, 1975).

Third, is the possibility of creating a reservoir of species that are, or may otherwise become, rare , threatened or endangered (Diekelmann and Schuster, 1982; Morrison, 1975).

And lastly, plant community re-creation provides an increase in the experience potential of a landscape. A natural landscape is dynamic and provides for a wide variety of experiences that the Standard Accepted Designed Environment (Morrison, 1975) may not allow. Many native communities allow for natural reproduction, community

composition and greater seasonal variety than do some traditional landscapes. Today the experiences available in the designed landscape are important due to the loss of the natural landscape to development (Martin, 1974; Morrison, 1975)

Several sources on natural community re-creation are available. Kropp (1975) outlines procedures for re-creating and preserving the prairie landscape through a monthly log. Morrison (1975) describes two case studies where native communities were restored on two different disturbed Wisconsin sites. Dorney (1975) provides guidelines for re-creating an historic early Ontario landscape on a residential lot. White (1982) explores the idea of using "visual essence' species to create the illusion of a plant community.

It should be noted here that re-creation does not replace preservation.

Several other examples of native landscaping are available to examine, critique and compare. Many botanic gardens and arboreta have native plant areas in their collections, and several botanic gardens across the country specialize in native plants (Hammitt and Wagner, 1972; Havlik, 1975; Moore and Bell, 1974). In Superior, Arizona, the Boyce Thompson Southwestern Arboretum has over sixty years of experience in cultivating, studying and comparing native and exotic desert plants. This arboretum has an excellent education and research program, much of which is dedicated to native plants, their ecology, culture and uses (Crosswhite, 1981a; Crosswhite, 1981b).

In the western United States the State of California, a leader in the native plant movement, has three botanic gardens which specialize

in native plants: Rancho Santa Ana Botanic Garden in Claremont, Santa Barbara Botanic Garden in Santa Barbara and Regional Parks' Botanic Garden in Berkeley. These gardens are dedicated to preservation, research, education, and introduction of California natives into the horticultural trade (Havlik, 1975).

Kruckeberg (1982) lists several public plant collections that include native plant sections. Other sites where natives are in cultivation include plant material centers, highway plantings and private gardens. Kruckeberg (1982) and Wilson (1984) both have extensive lists of sources of native plants and native plant societies. Sutton (1974) outlines two case studies using native Utah species on two different sites owned by the State of Utah. There are several popular articles and books available as how-to resources (Diekelmann and Schuster, 1982; Huddleston and Hussey, 1975; Kruckberg, 1984; Odenwald, 1960; Smyser, 1982; Stark, 1974). Visibility of native plants in the built environment will initiate further research and increase the use of native plants as ornamentals (Tipton and McWilliams, 1974).

Selection and Scoring of Native Plants

Although the bulk of the research on native plants has been in the areas of wildlife browse and nutritive values (Blaisdell, 1971; Monsen and Christensen, 1975), and more recently in reclamation (Stark, 1966; USDA, 1981; Wasser, 1982), the value of native plants as ornamentals has long been recognized (Tipton and McWilliams, 1979).

Henry David Thoreau (1960) recognized the beauty of our native vegetation, and natural landscape as early as 1854. In 1868 Frederick Law Olmstead specified the preservation of Strawberry Canyon as a natural backdrop to the University of California (Wilson, 1984). Ornamental value of native Atriplex species in southern California was reviewed by Griffith in 1910. Van Dersal has been studying the uses of native plants ornamentally and as erosion control and wildlife cover since the 1930´s (Van Dersal, 1938; Van Dersal, 1942; Van Dersal, 1972). In 1937 Parks recognized the ornamental value of many Texas natives (Parks, 1937). Sutton (1974) reviews the historical philosophical evolution of native plants as ornamentals and of natural landscaping. Through the thoughts of six horticulturists landscape architects/gardeners Sutton illustrates the theory and practice of native plant use at a natural level of design throughout the twentieth century.

Botanists and plant collectors have long sensed the value of native North American plant species as ornamentals. These early explorers collected seed and specimens to send back to Europe where they have been grown and cultivated and finally, returned to their native home (Hildreth, 1977; Mc Williams and Welch, 1975). In 1929, 487 plant species were being cultivated in England as ornamentals but were not being grown in their native country, the United States (McWilliams and Welch, 1975). "Many plants become popular ornamentals in their native environments only after being developed elsewhere" (Arbegast, 1975; Tipton and McWilliams, 1979). But successful reintroduction of exported native species is not a consistent,

reliable process. Many times promising species are not adapted to the foreign environment and so are never established as ornamentals (Tipton and Mc Williams, 1979). Native plants aren't being researched and developed in their native ranges because the exotic plants always seem to be preferred (Arbegast, 1975). Moreover, the exotic plant is usually the one available. The intrinsic value of native plants is not yet widely recognized (Mc Williams and Welch, 1975; Pesman, 1961; Sutton, 1974).

In order for this value to be recognized several things must happen. First, the understanding of the potentials and limitations of native plants must keep pace with the demand for them (Havlik, 1975). Second, examples of native landscapes must be visible (Rooke, 1974; Sutton, 1974). The aforementioned gardens and case studies are good examples making native plants visible. The numerous native plant societies are also making the case for native plants more visible while at the same time helping to preserve them.

Third, information concerning the merits of using native species must be made available to all branches of the landscaping industry, increasing communication effectiveness.

And fourth, further research on promising indigenous species must be undertaken. Information on selection, breeding, propagation, cultural requirements and use must be established so native species can compete with currently marketed ornamentals.

Tipton and Mc Williams (1974) developed a schematic diagram illustrating a proposed pathway for the successful transition of a native plant into an established ornamental.

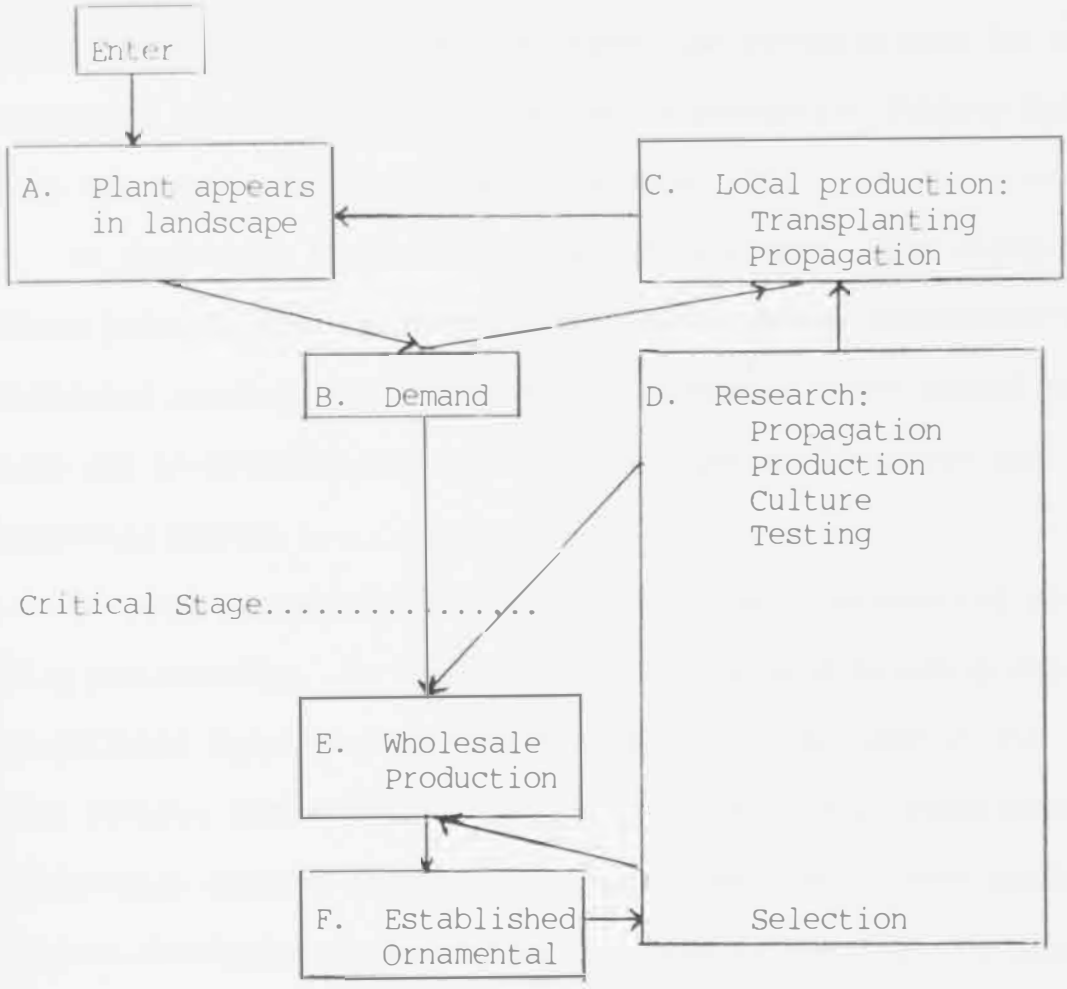


Figure 1. Tipton and Mc Williams. 1974. Commercializing native plants as ornamentals. p.10.

The first step (A) is appearance of a native plant in the built landscape. This may be in any of the examples already mentioned, highway plantings, botanic gardens, private gardens, etc. This public visibility may create a local demand for that particular native species (B). This demand stimulates local production (C) which in turn increases visibility and demand. This demand spurs research on the species in the areas of propagation, production, culture and selection

and breeding (D). If a feasible production schedule that is profitably promising is found, wholesale production follows and the plant may become an established ornamental (F).

In this cycle there are two selection phases. The first one occurs prior to the appearance stage, when someone determines that a particular species has promise as an ornamental. The second selection stage (D) is breeding and selection of superior forms for the commercial market.

Breeding and selection of improved forms of ornamental plants is not a new practice. In the case of native plants breeding research has followed the same progression as already described in the use and merit review, from wildlife habitat creation to soil stabilization to reclaimation species to ornamental landscape plant. Most breeding research developing native shrubs has been in the areas of forage, erosion control and land reclamation (Monsen and Christensen, 1975).

Selection of plant species, whether native or introduced, is dependent upon the function the plant will perform. By observing how native species function in their own natural communities it is possible to select plants to carry over natural functions into the artificially constructed landscape (Crosswhite, 1981b).

When studying 70 forb species for potential value in revegetation work, Van Dyke and Currah (1983) selected species based on their soil stabilizing properties, ability to compete with other less desirable species, food and shelter providing qualities and aesthetic characteristics. Monsen and Christensen (1975) set three criteria species must meet as range restoration plants, (1) plants must be

adapted to the site, (2) species must also provide forage, groundcover and protection to animals, and (3) seedlings must be highly successful in establishing and surviving to maturity. For ornamental use Conner (1977) states that native plants must be selected on the basis of criteria that are established by the landscaping industry, (1) the species must be commercially available, (2) the plant must be superior or equal in quality, as free from disease and pest problems, and equally adaptable functionally as other plants that are available and suited to the same purpose, (3) the plant must perform well in situations in which few other plants survive, and (4) economics must permit the purist viewpoint of native landscaping.

Different selection criteria are used by arborists when selecting street trees. Space restrictions, soils, microclimate, and risk of injury by disease and insects have been determined to be major considerations when selecting street trees (Gerhold et al, 1979). Plant appraisers use still different criteria when determining plant value; species, size and physical condition are the criteria. As these examples illustrate selection criteria are primarily determined by the function the plant is intended to perform and many times a plant can meet these criteria only if it has been adequately researched.

Kenneth Brooks (1977) sets forth the information needs of landscape architects and horticulturists on plant materials they use. Brooks found that these professionals needed information on environmental and cultural adaptation, landscape value and use, and

commercial availability. These categories should define the criteria for selecting plants as ornamentals.

The process of scoring plants for different purposes is not new. Field scoring is a common practice of agronomic crop researchers, as is disease scoring by plant pathologists. But little work has been done in this area with aesthetic characteristics of ornamental plants.

Ray (1983) developed an evaluation system that rated several trees for the northern United States using a numeric scoring system. A survey was designed which rated 51 tree species on ten different characteristics and awarded point values accordingly. Ray scored each species on shape (10), fall color (10), winter interest (10), cleanliness (5), disease resistance (10), pest resistance (10), hardiness (10), and life expectancy (5). (Point values assigned to each category are shown in parentheses.) Additional penalties and bonuses were given for other adverse or enhancing characteristics. Total point scores were then compared and the species ranked according to these scores. Numeric distinction between species was minimal or non-existent in many cases. No statistical analysis to indicate significant differences was conducted. This scoring process successfully created a rating system that allowed comparison of 51 tree species for ten factors and for overall performance.

At the present time the preappearance selection process is extremely subjective. The two primary objectives of this thesis are to: (1) establish criteria for selecting native plants for use as ornamentals in the nursery trade, and (2) to establish a method of scoring plants on these criteria in order to provide a basis for

determining which natives exhibit high potential as competitive retail ornamentals.

CHAPTER 3

METHODS AND MATERIALS

In order to provide a basis for selecting native plants that will have a market demand and compete economically with exotic ornamentals already on nursery lists an ornamental scorecard was developed. This scorecard was designed to rate plant species on aesthetic characteristics and environmental qualities.

Forty-four plant species were chosen for scorecard evaluation (Table 1). Of these, twenty-four were native species selected using four primary factors. They must: (1) be native to Montana; (2) not be readily available on the commercial ornamental market; (3) exhibit obvious visual characteristics that give promise for ornamental use; and (4) be available for photographing in a cultivated situation.

In addition to satisfying these criteria the native species scored in this project had to exhibit ornamental potential. The definition of ornamental potential and the selection of species that exhibit this potential is a somewhat arbitrary process. This author defined ornamental potential as the outward promise of a plant species to provide positive visual and/or functional qualities that are of equal or greater value than those exhibited by plants already available on the retail market.

The value potential of the 24 native plant species scored by this research was determined through the literature search. Appendix E

cites current use and value references supporting the selection of these species for their aesthetic characteristics and/or functional qualities.

Exotic ornamentals were selected on the basis of their availability on the retail market in Montana. All are commonly used in Montana landscapes, readily available on the commercial ornamental market, and are not native to Montana. Exotic species were selected that could be paired with the native species for a future consumer preference test.

Table 1. Species scored by the ornamental scorecard.

CODE	SCIENTIFIC NAME **	COMMON NAME
	GROUNDCOVERS	
ANMA	Anaphalis margaritacea (L.) B. & H. *	Pearly Everlasting
ANRO	Antennaria rosea Greene *	Pink Pussytoes
ARCA	Artemisia cana Pursh. *	Silver Sage
ARFR	Artemisia frigida Willd. *	Fringed Sage
ERUM	Eriogonum umbellatum Torr. *	Sulfur Buckwheat
SPBE	Spiraea betulifolia Pall. *	Shiny-leaf Spirea
AJRE	Ajuga reptans L.	Bugleweed
CETO	Cerastium tomentosum L.	Snow-in-Summer
POTA	Potentilla tabernaimontanii Asch.	Spring Cinquefoil
SESP	Sedum spurium Bieb.	Dragon's Blood Sedum
VIMI	Vinca minor L.	Periwinkle

* Indicates species is native to Montana

Table 1. (Con't)

CODE	SCIENTIFIC NAME **	COMMON NAME
	CONIFEROUS TREES	
ABGR	Abies grandis (Doug. ex D.Don) Lindl. *	Grand Fir
ABLA	Abies lasiocarpa (Hook.) Nutt.*	Alpine Fir
PIEN	Picea engelmannii Parry ex. Engelm. *	Engelmann Spruce
PICO	Pinus contorta v. latifolia Engelm. *	Lodgepole Pine
ABCO	Abies concolor (Gord. & Glend.) Lindl.	Concolor Fir
PIGL	Picea glauca (Moench) Voss v. densata	Black Hills Spruce
PIPU	Picea pungens Engelm.	Colorado Spruce
PISY	Pinus sylvestris L.	Scotch Pine
	VINES	
CLLI	Clematis ligusticifolia Nutt. *	Western Clematis
PAQU	Parthenocissus quinquefolia (L.) Planch.*	Virginia Creeper
HULU	Humulus lupulus L.	Hops
LOSE	Lonicera sempervirens L.	Trumpet Honeysuckle Vine
	DECIDUOUS TREES	
ACGL	Acer glabrum Torr. *	Rocky Mountain Maple
ALIN	Alnus incana Nutt. *	Thinleaf Alder
BEOC	Betula occidentalis Hook *	Water Birch
LAOC	Larix occidentalis Nutt. *	Western Larch
POTR	Populus tremuloides Michx. *	Quaking Aspen

Table 1. (Con´t)

CODE	SCIENTIFIC NAME **	COMMON NAME
	DECIDUOUS TREES (CON´T)	
ACGI	Acer ginnala Maxim.	Amur Maple
LASI	Larix sibirica Ledeb.	Siberian Larch
SOAU	Sorbus aucuparia L.	European Mountain Ash
	DECIDUOUS AND BROADLEAVED SHRUBS	
CEVE	Ceanothus velutinus Dougl.	Snowbrush
CELE	Cercocarpus ledifolius Hutt. *	Curlleaf Mountain Mahogany
PHLE	Philadelphus lewisii Pursh. *	Lewis Mockorange
PUTR	Purshia tridentata (Pursh) DC *	Antelope Bitterbrush
RHTR	Rhus trilobata Nutt. *	Skunkbrush Sumac
RIAU	Ribes aureum Pursh. *	Golden Currant
MAAQ	Mahonia aquifolium (Pursh) Hutt.	Oregon-grape
PHVI	Philadelphus x virginalis Rehd.	Virginal Mockorange
RIAL	Ribes alpinum L.	Alpine Currant
SYVU	Syringa vulgaris L.	Common Lilac
VITR	Viburnum trilobum L. `Compacta´	Dwarf Highbush Cranberry
	CONIFEROUS SHRUBS	
JUCO	Juniperus communis L. *	Common Juniper
JUCH	Juniperus chinensis L. `Pfitzeriana´	Pfitzer Juniper

** Authorities used were Little, 1979; Bailey and Bailey, 1976.

Factor Selection

Factors to be scored were determined through the literature search. Information necessary for members of the landscape horticulture profession to intelligently utilize a plant as an ornamental was the primary consideration in factor selection.

Form/habit, flower, fruit, bark and seasonal characteristics are the primary factors designers use when selecting a plant to serve a visual function (Brooks, 1977; Sutton, 1974), and were used as factors scored in the Aesthetic Scorecard portion of this study.

All of the environmental factors scored provide a measure of a plan's ability to satisfy specific environmental conditions or to determine the economic feasibility of marketing the plant as an ornamental. The factors scored in the environmental scorecard were lifespan, transplantability, propagation, maintenance/cleanliness, soil texture and pH, moisture regime adaptability, exposural adaptability, insect and disease resistance.

Aesthetic Scorecard

The Aesthetic Scorecard used color photographs and written descriptions to evaluate the selected plant species on visual characteristics. Three to seven color prints depicting each characteristic to be scored were compiled into photo sets for each species to be evaluated. Written descriptions included mature size, details of leaves, fruit, bark and flowers which may not have been

successfully portrayed in the photographs. Length and time of bloom period and period of fruit effectiveness were also included.

The color photographs were taken with a 35 mm camera using Kodacolor and Seattle Film Works film. Photographs that depicted several individual specimens in varying seasons and locations were selected so as to give a broad representation of the species. Whenever possible photographs were taken of the plants in a cultivated setting. In a few instances Kodacolor prints were not available. Polaroid prints from Kodachrome slides were substituted in these cases. Sets were color coded according to plant type. Color coding allowed easy organization of plant type groups, alerted evaluators to plant type categories, and simpified score recording. These sets were sent to 28 evaluators in one or two mailings at their preference. The first mailing consisted of 11 groundcovers (coded pink) and 9 evergreen trees (coded green). The second mailing included 4 vines (coded pink), 8 deciduous trees (coded yellow), 2 evergreen shrubs (coded blue), 3 broadleaf evergreen shrubs (coded blue), and 8 deciduous shrubs (coded blue). Sets were identified only by a photo set number, not by plant names. The 28 evaluators who participated in the project were professionals in the fields of landscaping, horticulture and botany (Appendix F). All of the evaluators had previously agreed to participate in the project through written and/or verbal correspondence.

The scoring scale of 1 to 5, with 1 being low and 5 being high was selected for ease of evaluation and simplicity of numeric manipulation. A negative or detrimental aesthetic trait was scored as

a 1. An aesthetic characteristic that had no visible effect or one that did not exist was scored as a 3 and a trait that had a very positive or enhancing effect scored a 5. Form/habit and seasonal characteristics were weighted twice as heavily as other factors scored since form is an important visible trait throughout the year and seasonal character represents the overall appearance of a plant. All other characteristics were given the exact evaluators score. This system gave a possible score that varied with plant type and characteristics scored (Table 2).

Table 2. Characteristics scored and point value for plant types.

Plant type	Aesthetic Characteristic						
	Form/habit	Flower	Fruit	Bark	Leaf	Seasonal	Total
Evergreen Tree	10			5	5	10	35
Deciduous Tree	10	5	5	5	5	10	40
Broadleaf Shrub Evergreen	10	5	5		5	10	35
Deciduous Shrub	10	5	5		5	10	35
Coniferous Shrub	10		5		5	10	30
Groundcover	10	5	5		5	5	30
Vine	10	5	5		5	10	35

Evaluator scores were totaled for each characteristic scored and for overall aesthetic scores. The raw overall scores were then converted to a percentage of the possible score. Percentages were

used to standardize the perfect overall score at 100. This eliminates the variance in the possible score between plant types. The raw score to percent conversion formula is:

$$\frac{\text{Total of Evaluators Scores}}{\text{(Perfect ASC Total) x (\# of Evaluators)}} \times 100 = \text{Overall Aesthetic Score}$$

(ASC=Asthetic Scorecard)

All other scores were presented as means compared to point values in Table 2.

Raw scores were then used to rank the species within plant type groups.

Mean scores were then analyzed using Tukey's Studentized Range at the .05 level of significance (Neter and Wasserman, 1974). Species, evaluator groups and native species versus exotic species groups were analyzed. To reduce factor sample size variation, all incomplete entries were deleted.

The Aesthetic Scorecard is presented in its entirety in Appendix F.

Environmental Scorecard

The same 44 plant species were rated on 13 environmental qualities and cultural requirements using a numeric scale of one to five. The categories scored were transplantability, lifespan, propagation, maintenance/ cleanliness, soil texture and pH, moisture

regime adaptability (both drought and flood tolerance), exposure adaptability (temperature, light and wind), insect resistance, and disease resistance. The scoring criteria and scale definitions are described in Appendix E.

Prospective evaluators were asked to fill out the matrix shown in Appendix E. They were then sent a scorecard for each species they agreed to score. Evaluators were asked to score only those categories they were professionally qualified to evaluate. (See evaluator request letter-Appendix E.) The scorecard included current information from the literature in each category being scored and asked for additional information evaluators could provide on that species in that category. Evaluators then scored the species using a scale of 1 to 5. One being poor or narrow range of adaptability, 3 being moderate, and 5 being excellent or wide range of adaptability. An example scorecard appears in Appendix E.

All environmental categories were given point values of 5 and totaled for each factor scored and for overall environmental scores. Overall scores were converted to a percentage of the possible to standardize the perfect overall score at 100. The raw score to percent conversion formula is:

$$\frac{\text{Total of Evaluators Scores}}{(\text{Perfect ESC Total}) \times (\#\text{ of Evaluators})} \times 100 = \text{Overall Environmental Score}$$

Species were then ranked according to scores within plant type groups. Mean scores were analyzed using Least Significant Difference at the .05 level of significance (Neter and Wasserman, 1974).

Evaluators for the environmental scorecard were professionals in the fields of ornamental nurseries, landscape architecture, horticulture or botany. Environmental evaluators are listed in Appendix E.

The environmental score and aesthetic score were weighted equally and combined for an overall ornamental score.

CHAPTER 4

RESULTS AND DISCUSSION

The ornamental scorecard developed as a result of this research successfully enables evaluation and comparison of plant species as ornamentals. The degree of success varies with plant types. Deciduous trees, deciduous and broadleaved shrubs, vines and groundcovers showed the greatest differences for aesthetic qualities. Evergreen trees and shrubs exhibited minimal statistical differences. The environmental scorecard showed little statistical difference for any plant type group, but does allow for comparisons between species and for overall environmental rankings. A combination of aesthetic and environmental scores into an overall ornamental score allowed species ranking and allowed some numeric distinction between certain species for specific traits, but did not allow for statistical analysis.

Several problems with using an aesthetic scorecard to evaluate ornamental potential were noted. Most of the problems encountered center around the issue of subjectivity. An evaluator´s personal tastes and biases appeared to enter into the scoring process. This seemed to result from the evaluator´s previous knowledge of certain of the species used. Such previous knowledge may have led to opinions about the species. These personal opinions have been structured by visual qualities and cultural requirements and adaptations. Thus,

even though evaluators were instructed not to consider cultural and environmental factors some bias in their scores may have been introduced. The existence of this bias was confirmed through evaluator comments made in follow-up communications.

Another bias was within the scorecard tool itself. The quality of the color photographs varied from species to species and character to character. To be completely consistent, all photographs should have been taken under the same light conditions, at the same time of day, at the same point in the factors development, with the same background, using the same camera and film throughout. This could not be done. Thus, scores may vary according to the photographs presented for each species. Also, the photographs depict a few individuals which may or may not be representative of the species population. Several Polaroid reprints of Kodachrome slides were used due to economic and time restrictions. The reduced quality of these prints is reflected in the scores these plants received. Also, evaluators may have scored species they were familiar with using mental pictures formed from their experience with them to augment the photograph display.

Much of the bias within the aesthetic scorecard can be justified simply by realizing that visual qualities are constantly subject to personal taste and opinion. "Beauty is in the eye of the beholder."

Another problem with the analysis of aesthetic scores lies in the inconsistency of evaluators to assign scores to every species for every factor. Ideally all 44 plant species were to have been scored in each applicable category by all 27 evaluators. Unfortunately some

of the species and categories were omitted by some evaluators. Thus, the sample size varies from species to species and character to character.

A final problem encountered in the scoring of aesthetic traits was the variance in evaluator interpretation of the scoring scale. The scale was clearly defined in the Guidelines and Instructions for Evaluation as presented in Appendix E. But, some evaluators failed to interpret the scale consistently or to utilize these guidelines at all.

The aesthetic scorecard allowed for statistical manipulation of evaluator scores. But, due to the great variation in sample size between species and between factors within species the environmental scores could not be accurately analyzed. A much greater number of evaluators was necessary in order to get an even distribution of scores across factors and species within plant type groups so that scores can be reliably analyzed.

Statistical analysis was done on all environmental scores using Least Significant Differences at the .05 level of significance. This analysis indicated few statistical differences between species. The lack of statistical significance is the result of several factors: first, as already stated, the variance in sample size is great and in most cases sample size is too small to give reliable mean scores.

Second, more cultural and functional information is available on commonly used ornamentals than on native species not on the market. In general, professionals in the nursery trade and plant sciences fields have had more experience with the commercial ornamentals than

with the untried natives. Thus, it is much easier for evaluators to score commonly used ornamentals than noncommercial native plants. Scores for exotics may be more reliable because of this knowledge and experience concerning species' tried-and-true responses.

Another major area of concern when scoring environmental and cultural factors is the lack of a reference base for scores. It is difficult to compare species that have been thoroughly researched to untried species for several of the factors scored (i.e. transplantability, maintenance/cleanliness, and ease of propagation). Hopefully this research will provide a basis of comparison for future scoring attempts.

The results of the statistical analysis follows, organized by plant types. All statements concerning groups and scores are in relation to the statistical analysis unless stated as raw score comparisons. All statements concerning rankings are based on raw numeric scores. Statements made concerning actual responses of species to environmental and cultural factors are based on the literature reviewed, personal experiences and evaluator comments.

Groundcovers

Of the eleven groundcover species scored, seven were ranked in the top group (Table 3). Of these seven species *Antennaria rosea* and *Eriogonum umbellatum* are native to Montana and are not currently in common use as ornamental groundcovers. These two native species are accompanied in this top group by *Vinca minor*, *Sedum spurium*, *Cerastium tomentosum*, *Potentilla tabernaemontanii*, and *Ajuga reptans*, the five

most popular and common groundcovers used in Montana (as determined by a review of nursery lists). The ranking of two natives with already proven species indicates good marketing potential for these species.

Artemisia cana* and Anaphalis margaritacea* were the lowest ranked species. Their scores were lower than all but Spiraea betulifolia* and Artemisia frigida*. The lower scores of these four species do not necessarily indicate poor visual qualities, but rather may indicate poor photographic representation and/or evaluator biases.

Fruit does not appear to be a differentiating characteristic for these eleven groundcover species. Had groundcover species, such as Arctostaphylos uva-ursi (L.) Spreng. (Kinnikinick) or Mahonia repens Lindl. (Creeping Oregon Grape), which have more visible fruit been included the importance of the fruit scores may have been greater.

As a group natives scored lower for all factors (Table 15). Again, this may be attributed to poor photographs and/or evaluator biases. A factor which may be indicated by these scores is the tendency for evaluators to score familiar species higher. Mental images of known species may augment the photograph display and bias evaluator scores.

In comparing evaluator groups, nurserymen vs. botanists vs. horticulturists vs. landscape designer/architects, little difference is indicated (Table 16). Only for flower did botanists score higher than nurserymen and horticulturists. This may be due to a greater appreciation of floral detail by botanists, or the botanists

* Indicates species is native to Montana.

may have been more familiar with native species than the other evaluators, or the botanists as a group may have fewer cultural prejudices than do the nurserymen and horticulturists.

The environmental scores indicate few differences between groundcover species for the 13 factors scored (Table 4).

The transplant scores indicate that the groundcovers grown and sold commercially are more easily transplanted than the natives. Four of the six native Montana species rank in the lowest group. Anaphalis margaritacea* ranks number one. This is probably a reflection of the low number of observations available on this species, rather than a true indication of its transplant success. With more research and experience the ease and success of transplanting natives might be increased.

The scores for soil texture, soil pH, insect resistance, and disease resistance indicate no differences between species. The native groundcover species seem to be evenly distributed across the range of evaluator scores. Natives rank high for soil ph tolerance, insect resistance and disease resistance. The insect and disease scores for the native species are based primarily on literature and evaluator experience on the species performance in their native environment. These species may not be so insect and disease free under cultivation where introduced to exotic pests.

The range of scores for insect and disease resistance is narrow indicating these eleven groundcover species as a group are relatively free from harmful insects and disease pathogens.

Scores for lifespan, ease of propagation, cleanliness/maintenance, and wind tolerance indicate a minimal amount of statistical variation. The differences indicated are minor and are probably inaccurate due to the wide variation in sample size for all four groups.

Of six groundcover species in the top group five native Montana species rank 1, 2, 3, 4, and 6 for drought tolerance. One consideration when examining these scores is that most of the native species selected for scoring are dryland plants. Three exotic species scored ranked ninth, tenth and eleventh for drought tolerance. The same three species ranked one, two and three for flood tolerance. The exotic species scored are commonly cultivated in the urban/suburban landscape where irrigation water is available. As water conserving landscapes become more desirable due to water shortages, research on propagation, cultivation and marketing of native dryland species will increase in importance.

The two species of Artemisia ranked very low for all aesthetic characteristics, but ranked first and second for temperature adaptation, second and third for drought tolerance, and first and third for soil ph adaptability. Vinca minor ranked first for overall aesthetic value but ranks last for temperature adaptation, tenth for drought tolerance, and tenth for soil ph adaptation. These scores point out the important interaction between aesthetic characteristics and environmental adaptation for ornamental plants. In Montana a useful and successful ornamental species must be adapted to a wide range of temperature extremes, soil types and moisture conditions. In some cases a more environmentally adapted species must be selected

over an aesthetically pleasing but less adapted species. The selection of ornamental species relies not only on visual ornamental potential but on environmental adaptations, cultural requirements and the resulting functional ornamental potential.

The statistical analysis of light range adaptability is fairly indicative of shade tolerance levels. Evaluators were scoring the range of light conditions to which the species are adapted. Generally the sun loving species scored 1.60 to 2.67 indicating a narrow range of adaptability. Those species that can tolerate both shade and sun scored 3.83 to 4.60 indicative of a wide range of adaptability. These scores accurately reflect the light conditions these species will tolerate but may not accurately reflect a true hierarchial ranking of the eleven species' light tolerance levels.

In comparing the natives as a group to the exotics few differences are indicated (Table 17). Natives were lower than exotics for ease in transplanting and flood tolerance, higher for drought tolerance and temperature adaptation. These differences seem to accurately reflect differences found between the species. The lack of statistical difference found for the remaining factors is due largely to the small and variable sample size.

The overall environmental scores were used to rank these eleven groundcover species (Table 4). Sedum spurium was first, Artemisia frigida* second, Spiraea betulifolia* third, and Artemisia cana* fourth. The three native species ranked 9, 8 and 10 respectively for aesthetic characteristics. This reemphasizes the important

interaction of environmental and aesthetic characteristics in the selection of ornamental species.

The combination of overall aesthetic and overall environmental scores changed the aesthetic score rankings very little (Table 4).

Coniferous Trees

In the coniferous tree group very little statistical difference was observed overall (Tables 5 and 6). Picea engelmannii*, Abies concolor, Abies lasiocarpa*, Picea pungens, Abies grandis*, Pinus sylvestris, Picea glauca v. densata, and Larix occidentalis* rate together in one group for overall aesthetic value.

Pinus contorta v. latifolia* and Larix sibirica score significantly lower than Picea engelmannii*, Abies concolor, Abies lasiocarpa*, and Picea pungens for overall aesthetic scores and form. The native species as a group received higher form scores than the exotics.

Not surprisingly, Pinus sylvestris received the highest score for bark. Picea engelmannii*, Abies concolor, and Larix sibirica all scored in the same group with Pinus sylvestris. As a group the five native species ranked lower for bark than the commercial species (Table 18).

Apparently leaf is not a distinguishing characteristic between these ten coniferous trees. Only photographs of the overall leaf canopy were presented for evaluation. The overall foliage appearance was assumed to be the critical visual consideration for consumer selection and for aesthetic function in landscape designs. If a

close-up of the needles had been included in the photo sets this score may have been more distinguishing.

The two species of Larix received the lowest scores for seasonal characteristics. Apparently the green color year round weighs heavier than seasonal variation in the minds of these 27 evaluators for this plant type.

Neither buds nor cones were scored. Although, both characteristics have distinctive visual impact in the landscape, they are not primary considerations when specifying or purchasing a coniferous tree. The scoring of these factors may have widened the margin of difference between the coniferous tree scores and perhaps would have been a useful and interesting characteristic to score for this reason.

As a group botanists scored the ten species higher than the other evaluator groups on aesthetic characteristics (Table 19).

Although not widely available, Larix sibirica was included to provide a comparison for the native Larix occidentalis. Larix sibirica scored lower (although not statistically different) than Larix occidentalis* for all but bark where it was not significantly higher. These scores probably are not a true indication of differences between species, but rather indicate the poor specimen photographed for Larix sibirica.

Of the native Montana conifers scored with this scorecard, Picea engelmannii*, Abies lasiocarpa*, Abies grandis*, and Larix occidentalis* are the primary species that merit further research on the basis of aesthetic values. Pinus contorta v. latifolia* received

consistently low scores when compared with the other nine species and thus merits less attention, although this author strongly feels it has a place in the man-made landscape.

In further scoring attempts on aesthetic characteristics, all factors should be weighted equally and evaluation of detailed characteristics should be considered.

The environmental scorecard for coniferous trees revealed few differences between species. No differences were indicated for transplantability, propagation, soil texture adaptability, flood tolerance, wind tolerance, insect resistance, or disease resistance.

In general the differences indicated by the analysis for the other environmental factors are not reliable. Sample sizes range from only one observation to 10. This variance in sample size does not allow for reliable statistical analysis.

No scores were available for soil texture or soil pH for Larix occidentalis*. Abies lasiocarpa* was not scored for soil pH (Table 6).

In comparing the group of native species to the exotics the exotics appear to be more drought tolerant and more widely adaptable to soil texture and pH variations. These differences may be indication of true responses by the exotic species to environmental stimuli. But once the native species have been tested they may prove to be equally adaptable (Table 20).

Overall environmental scores were used to rank conifer tree species (Table 6). Picea pungens ranked first, Pinus sylvestris second, Picea glauca v. densata third and Abies lasiocarpa* forth.

Picea engelmannii* which was ranked number one aesthetically dropped to seventh. Abies concolor dropped from second to sixth. Again the important interaction of visual and environmental functions is illustrated.

Overall ornamental scores (Table 6) ranked Picea pungens first, Abies lasiocarpa* second, Pinus sylvestris third, Abies concolor fourth, and Picea engelmannii* fifth. These rankings indicate Picea engelmannii* and Abies lasiocarpa* should be primary considerations for further research.

Vines

Two native and two exotic vines were scored on their aesthetic characteristics. One of the natives, Parthenocissus quinquefolia is widely available at the retail nursery level. It was included for use as a reference base for the other native vine, Clematis ligusticifolia (Table 7). Both natives ranked higher for fruit than Humulus Lupulus and Lonicera sempervirens. Both scored in the first group for overall and seasonal characteristics along with Lonicera sempervirens.

Parthenocissus* scored higher for leaf characteristics than all three of the other vines. Clematis* and Lonicera scored significantly higher than Humulus Lupulus and Parthenocissus quinquefolia* for floral characteristics.

Humulus Lupulus scored lower than the natives and Lonicera sempervirens for all characteristics but leaf and form, although differences were not significant for all of these characteristics.

Form was not a distinguishing factor for vines and as such should be eliminated when scoring other vine species.

Botanists scored overall, flower and leaf higher than did the horticulturists (Table 22).

As a group the two native species scored higher than the combined commercial species for overall, fruit and seasonal scores (Table 21). But again, Parthenocissus* partially fits the definition of the commercial ornamentals as well as the native group. And, Humulus Lupulus is not readily available on the Montana retail market, but was included to increase the reference base for the vine group.

No differences were determined between the four vine species for soil pH adaptability, drought tolerance, flood tolerance, wind resistance, insect resistance, or disease resistance. In general the species ranking for each of these factors do not necessarily reflect the species actual known responses to these environmental/cultural factors.

The differences indicated by the mean scores for transplantability may not be accurate. The sample size ranges from five observations for Clematis* and Humulus to ten observations for Parthenocissus*. The analysis indicates that Clematis ligusticifolia* is more easily transplanted then Humulus Lupulus, but none of the information from the literature or evaluators indicate that this is true. The same statements can be made for propagation scores.

The analysis of lifespan scores indicate that Parthenocissus quinquefolia* is longer lived than Clematis ligusticifolia* and Lonicera sempervirens. Humulus Lupulus does not differ from the other

three species. The natives as a group appear to be longer lived than the two exotic vines (Table 23).

The maintenance/cleanliness factor analysis also reflects inaccuracies in the scorecard. Parthenocissus quinquefolia* is ranked with Lonicera sempervirens as being relatively low maintenance. But as experienced evaluators comment Parthenocissus quinquefolia* can be a maintenance headache with messy and potentially toxic fruit, invasiveness, and heavy leaf fall. Parthenocissus also experiences mite and aphid problems.

The temperature scores indicate Lonicera sempervirens is less adapted to extreme temperatures than the other three vines. This analysis accurately reflects the true responses of these species to temperature extremes. The analysis for light range adaptability also accurately reflects these species' responses to various light conditions.

Overall environmental scores rank Parthenocissus quinquefolia* first, Lonicera sempervirens second, Clematis ligusticifolia* third, and Humulus Lupulus forth (Table 8).

When aesthetic and environmental scores are combined (Table 8) Parthenocissus quinquefolia* remains number one for overall ornamental scores. Clematis ligusticifolia* is second, scoring higher than both Lonicera sempervirens and Humulus Lupulus indicating Clematis ligusticifolia should be considered for introduction into the nursery trade in Montana.

Most of the inaccuracies incurred with the environmental scoring and analysis of vines can largely be attributed to the small and

variable sample size, rather than mechanical problems in the scorecard structure.

Deciduous Trees

Six deciduous tree species were included for scoring in the ornamental scorecard. Of four species native to Montana one, Populus tremuloides*, is currently very popular in the landscaping industry. It was included in the group to expand the number of species being scored and as a basis of comparison for the other native species not common on the retail market. In contrast to the other 5 species, Populus tremuloides* scored significantly lower than Acer ginnala and Sorbus aucuparia for overall aesthetic value (Table 9). It was significantly lower for fruit than all other species except Betula occidentalis*. When comparing the other three natives with Populus tremuloides*, raw scores for Alnus incana* for overall, form, flower and seasonal were higher. Betula occidentalis* scored statistically equal to Populus tremuloides* for all factors and Acer glabrum* was equal for all factors except fruit where it was significantly higher than Populus tremuloides*. On this basis, all three of the other natives scored have the potential to equal or surpass the marketability of Populus tremuloides*.

Overall Sorbus aucuparia was the highest scored species, statistically equal only to Acer ginnala. Sorbus aucuparia also ranked highest for floral qualities again equal only to Acer ginnala. The poor floral scores of the native species are due to two factors: first, Acer glabrum* was not included in the analysis because a

suitable photograph was unavailable. This maple should probably rank nearly equal to Acer ginnala. Second, the selection of species to be scored was somewhat arbitrary and by no means all inclusive. Several exotic species with inconspicuous flowers could have been included for scoring. The species selected portray a variety of characteristics over a wide range in order to better test and develop the scoring tool.

Sorbus aucuparia was the highest ranked species for fruit, again equal to Acer ginnala. Here again a wide range of fruit types were scored, but none of the native species displayed particularly showy fruit so these scores were expected.

No differences between species were indicated by the form scores, indicating that this characteristic is not important in numerically differentiating deciduous trees. In another scorecard form might be deleted or weighted the same as the other factors.

Acer ginnala ranked lowest for bark in the same group as Acer glabrum* but lower than the other four species.

Leaf was not a distinguishing characteristic. Apparently fall leaf color was not indicated by evaluator scores.

In the seasonal category Sorbus aucuparia received the highest scores. Ranking in the same group were Acer ginnala, and Alnus incana*. Acer glabrum* was ranked lowest for seasonal qualities, grouped with Betula occidentalis* and Populus tremuloides*.

Acer ginnala ranked fairly high for all categories except bark. Much of its success may be attributed to the excellent specimens presented in the photographs.

The natives as a group scored lower for form, flower, leaf, seasonal and overall aesthetic characteristics (Table 24). This poor showing is due primarily to the species selected and would vary considerably with other species. The scorecard use should be emphasized for comparing individual species rather than for group generalizations.

This group of species is quite diverse in their visual qualities. The number of species is limited, the number of observations is small and variation from the mean is wide. Despite these problems the statistical analysis was sensitive enough to obtain good statistical differentiation.

The analysis of the environmental scorecard for deciduous tree was not so successful (Table 10). No differences were indicated for ease of propagation, soil texture, or temperature adaptation. Better differentiation between these six species were expected particularly for temperature. Populus tremuloides* is grown in much harsher environments than Sorbus aucuparia will tolerate, yet no difference between these species was determined by the statistical analysis.

As with groundcovers the group of native species was lower for ease of transplanting than the combined exotic species (Table 26). Again, further research and experience with the natives may eliminate this difference.

Populus tremuloides* scored lower for lifespan than Acer ginnala and Sorbus aucuparia. The other three species were not different. Populus tremuloides* is known to be short lived and should be ranked low as the analysis indicated.

Sorbus aucuparia ranks lower for maintenance/cleanliness factors than Alnus incana* and Acer ginnala. It is surprising that the messy fruit of Sorbus did not rank it lower in comparison with the other three species. A larger sample size might bring this difference out more distinctly. In general the natives were more maintenance free than the exotics (Table 26).

Populus tremuloides* is adapted to a wider range of soil pH conditions than is Sorbus aucuparia. Differentiation between the other species is poor. Here again a larger sample size might distinctly describe the differences in pH adaptability between these six species.

Scores for drought tolerance range from 1.00 to 3.50 indicating that none of the species scored is particularly drought tolerant. The ranking of the raw scores indicates the relative drought tolerance of each species in relation to the others. As a group the native species are more drought tolerant than the exotics (Table 26).

The scores for flood tolerance indicate a wide range of adaptability between these six species. Alnus incana*, Betula occidentalis* and Acer glabrum* are grouped together as the most flood tolerant species. Populus tremuloides* and Sorbus aucuparia scored significantly lower for flood tolerance than these three species.

The range of light tolerance levels is not well defined by the statistical analysis. Populus tremuloides* is very intolerant of shade but is ranked equivalent to Betula occidentalis*, Acer ginnala and Sorbus aucuparia. All of these other species can tolerate some shade, especially Sorbus aucuparia. Alnus incana* and Acer glabrum*

are well adapted to a wide range of light levels and rank one and two as significantly more adaptive than Populus tremuloides*.

Disease and insect resistance scores reflect known qualities for Populus tremuloides* and Sorbus aucuparia. Both of these species are known to suffer severe damage from insect and disease pests. These two species are ranked fifth and sixth for insect and disease resistance, significant from all four other species for disease resistance. Sorbus aucuparia scored lower for insect resistance than Acer ginnala and Alnus incana*, Populus tremuloides* is the only other species to score below 3.00 for insect resistance.

In general the natives were more wind resistant and more insect resistant than the exotic ornamentals (Table 26).

Because sample sizes for Alnus incana* and Betula occidentalis* are consistently low, their scores may be less reliable than for those species with larger numbers of observations.

Despite their poor performance as a group aesthetically, the natives' performance environmentally merits their consideration as Montana ornamentals. Environmental overall scores rank the four natives first (Alnus incana), third (Betula occidentalis), forth (Acer glabrum), and fifth (Populus tremuloides).

Overall ornamental scores rank Acer ginnala first, Alnus incana* second, Sorbus aucuparia third, Betula occidentalis* forth, Acer glabrum* fifth, and Populus tremuloides* sixth. When the commercial success of Populus tremuloides* is considered, the other three native Montana species exhibit good marketing potential.

Broadleaf and Deciduous Shrubs

Of the eleven shrubs in this plant type group three are broadleaf shrubs, six are native to Montana. Four of these native shrubs rank in the top group of six shrubs for overall aesthetic qualities. These species then should be strongly considered for future research, they are: Ribes aureum*, ranking third for overall value, second for flower, third for fruit, fifth for leaf, and fourth for seasonal characteristics; Rhus trilobata*, ranking fourth overall, second for fruit, fourth for leaf, and fifth for seasonal; Ceanothus velutinus*, ranking fifth overall, fifth for form, fifth for flower, sixth for leaf, and sixth for seasonal; and Cercocarpus ledifolius*, ranking sixth overall, sixth for form, sixth for leaf, and third for seasonal characteristics (Table 11).

The natives as a group scored lower for form which might be attributed to the lack of native specimens available in cultivated settings (Table 27). If these species were grown in a cultivated setting and maintained for form like the photographed commercially available species, their form scores may have been higher.

Three natives (Ribes aureum*, Ceanothus velutinus*, and Philadelphus lewisii*) ranked in the top group for floral characteristics. The photograph for Ceanothus velutinus* may have biased this score because it depicted a very showy close-up of the Ceanothus flower. The actual floral display is not really as effective as this photograph indicated. The ranking of Ribes aureum* in this group certainly warrants attention. Further scorecards should utilize flower photographs taken from the same aspect.

For all factors the native Philadelphus lewisii* had raw scores greater than Philadelphus x virginalis which is commonly planted in our area, indicating it may be a better Philadelphus species for Montana.

Seven shrub species ranked together in the highest group for leaf characteristics. All three broadleaf evergreens are in this group, but somewhat surprisingly rank 2, 3 and 6 with Viburnum opulus 'Nanum' ranking as number one. Rhus trilobata* ranked fourth and Ribes aureum* fifth. These scores indicate that seasonal fall leaf color is a desirable trait when compared to broadleaf evergreens for these 27 evaluators. This contrasts with the coniferous tree leaf scores where the Larix fared poorly with fall leaf color.

As a group, botanists scored all factors except flower higher than the other three evaluator groups (Table 28).

In general the environmental evaluation showed minimal statistical distinction between shrub species (Table 29). Ceanothus velutinus* and Purshia tridenta* are more difficult to transplant than eight of the other eleven species. Ease of transplanting these two natives might be increased with further research on transplanting methods and container growing.

Although Philadelphus lewisii*, Ribes aureum* and Rhus trilobata* ranked in the top group for ease of transplanting their scores may not accurately reflect success in transplanting relative to the exotic species they are grouped with.

Mahonia aquifolium and Viburnum opulus 'Nanum' received the lowest scores for lifespan. These two shrubs scored one and two for

overall aesthetic value. The comparison of these two categories expresses the importance of tempering aesthetic value with environmental adaptability when selecting ornamental plants.

Ceanothus velutinus* scored lower than all ten of the other species for ease of propagation. The difficulty of propagating Ceanothus may be overcome by thorough research, but perhaps research on the other promising native species should be emphasized.

Reliable differences between species are not illustrated for maintenance/cleanliness, soil texture, soil pH, drought tolerance, insect resistance, and disease resistance. The native shrubs as a group scored higher for maintenance/cleanliness, drought tolerance, wind resistance, and insect resistance than the exotic shrubs (Table 29).

The two species of Ribes scored highest for flood tolerance. Cercocarpus ledifolius*, Rhus trilobata* and Purshia tridentata* scored lowest. These same three native dryland species ranked one, two and three for drought resistance.

Two of the broadleaf evergreens, Mahonia aquifolium and Ceanothus velutinus* scored very low for temperature range adaptation. These scores may reflect the need for snow cover to prevent winter burn on these two species. All five of the other native species ranked in the top group of eight species for temperature adaptation.

Light scores accurately reflect the tolerance of these eleven species to varying light levels.

Ten of the eleven species scored were equal for wind resistance. The range of these ten scores was only eight-tenths of a point apart.

The eleventh species was Mahonia aquifolium with a score of 1.75, indicating its extreme susceptibility to winterburn in our climate.

Native Montana shrubs scored very well for overall environmental factors. Ribes alpinum ranked first, Rhus trilobata*, Ribes aureum*, Philadelphus lewisii*, and Cercocarpus ledifolius* were 2, 3, 4, and 5 respectively.

Combination of aesthetic and environmental characteristics rank two natives, Rhus trilobata* and Ribes aureum* one and two for overall ornamental scores. These scores reinforce the earlier recommendation of these two shrubs for further research.

Juniper Shrubs

No differences between the two Juniper shrubs compared with this aesthetic scorecard were determined. The raw scores were higher for Juniperus chinensis 'Pfitzeriana' for all but form (Table 13).

Nurserymen assigned lower scores for overall, form, and seasonal factors. Perhaps their scores were influenced by their knowledge of improved juniper cultivars available in the nursery trade (Table 30).

The only statistical differences indicated in the environmental scorecard for Juniper shrubs were for ease of transplantability and light range adaptability. Juniperus communis* scored lower than Juniperus chinensis 'Pfitzeriana' for ease in transplanting and higher in light range adaptability.

The rating of Juniperus communis* equal to the very common Juniperus chinensis 'Pfitzeriana' indicates it could compete with this popular ornamental evergreen shrub.

In order to increase the effectiveness of the scorecard for coniferous evergreen shrubs the number of species scored needs to be greater and the number of observations per factor need to be increased. The statistical analysis indicates no alterations to the structure of the scorecard itself.

Several general interpretations from the statistical analysis are necessary to put the ornamental scorecard into perspective. In general the statistical sensitivity of the scorecard is low. This is due to the small sample size, to the great variation in the number of observations, both between species and from factor to factor within species, and to the wide deviation from the mean. To increase the accuracy of the statistical analysis a larger number of evaluators is required.

The selection of the species themselves also biased the statistical results. For example, the native species generally were more drought tolerant than the exotics. This was due entirely to species selection, most of the natives scored were dryland species. Aesthetic scores are equally controlled by species selection. As discussed in the deciduous tree results, flower scores for the native species were low because of the species scored, not because native deciduous trees do not have showy flowers.

The scorecard thus becomes a tool for comparison and evaluation of individual species rather than a method of comparing groups of species. Species should be evaluated according to the site criteria for aesthetic functions, environmental adaptations and cultural requirements and selected on their ability to fulfill these criteria.

CHAPTER 5

SUMMARY AND CONCLUSIONS

The literature survey and scorecard surveys conducted as part of this research have been directed at satisfying the objectives outlined in Chapter 1. The review of current information available on the uses, merits and disadvantages of native plants shows that while there are many positive aspects of native landscaping there are several disadvantages as well. An ornamental plant should not be selected solely on the basis of origin but on aesthetic qualities, utilitarian functions and environmental adaptations that satisfy the required criteria.

The summary of information currently available from the literature combined with comments gleaned from professional evaluators participating in the scoring process is presented in Appendix E and provides information on propagation, cultural requirements, and environmental adaptations as well as availability and references on twenty - four plant species native to Montana.

Through the scoring process criteria for selecting ornamental plants for the nursery trade were established. These criteria were found to vary by plant type. The scoring process also produced a tool designed to rate plant species on aesthetic characteristics and environmental qualities. This tool enables evaluation and comparison of plant species as ornamentals.

Aesthetic scores indicate differences that allow evaluation and comparison of plant species enabling selection of ornamental plants that fulfill specific visual functions.

Although environmental scores were not obtained in a sample size large enough to produce reliable statistical analysis, by increasing the sample size, environmental and cultural requirement decisions could be aided through the use of a scoring process. The scores obtained from this group of evaluators provide a base from which to select certain native species that exhibit ornamental potential.

For further scoring attempts the following recommendations are made:

1) a minimum of 20 scores is necessary for each species in each category in order to conduct reliable statistical analysis;
2) the scoring scale, to clearly indicate the system of positive versus negative traits should be altered to a -5, -3, 0, 3, 5 scale;
3) evaluators should be carefully instructed in correct scoring procedures and monitored closely to ensure consistent assignation;
4) further score manipulation should be conducted to determine relative factor weighting values*;
5) groundcover species should be scored for form, flower, fruit, leaf, and seasonal characteristics all weighted equally;
6) coniferous tree species should be scored for form, leaf (include detail and canopy photographs), bark, cones (pictured throughout development), and seasonal all weighted equally;

* Weights listed are suggested as a basis for further manipulation.

7) vines should be scored for flower, fruit, leaf, and seasonal weighted 5, 5, 5, and 10 respectively;

8) deciduous trees should be scored for form, flower, fruit, bark, leaf and seasonal weighted 5, 5, 5, 5, 5, and 10 respectively. The weighting of form should be explored further. A diversity of species should be scored, exploring the importance of flower and fruit more extensively.

9) deciduous and broadleaved shrubs should be scored for form, flower, fruit, leaf, and seasonal weighted as 10, 5, 5, 5, and 10 respectively;

10) coniferous evergreen shrubs should be scored for form, fruit, leaf and seasonal - weighted as 10, 5, 5, and 10 respectively;

11) a consumer preference test should be developed to allow prospective buyers to evaluate these same 44 species on visual characteristics and establish which species they would purchase. This would be the final test of the scorecard. It would provide an indication of which species would compete economically on the retail market;

12) further use of this system is necessary to determine all of the modifications required to make a more useful and successful selection tool.

Although not intended as a comprehensive search for native ornamentals, several species did rate high in the scores and should be considered in further research development. On the basis of the scores obtained in this study the following native Montana species

exhibit potential as ornamentals and are highly recommended for further research on cultivation, propagation, and marketing methods:

Groundcovers: Antennaria rosea and Eriogonum umbellatum

Coniferous Trees: Picea engelmannii and Abies lasiocarpa

Vines: Clematis ligusticifolia

Deciduous Trees: Alnus incana, Betula occidentalis, and Acer glabrum

Deciduous and Broadleaved Evergreen Shrubs: Ribes aureum and Rhus trilobata

Coniferous Evergreen Shrubs: Juniperus communis

By examining the scoring process and the resulting scores some conclusions can be drawn. First, ornamental species can be scored as long as the inherent subjectivity of the topic is recognized. Second, a scoring tool has been developed which should aid in the ornamental selection process by working as a screen to sieve through native and introduced plant species and pinpointing those that exhibit high ornamental potential. And third, by using the scoring tables as a matrix, plants that will perform certain functions or fulfill certain cultural and/or environmental requirements can be selected. Species should be looked at individually as to their characteristics, functions, adaptations, and requirements and selected on this basis.

The main objective of any ornamental research is to expand and diversify the plant palette from which landscapes are painted. The plants selected from this palette are determined by the design setting. A designer must consider the character of the surrounding environment, the design style to be followed, and the plant

characteristics that will satisfy that style of design. The character of the design dictates the character of the plants within that design. It is the designer's responsibility to maintain design character by selecting species which will create and retain this character. With careful selection native plants that satisfy almost any situation can be selected. This is not to say that only native species should be considered when selecting ornamentals. To say this would eliminate thousands of valuable exotic species which grace our landscapes with their beauty and relieve the monotony which the use of a limited number of natives would create. But a combination of introduced and native species which satisfy the harsh conditions of the Montana climate is desirable. At times it may not be desirable to go completely native, but it is always desirable to select hardy, tolerant species which satisfy the desired design criteria.

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APPENDICES

APPENDIX A

BOTANIC NAME INDEX AND COMMON NAME INDEX

APPENDIX A

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APPENDIX B

PLANTS FOR FURTHER SCORING

Plants for Further Scoring

* Atriplex canescens (Pursh) Nutt.
* Atriplex nuttalli Wats.
* Cornus canadensis L.
* Crataegus douglasii Lindl.
* Larix lyallii Parl.
* Linnaea borealis L.
* Lonicera involucrata (Rich.) Banks
* Pachystima myrsinites (Pursh) Raf.
* Phyllodoce empetriformis (Sw.) D.Don
* Physocarpus malvaceus (Greene) Kuntze
* Pinus albicaulis Engelm.
* Pinus flexilis James
* Pinus monticola Dougl.
* Potentilla biennis Greene
* Potentilla hippiana Lehm.
* Rhamnus alnifolia L´Her.
* Rhamnus purshiana DC.
* Salix wolfii Bebb
* Shepherdia canadensis (L.) Nutt.
* Spiraea douglasii Hook.
* Taxus brevifolia Nutt.
* Thuja plicata Donn.
* Tsuga mertensiana (Bong.) Carr.

APPENDIX C

NATIVE PLANT SOURCES

Native Plant Sources

1. Applewood Seed Co.
   P.O. Box 10761, Edgemont Station
   Golden, Co 80401

2. Big Sky Wholesale Seeds, Inc.
   P.O. Box 852
   Shelby, MT 59474

3. Callahan-Seeds
   6045 Foley Lane
   Central Point, OR 97502

4. Clifty View Nursery
   Route 1, Box 509
   Bonners Ferry, ID 83805

5. Clyde Robin Seed Co.
   25670 Nickel Place
   Hayward, CA 94545

6. Dean Swift Seed Co.
   P.O. Box B
   Jaroso, CO 81138

7. Environmental Seed Producers, Inc.
   P.O. Box 5904
   El Monte, CA 91734

8. Green Horizons
   500 Thompson Drive
   Kerrville, TX 78028

9. Horizon Seeds, Inc.
   P.O. Box 81823
   Lincoln, NB 68501

10. Kester's Wild Game Food Nurseries, Inc.
    P.O. Box V
    Omro, WI 54963

11. Little Valley Wholesale Nursery
    13022 East 136th Avenue
    Brighton, CO 80601

12. Mitsch Nursery, Inc.
    6652 S. Lone Elder Road
    Aurora, OR 97002

13. Moses Lake Conservation District Nursery
    Route 3, Box 415
    Moses Lake, WA 98837

14. Native Plants Inc.
    9180 So. Wasatch Blvd.
    Sandy, UT 84092

15. Nature's Garden, Woodland and Rock Plants
    Route 1, Box 488
    Beaverton, OR 97007

16. Nichols Herb and Rare Seeds
    1190 North Pacific Highway
    Albany, OR 97321

17. Northplan
    P.O. Box 9107
    Moscow, ID 83843

18. Plants of the Wild
    P.O. Box 866
    Tekoa, WA 99033

19. Prairie Ridge Nursery
    R.R. 2 9738 Overland Road
    Mount Horeb, WI 53572

20. Schlichenmayer's Old Farm Nursery, Inc.
    5550 Indiana Street
    Golden, CO 80403

21. Sharp Brothers Seed Co.
    Healy, KN 67850

22. Siskiyou Rare Plant Nursery
    2825 Cummings Road
    Medford, OR 97501

23. Stock Seed Farms, Inc.
    R.R. 1, Box 112
    Murdock, NB 68407

24. Windrift Prairie Shop and Nursery
    R.D. 2
    Oregon, IL 61061

* This list is not all inclusive

APPENDIX D

TABLES 3 - 30

Table 3. Aesthetic scores for groundcovers

CODE**	N	FORM***	FLOWER***	FRUIT***	LEAF***	SEASONAL***	OVERALL****
TOTAL	265	7.57	3.82	2.72	4.05	6.68	70.92
ANMA*	26	5.62A	3.65 B	2.46A	2.96A	5.00A	56.26A
ARCA*	24	6.17A	2.42A	2.38A	3.21A	6.08AB	57.61A
ARFR*	23	6.61ABC	2.65A	2.48A	4.39 B	6.26ABC	63.97AB
SPBE*	25	6.32AB	3.88CB	3.08A	3.36A	6.16AB	65.14ABC
ERUM*	26	7.92 BCD	3.73 B	2.92A	4.23 B	6.77 BC	73.07 BCD
AJRE	23	8.17 CD	4.65C D	2.35A	4.26 B	6.61ABC	74.65 BCD
POTA	21	8.67 D	4.19CBD	2.91A	4.10 B	6.38ABC	74.96 BCD
ANRO*	25	8.24 CD	3.52 B	3.08A	4.40 B	7.52 BC	76.45 BCD
CETO	24	8.33 CD	4.79 D	2.58A	4.42 B	6.92 BC	77.26 BCD
SESP	25	8.24 CD	4.20CBD	2.56A	4.52 B	7.84 BC	78.17 CD
VIMI	23	9.30 D	4.35CBD	3.13A	4.78 B	8.04 C	84.22 D

* Indicates species is native to Montana
** CODE- See Table 1.
*** Form, flower, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, and 10 respectively.
**** Overall scores are presented as a percent score using the formula on page 31.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range.

Table 4. Environmental scores for groundcovers

	TRANSPLANT***		LIFESPAN***		PROPAGATE***		CLEANLINESS***		TEXTURE***		PH***	
TOTAL	83	4.422	83	4.133	71	4.535	89	3.719	52	3.962	37	3.919
CODE**	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
ANMA*	4	5.00 C	4	3.75AB	4	4.50AB	5	3.40ABC	4	3.50A	3	3.33A
ARCA*	5	3.80ABC	5	4.20AB	4	4.00AB	6	4.50 C	5	3.80A	3	4.33A
ARFR*	8	4.75 C	8	4.13AB	6	4.67AB	9	3.78ABC	5	4.40A	4	4.50A
SPBE*	6	4.17ABC	6	4.17AB	3	5.00 B	7	3.43ABC	2	4.50A	2	4.50A
ERUM*	6	3.33A	6	3.50A	5	3.60A	6	3.67ABC	4	3.50A	3	3.67A
AJRE	11	4.36 BC	11	3.73A	10	4.50AB	11	3.00A	6	4.50A	4	3.75A
POTA	5	5.00 C	4	3.75AB	5	4.60AB	6	4.50 C	5	3.60A	3	4.00A
ANRO*	8	3.63AB	9	3.89AB	7	4.29AB	9	3.33AB	5	3.40A	3	4.00A
CETO	9	5.00 C	9	4.22AB	8	4.62AB	9	3.11A	5	4.20A	4	3.75A
SESP	11	4.82 C	11	4.91 B	10	5.00 B	11	4.27 C	6	4.00A	4	4.00A
VIMI	10	4.50 BC	10	4.50AB	9	4.67AB	10	4.20 BC	5	4.20A	4	3.50A

* Indicates species is native to Montana
** CODE- See Table 1.
*** Scores for transplant, lifespan, propagate, cleanliness, texture, pH, are based on perfect scores of 5.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 4 (cont.). Environmental scores for groundcovers

	DROUGHT***		FLOOD***		TEMPERATURE***		LIGHT***		WIND***		INSECT***	
TOTAL	57	3.912	51	1.627	58	4.448	58	2.638	57	4.649	52	4.615
CODE**	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
ANMA*	4	4.25CED	4	1.25AB	5	4.60 C	5	2.00AB	4	4.75 B	2	5.00A
ARCA*	6	4.67 ED	5	1.60ABC	6	5.00 C	6	1.67A	6	5.00 B	4	4.50A
ARFR*	6	4.67 ED	6	1.33AB	6	5.00 C	5	2.20AB	6	4.50AB	5	4.80A
SPBE*	3	3.33CB	3	2.00ABC	3	4.33 BC	3	4.33D C	3	4.33AB	3	4.67A
ERUM*	5	4.60 ED	5	1.00A	6	4.50 C	6	2.00AB	6	4.83 B	2	5.00A
AJRE	6	1.50A	6	2.50 C	6	3.50AB	6	3.83D C	6	3.67A	7	4.14A
POTA	5	3.20 B	3	2.67 C	5	4.40 BC	5	3.00 BC	5	4.60AB	4	4.00A
ANRO*	6	5.00 E	6	1.33AB	6	4.67 C	6	2.67AB	6	5.00 B	5	4.60A
CETO	5	4.60 ED	5	1.20AB	5	4.80 C	5	1.60A	5	4.80 B	5	5.00A
SESP	6	4.17C D	5	1.40ABC	5	4.80 C	6	2.00AB	5	5.00 B	9	4.89A
VIMI	5	2.80 B	3	2.33 BC	5	3.20A	5	4.60D	5	4.60AB	6	4.50A

* Indicates species is native to Montana
** CODE- See Table 1.
*** Scores for drought, flood, temperature, light, wind, insect, are based on perfect scores of 5.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 4 (cont.). Environmental scores for groundcovers

	DISEASE***		ENVIRONMENTAL OVERALL****		+	AESTHETIC OVERALL****		=	ORNAMENTAL OVERALL****	
TOTAL	51	4.549	71.38		+	70.92		=	74.96	
CODE**	N	MEANS	MEANS	RANK	+	MEANS	RANK	=	MEANS	RANK
ANMA*	2	5.00A	77.44	9	+	56.26	11	=	66.85	11
ARCA*	3	5.00A	80.10	4	+	57.61	10	=	68.86	10
ARFR*	5	4.80A	82.34	2	+	63.97	9	=	73.15	9
SPBE*	3	4.33A	81.68	3	+	65.14	8	=	73.41	7
ERUM*	2	5.00A	74.15	10	+	73.07	7	=	73.61	6
AJRE	8	3.75A	71.90	11	+	74.65	6	=	73.27	8
POTA	3	4.33A	79.46	7	+	74.96	5	=	77.21	4
ANRO*	5	4.80A	77.85	8	+	76.45	4	=	77.15	5
CETO	5	4.80A	79.55	6	+	77.26	3	=	78.41	3
SESP	9	4.78A	83.13	1	+	78.17	2	=	80.65	2
VIMI	6	4.33A	79.90	5	+	84.22	1	=	82.06	1

* Indicates species is native to Montana
** CODE- See Table 1.
*** Scores for disease are based on perfect scores of 5.
**** Overall scores are presented as a percent score using the formula on page 32.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 5. Aesthetic scores for coniferous trees

		FORM***	BARK***	LEAF***	SEASONAL***	OVERALL****
TOTAL	251	8.53	3.76	4.09	8.92	84.30
CODE**	N	MEANS	MEANS	MEANS	MEANS	MEANS
LASI	23	7.30A	3.78AB	3.70A	7.39A	73.91A
PICO*	26	7.39A	3.46A	3.69A	8.31AB	76.15A
LAOC*	22	8.36AB	3.73A	4.36A	8.09AB	81.82AB
PIGL	25	8.24AB	3.60A	3.96A	9.20 BC	83.33AB
PIST	26	8.15AB	4.46 B	3.96A	8.85 BC	84.74AB
ABGR*	26	8.69AB	3.39A	4.23A	9.31 BC	85.38AB
PIPU	26	9.15 B	3.73A	4.23A	9.46 BC	88.46 B
ABLA*	26	9.31 B	3.62A	4.35A	9.31 BC	88.59 B
ABCO	26	9.23 B	3.81AB	4.31A	9.31 BC	88.84 B
PIEN*	25	9.36 B	4.00AB	4.08A	9.68 C	90.40 B

* Indicates species is native to Montana
** CODE - See Table 1.
*** Form, bark, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, and 10 respectively.
**** Overall scores are presented as a percent score using the formula on page 31.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range.

Table 6. Environmental scores for coniferous trees

	TRANSPLANT***		LIFESPAN***		PROPAGATE***		CLEANLINESS***		TEXTURE***		PH***	
TOTAL	81	4.00	84	4.51	46	4.15	89	4.12	28	3.32	21	3.33
CODE**	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
LASI	5	3.60AB	6	4.50AB	3	3.67A	6	4.17ABC	2	3.50ABC	2	4.50 C
PICO*	10	4.10AB	10	3.80A	6	4.67A	10	3.90AB	3	2.33AB	1	1.00A
LAOC*	4	4.50AB	7	4.57AB	3	4.33A	8	3.50A				
PIGL	8	4.63A	8	4.63AB	4	3.50A	8	4.00ABC	3	3.67ABC	2	3.00ABC
PISY	12	4.08AB	11	4.55AB	7	4.00A	12	4.00AB	4	4.50 C	3	3.33 BC
ABGR*	4	3.50A	5	4.60AB	3	4.33A	5	4.60 BC	1	2.00A	1	3.00ABC
PIPU	11	4.09AB	10	4.80 B	6	4.50A	12	4.17ABC	5	4.00A C	4	4.25 C
ABLA*	7	4.00AB	8	4.63AB	4	4.50A	8	4.88 C	1	3.00ABC		
ABCO	10	3.80AB	9	4.22AB	5	3.40A	9	4.56 BC	4	2.75AB	3	3.67 BC
PIEN*	10	3.60 B	10	4.90 B	5	4.40A	11	3.82AB	5	2.80AB	5	2.60AB

* Indicates species is native to Montana

** CODE- See Table 1.

*** Scores for transplant, lifespan, propagate, cleanliness, texture, pH are based on perfect scores of 5.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 6 (cont.). Environmental scores for coniferous trees.

	DROUGHT***		FLOOD***		TEMPERATURE***		LIGHT***		WIND***		INSECT***	
TOTAL	41	3.34	39	1.64	40	4.25	39	2.67	34	3.29	62	3.61
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
LASI	2	2.00A	2	2.000A	1	5.000 B	1	2.000ABCD	1	4.000A	4	4.000A
PICO*	5	4.00 BC	4	1.250A	5	4.400 B	5	1.800AB	4	3.750A	4	4.000A
LAOC*	2	2.00A	2	1.500A	2	2.500A	2	1.000A	1	3.000A	7	3.714A
PIGL	5	4.60 C	4	1.250A	5	4.800 B	5	3.200 CD	4	3.750A	4	3.000A
PISY	6	4.50 C	6	1.667A	6	4.667 B	6	2.167ABCD	5	3.400A	9	3.889A
ABGR*	1	2.00AB	1	1.000A	1	3.000AB	2	2.000ABC	2	2.000A	4	3.750A
PIPU	6	3.33ABC	7	2.143A	6	4.500 B	6	2.667 BCD	5	3.400A	10	3.400A
ABLA*	3	2.33AB	3	2.000A	4	4.000AB	3	3.333 CD	3	2.667A	6	3.833A
ABCO	4	3.25ABC	4	1.250A	4	3.500AB	4	3.250 CD	3	4.000A	5	3.600A
PIEN*	7	2.43AB	6	1.667A	6	4.333 B	5	3.800 D	6	2.833A	6	2.833A

* Indicates species is native to Montana

** CODE- See Table 1.

*** Scores for drought, flood, temperature, light, wind, and insect are based on perfect scores of 5.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 6 (cont.). Environmental scores for coniferous trees.

	DISEASE***		ENVIRONMENTAL OVERALL****		+	AESTHETIC OVERALL****		=	ORNAMENTAL OVERALL****	
TOTAL	57	4.11	69.87		+	84.30		=	77.02	
CODE**	N	MEANS	MEANS	RANK	+	MEANS	RANK	=	MEANS	RANK
LASI	4	4.000A	72.21	5	+	73.91	10	=	73.06	8
PICO*	8	3.750A	65.77	8	+	76.15	9	=	70.96	10
LAOC*	7	3.857A	62.68	9	+	81.82	8	=	72.25	9
PIGL	4	4.250A	74.26	3	+	83.33	7	=	78.79	6
PISY	8	4.125A	75.19	2	+	84.74	6	=	79.97	3
ABGR*	2	4.500A	61.97	10	+	85.38	5	=	73.68	7
PIPU	8	4.375A	76.35	1	+	88.46	4	=	82.40	1
ABLA*	5	4.400A	72.61	4	+	88.59	3	=	80.60	2
ABCO	5	4.200A	69.92	6	+	88.84	2	=	79.38	4
PIEN*	6	4.000A	67.71	7	+	90.40	1	=	79.06	5

* Indicates species is native to Montana
** CODE- See Table 1.
*** Scores for disease are based on perfect scores of 5.
**** Overall scores are presented as a percent score using the formulas on pages 32
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 7. Aesthetic scores for vines

CODE**	N	FORM***	FLOWER***	FRUIT***	LEAF***	SEASONAL***	OVERALL AESTHETIC****
TOTAL	83	7.52	3.58	3.51	4.08	6.92	73.11
HULU	23	7.65A	2.56A	2.78A	3.95A	5.91A	65.34A
LOSE	19	7.26A	4.63 B	3.05A	4.05A	6.63AB	73.63AB
CLLI*	23	7.13A	4.08 B	4.00 B	3.73A	7.39 B	75.28AB
PAQU*	18	8.11A	2.83A	4.27 B	4.72 B	7.88 B	79.52 B

* Indicates species is native to Montana
** Code - See Table 1.
*** Form, flower, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, and 10 respectively.
**** Overall scores are presented as a percent score using the formula on page 31.
NOTE: Means followed by the same letter are not significant at the .05 level for Tukey's Studentized Range.

Table 8 (con't). Environmental Scores for Vines

	INSECT***		DISEASE***		ENVIRONMENTAL OVERALL****		+	AESTHETIC OVERALL****		=	ORNAMENTAL OVERALL****	
TOTAL	20	3.95	15	4.73	79.17			73.11			76.14	
CODE**	N	MEANS	N	MEANS	MEANS	RANK	+	MEANS	RANK	=	MEANS	RANK
HULA	2	3.00A	1	5.00A	74.03	4		65.34	4		69.82	4
LOSE	7	4.14A	5	4.60A	78.88	2		73.83	3		76.36	3
CLLI*	3	5.00A	3	5.00A	78.00	3		75.28	2		76.64	2
PAQU*	8	3.63A	6	4.67A	85.77	1		79.52	1		82.65	1

* Indicates species is native to Montana
** CODE- See Table 1.
*** Scores for insect and disease are based on perfect scores of 5.
**** Overall scores are presented as a percent score using the formula on page 32.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 9. Aesthetic scores for deciduous trees

CODE**	N	FORM***	FLOWER***	FRUIT***	BARK***	LEAF***	SEASONAL***	OVERALL****
TOTAL	131	8.210	3.710	3.820	4.300	4.200	8.350	81.60
ACGL*		7.82 A		3.77 BC	4.05 AB	3.91 A	7.46 A	76.96A
BEOC*		8.00 A	3.14 A	3.27 AB	4.55 B	3.96 A	7.83 AB	77.55A
POTR*		8.00 A	3.26 A	2.91 A	4.48 B	4.39 A	7.91 AB	79.57A
ALIN*		8.17 A	3.65 A	3.91 BC	4.39 B	3.91 A	8.78 BC	79.67A
ACGI		8.84 A	3.90 AB	4.21 D C	3.68 A	4.53 A	8.95 BC	85.26AB
SOAU		8.55 A	4.64 B	4.96 D	4.55 B	4.55 A	9.27 C	91.25 B

* Indicates species is native to Montana

** Code - See Table 1.

*** Form, flower, fruit, bark, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, 5 and 10 respectively.

**** Overall scores are presented as a percent score using the formula on page 31.

NOTE: Means followed by the same letter are not significant at the .05 level for Tukey's Studentized Range.

Table 10. Environmental Scores for Deciduous Trees

	TRANSPLANT***		LIFESPAN***		PROPAGATE***		CLEANLINESS***		TEXTURE***		PH***	
TOTAL	58	4.03	61	2.98	30	4.40	62	3.32	25	3.48	19	3.32
CODE**	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
ACGL*	10	3.40A	10	3.10AB	5	4.20A	11	3.46AB	5	3.00A	4	3.50AB
BEOC*	8	3.63A	8	3.00AB	4	4.75A	8	3.13AB	3	3.33A	2	2.50AB
POTR*	14	4.00AB	15	2.33A	7	3.71A	15	3.13AB	5	4.40A	3	4.33 B
ALIN*	6	5.00 B	7	2.86AB	3	5.00A	7	3.86 B	3	3.33A	2	4.00AB
ACGI	8	4.25AB	9	3.33 B	4	4.75A	9	4.00 B	4	3.75A	3	3.67AB
SOAU	12	4.25AB	12	3.50 B	7	4.57A	12	2.75A	5	3.00A	5	2.40A

	DROUGHT***		FLOOD***		TEMPERATURE***		LIGHT***		WIND***	
TOTAL	32	2.41	30	3.17	33	4.30	30	3.20	29	3.76
CODE**	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
ACGL*	6	1.67AB	5	4.00 C	5	4.20A	4	4.00 B	5	4.40 B
BEOC*	4	3.50 C	4	4.25 D	4	5.00A	3	3.00AB	3	4.00AB
POTR*	8	2.63 BC	7	1.86A	8	4.63A	8	2.38A	7	2.57A
ALIN*	4	1.00A	4	5.00 D	4	3.75A	4	4.00 B	4	4.25 B
ACGI	4	3.50 C	4	3.00 BC	5	4.20A	5	3.20AB	4	4.00AB
SOAU	6	2.33ABC	6	2.17AB	7	4.00A	6	3.33AB	6	4.00AB

* Indicates species is native to Montana
** CODE- See Table 1.
*** Scores for transplant, lifespan, propagate, cleanliness, texture, pH, drought, flood, temperature, light, wind are based on perfect scores of 5.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 10 (con't). Environmental Scores for deciduous trees

	INSECT***		DISEASE***		ENVIRONMENTAL OVERALL****		+	AESTHETIC OVERALL****		=	ORNAMENTAL OVERALL****	
TOTAL	46	3.28	47	3.06	70.74			81.60			76.17	
CODE**	N	MEANS	N	MEANS	MEANS	RANK	+	MEANS	RANK	=	MEANS	RANK
ACGL*	8	3.63AB	8	3.50 B	70.86	4		76.96	6		73.91	5
BEOC*	6	3.33AB	6	3.83 B	72.69	3		77.55	5		75.12	4
POTR*	13	2.92AB	14	2.29A	63.35	5		79.57	4		71.46	6
ALIN*	4	4.25 B	5	4.40 B	78.00	1		79.67	3		78.84	2
ACGI	6	4.00 B	5	4.20 B	76.69	2		85.26	2		80.98	1
SOAU	9	2.56A	9	2.00A	62.86	6		91.25	1		77.06	3

* Indicates species is native to Montana
** CODE- See Table 1.
*** Scores for insect and disease are based on perfect scores of 5.
**** Overall scores are presented as a percent score using the formula on page 32.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 11. Aesthetic scores for deciduous and broadleaved evergreen shrubs

CODE**	N	FORM***	FLOWER***	FRUIT***	LEAF***	SEASONAL***	OVERALL****
TOTAL	250	7.63	4.01	3.11	3.94	7.36	74.44
PHVI	24	6.17A	4.21 CDE	2.25A	3.17A	5.42A	61.31A
PHLE*	23	7.13AB	4.44 DE	2.44AB	3.57AB	6.17AB	67.82AB
PUTR*	21	7.43ABC	3.81ABCD	2.47AB	3.57AB	7.14 BCDE	69.38AB
RIAL	21	8.38 BC	3.19AB	2.76AB	3.81ABC	6.52ABC	70.34ABC
SYVU	23	8.00ABC	4.78E	2.48AB	3.44AB	6.78ABCD	72.79ABC
CELE*	22	7.55ABC	3.09A	3.00ABC	4.00 BC	8.36 DE	74.28 BCD
CEVE*	23	7.91ABC	4.26 CDE	2.61AB	4.44 C	7.39 BCDE	76.02 BCD
RHTR*	24	6.75AB	3.46ABC	4.42D	4.38 C	8.00 CDE	77.14 BCD
RIAU*	24	7.25AB	4.46 DE	3.83D C	4.04 BC	8.17 DE	79.28 BCD
VIOP	21	9.14 C	3.95 BCDE	3.24 BC	4.48 C	8.38 DE	83.40 CD
MAAQ	24	8.50 BC	4.33 DE	4.50D	4.46 C	8.58	86.78 D

* Indicates species is native to Montana.
** CODE - See Table 1.
*** Form, flower, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, and 10 respectively.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range.

Table 12. Environmental scores for deciduous and broadleaved evergreen shrubs.

	TRANSPLANT***		LIFESPAN***		PROPAGATE***		CLEANLINESS***		TEXTURE***		PH***	
CODE**	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
TOTAL	85	4.13	84	3.89	49	4.06	89	3.88	36	3.69	28	3.68
PHVI	8	4.37D C	8	3.50AB	5	3.600 B	9	3.111A	4	2.750A	3	3.000AB
PHLE*	8	4.75D	8	4.25 BC	4	5.000 B	8	4.375 CD	2	3.500AB	1	3.000AB
PUTR*	4	2.25AB	5	3.40AB	3	3.667 B	4	5.000 D	1	5.000 B	1	5.000 B
RIAL	11	4.81D	8	4.12 BC	6	4.833 B	10	4.300 CD	4	4.500 B	4	4.000AB
SYVU	10	4.60D C	10	5.00 C	6	4.167 B	10	2.900A	4	4.250 B	4	4.000AB
CELE*	6	3.50 BC	7	4.71 C	3	4.333 B	6	4.833 D	3	3.333AB	4	4.000AB
CEVE*	8	1.50A	7	3.28AB	4	1.500A	7	3.286AB	2	3.000AB	1	3.000AB
RHTR*	8	4.50D C	8	4.12 BC	4	4.750 B	9	4.556 D	4	4.250 B	3	4.667 B
RIAU*	8	4.50D C	8	3.62AB	6	4.167 B	10	4.200 BCD	5	4.200 B	3	4.000AB
VIOP	8	4.62D C	8	3.25AB	6	3.833 B	9	3.556ABC	4	3.250AB	4	3.250AB
MAAQ	6	4.66D C	7	3.00A	2	5.000 B	7	3.286AB	3	2.667A	2	2.000A

* Indicates species is native to Montana.
** CODE - See Table 1.
*** Scores for transplant, lifespan, propagate, cleanliness, texture, pH, are based on perfect scores of 5.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Difference.

Table 12. (con't). Environmental scores for deciduous and broadleaved evergreen shrubs.

		DROUGHT***		FLOOD***		TEMPERATURE***		LIGHT***		WIND***		INSECT***	
CODE**	N	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
TOTAL		51	3.41	45	1.98	52	3.87	52	3.23	49	4.39	56	4.07
PHVI	41	5	2.40AB	5	2.40 CD	5	2.60AB	5	2.80 BC	5	4.40 B	4	3.25AB
PHLE*	42	2	2.50ABC	3	2.33 BCD	3	4.00 BC	3	3.33ABC	3	4.67 B	5	4.80 C
PUTR*	35	3	4.33A C	3	1.00A	3	3.67 BC	3	2.00AB	3	4.67 B	3	5.00 C
RIAL	36	7	3.43 BC	5	3.00E D	6	4.67 C	7	4.71 E	5	4.20 B	6	4.83 C
SYVU	39	6	4.33 DC	5	2.20 BCD	6	4.67 C	6	3.00DBC	6	4.67 B	9	3.00A
CELE*	33	5	5.00 D	4	1.00A	4	4.25 C	4	1.50A	4	4.75 B	4	5.00 C
CEVE*	38	3	4.00 DC	3	1.33AB	3	2.67AB	3	3.33DBC	3	4.67 B	4	4.00ABC
RHTR*	37	5	5.00 D	5	1.00A	5	4.60 C	5	3.00DBC	5	5.00 B	6	5.00 C
RIAU*	40	6	2.33AB	5	3.40 E	6	4.50 C	6	4.00 DE	5	4.80 B	4	3.75ABC
VIOP	34	5	2.40AB	4	1.75ABC	6	4.17 C	6	3.83DCE	6	4.50 B	7	3.14AB
MAAQ	32	4	1.50A	3	1.33AB	5	1.80A	4	2.25AB	4	1.75A	4	4.25 BC

* Indicates species is native to Montana.
** CODE - See Table 1.
*** Scores for drought, flood, temperature, light, wind, insect are based on perfect scores of 5.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Difference.

Table 12 (con't). Environmental scores for deciduous and broadleaved evergreen shrubs.

		DISEASE***	OVERALL ENVIRONMENTAL****		+	OVERALL AESTHETIC****		=	OVERALL ORNAMENTAL****	
CODE**	N	N	MEANS	MEANS	RANK		MEANS	RANK	MEAN	RANK
TOTAL		58	4.24	74.04		+	74.44		= 74.24	
PHVI	41	5	3.800A	64.12	9		61.31	11	62.72	11
PHLE*	42	5	4.800A	78.94	4		67.82	10	73.38	6
PUTR*	35	4	5.000A	76.91	7		69.38	9	73.15	8
RIAL	36	7	4.000A	85.23	1		70.34	8	77.79	3
SYVU	39	9	3.778A	77.80	6		72.79	7	75.30	7
CELE*	33	4	4.750A	78.38	5		74.28	6	76.33	5
CEVE*	38	3	4.000A	60.88	10		76.02	5	68.75	10
RHTR*	37	6	4.833A	85.05	2		77.14	4	81.10	1
RIAU*	40	5	4.200A	79.49	3		79.28	3	79.38	2
VIOP	34	5	4.200A	70.23	8		83.40	2	76.82	4
MAAQ	32	5	3.800A	57.38	11		86.78	1	72.08	9

* Indicates species is native to Montana.
** CODE - See Table 1.
*** Scores for disease are based on perfect scores of 5.
**** Overall scores are presented as a percent score using the formula on page 32.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Difference.

Table 13. Aesthetic scores for juniper shrubs

CODE**	N	FORM***	FRUIT***	LEAF***	SEASONAL***	OVERALL****
OVERALL	47	8.51	3.77	3.87	8.49	82.05
JUCO*		8.52A	3.69A	3.78A	8.48A	81.45A
JUCH		8.50A	3.83A	3.96A	8.50A	82.64A

* Indicates species is native to Montana
** Code - See Table 1.
*** Form, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, and 10 respectively.
**** Overall scores are presented as a percent score using the formula on page 31.
NOTE: Means followed by the same letter are not significant at the .05 level for Tukey's Studentized Range.

Table 14. Environmental Scores for Juniper Shrubs

	TRANSPLANT***		LIFESPAN***		PROPAGATE***		CLEANLINESS***		TEXTURE***		PH***	
TOTAL	23	4.52	25	4.24	12	4.00	25	4.36	10	4.10	9	4.11
CODE**	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
JUCO*	11	4.18A	13	4.39A	6	3.83A	13	4.23A	5	4.40A	4	4.25A
JUCH	12	4.83 B	12	4.08A	6	4.17A	12	4.50A	5	8.30A	5	4.00A

	DROUGHT***		FLOOD***		TEMPERATURE***		LIGHT***		WIND***	
TOTAL	13	4.39	13	1.46	13	4.23	13	3.00	14	4.64
CODE**	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
JUCO*	7	4.43A	6	1.33A	7	4.23A	6	4.00 B	7	4.71A
JUCH	6	4.33A	7	1.57A	6	4.00A	7	2.14A	7	4.57A

* Indicates species is native to Montana
** CODE- See Table 1.
*** Scores for transplant, lifespan, propagate, cleanliness, texture, pH, drought, flood, temperature, light, wind are based on perfect scores of 5.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 14 (con't). Environmental Scores for juniper shrubs

	INSECT***		DISEASE***		ENVIRONMENTAL OVERALL****		+	AESTHETIC OVERALL****		=	ORNAMENTAL OVERALL****	
TOTAL	17	4.12	18	3.83	78.37			82.05			80.21	
CODE **	N	MEANS	N	MEANS	MEANS	RANK	+	MEANS	RANK	=	MEANS	RANK
JUCO*	9	4.11A	9	3.44A	79.28	1		81.45	2		80.37	1
JUCH	8	4.13A	9	4.22A	77.45	2		82.64	1		80.05	2

* Indicates species is native to Montana
** CODE- See Table 1.
*** Scores for insect and disease are based on perfect scores of 5.
**** Overall scores are presented as a percent score using the formula on page 32.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 15. Native groundcovers versus exotic groundcovers group comparisons for aesthetic scores

CODE	N	FORM*	FLOWER*	FRUIT*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	265	7.57	3.82	2.72	4.05	6.68	70.92
NATIVE	149	6.82A	3.33A	2.74	3.75A	6.30A	65.48A
EXOTIC	116	8.63 B	4.44 B	2.70	4.42 B	7.18 B	77.90 B

* Form, flower, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, and 10 respectively.
** Overall scores are presented as a percent scores, using the formula on page 31.
NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 16. Evaluator group comparisons for groundcover aesthetic scores

CODE	N	FORM*	FLOWER*	FRUIT*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	265	7.57	3.82	2.72	4.05	6.68	70.92
NURSERYMEN	76	7.34 A	3.58 A	2.61 A	3.97 A	6.47 A	68.49 A
DESIGNER/ARCH	85	7.77 A	4.00 AB	2.78 A	4.14 A	6.82 A	72.87 A
BOTANIST	55	7.93 A	4.11 B	2.89 A	4.18 A	6.56 A	73.19 A
HORTICULTURIST	49	7.18 A	3.53 A	2.61 A	3.84 A	6.90 A	68.74 A

* Form, flower, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 17. Native groundcovers versus exotic groundcovers group comparisons for environmental scores

	TRANSPLANT*		LIFESPAN*		PROPAGATE*		CLEANLINESS*		TEXTURE*		PH*		DROUGHT*	
TOTAL	83	4.42	83	4.13	71	4.54	89	3.72	52	3.96	37	3.92	57	3.91
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	37	4.08 A	38	3.95 A	29	4.31 A	42	3.67 A	25	3.80 A	18	4.06 A	30	4.53A
EXOTIC	46	4.70 A	45	4.29 A	42	4.69 A	47	3.77 A	27	4.11 A	19	3.79 A	27	3.22 B

	FLOOD*		TEMPERATURE*		LIGHT*		WIND*		INSECT*		DISEASE*	
TOTAL	51	1.63	58	4.45	58	2.64	57	4.65	52	4.62	51	4.55
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	29	1.38 A	32	4.72 A	31	2.32 A	31	4.77 A	21	4.71 A	20	4.39 A
EXOTIC	22	1.96 B	26	4.12 B	27	3.00 A	26	4.50 A	31	4.71 A	31	4.80 A

* Scores for Transplant, lifespan, propagate, cleanliness, texture, pH, drought, flood temperature, light, wind, insect, and disease are based on perfect scores of 5.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 18. Native coniferous trees versus exotic coniferous trees group comparisons for aesthetic scores

CODE	N	FORM*	BARK*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	251	8.53	3.76	4.09	8.92	84.30
NATIVE	125	8.62 B	3.63A	4.14A	8.96A	84.50A
EXOTIC	126	8.44A	3.88 B	4.04A	8.88A	84.10A

* Form, bark, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 19. Evaluator group comparisons for coniferous trees aesthetic scores

CODE	N	FORM*	BARK*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	251	8.53	3.76	4.09	8.92	84.08
NURSERYMEN	74	8.24 A	3.76 A	3.96 A	8.78 A	82.27 A
DESIGNER/ARCH	80	8.40 A	3.56 A	4.00 A	7.78 A	82.30 A
BOTANIST	48	9.38 B	4.35 B	4.56 B	9.58 B	92.91 B
HORTICULTURIST	49	8.37 A	3.49 A	3.96 A	8.69 A	81.07 A

* Form, bark, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 20. Native coniferous trees versus exotic coniferous trees group comparisons for environmental scores.

	TRANSPLANT*		LIFESPAN*		PROPAGATE*		CLEANLINESS*		TEXTURE*		PH*		DROUGHT*	
TOTAL	81	4.00	84	4.51	46	4.15	89	4.12	28	3.32	21	3.33	41	3.34
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	35	3.91 A	40	4.48 A	21	4.48 A	42	4.07 A	10	2.60 A	7	2.43 A	18	2.78 A
EXOTIC	46	4.07 A	44	4.55 A	25	3.88 A	47	4.17 A	18	3.72 A	14	3.79 A	23	3.78 B

	FLOOD*		TEMPERATURE*		LIGHT*		WIND*		INSECT*		DISEASE*	
TOTAL	39	1.64	40	4.25	39	2.67	34	3.29	62	3.61	57	4.11
CODE*	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	16	1.56 A	18	4.00 A	17	2.59 A	16	2.94 A	30	3.63 A	28	4.00 A
EXOTIC	23	1.70 A	22	4.46 A	22	2.73 A	18	3.61 A	32	3.59 A	29	4.21 A

* Scores for Transplant, lifespan, propagate, cleanliness, texture, pH, drought, flood temperature, light, wind, insect, and disease are based on perfect scores of 5.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 20. Native coniferous trees versus exotic coniferous trees group comparisons for environmental scores.

	TRANSPLANT*		LIFESPAN*		PROPAGATE*		CLEANLINESS*		TEXTURE*		PH*		DROUGHT*	
TOTAL	81	4.00	84	4.51	46	4.15	89	4.12	28	3.32	21	3.33	41	3.34
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	35	3.91 A	40	4.48 A	21	4.48 A	42	4.07 A	10	2.60 A	7	2.43 A	18	2.78 A
EXOTIC	46	4.07 A	44	4.55 A	25	3.88 A	47	4.17 A	18	3.72 A	14	3.79 A	23	3.78 B

	FLOOD*		TEMPERATURE*		LIGHT*		WIND*		INSECT*		DISEASE*	
TOTAL	39	1.64	40	4.25	39	2.67	34	3.29	62	3.61	57	4.11
CODE*	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	16	1.56 A	18	4.00 A	17	2.59 A	16	2.94 A	30	3.63 A	28	4.00 A
EXOTIC	23	1.70 A	22	4.46 A	22	2.73 A	18	3.61 A	32	3.59 A	29	4.21 A

* Scores for Transplant, lifespan, propagate, cleanliness, texture, pH, drought, flood temperature, light, wind, insect, and disease are based on perfect scores of 5.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 21. Native vines versus exotic vines group comparisons for aesthetic scores

CODE	N	FORM*	FLOWER*	FRUIT*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	83	7.52	3.52	3.51	4.08	6.92	73.11
NATIVE	41	7.56A	3.54A	4.12 B	4.17A	7.61 B	77.14 B
EXOTIC	42	7.48A	3.50A	2.90A	4.00A	6.24A	69.18A

* Form, flower, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 22. Evaluator group comparisons for vine aesthetic scores

CODE	N	FORM*	FLOWER*	FRUIT*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	83	7.52	3.52	3.51	4.08	6.92	73.11
NURSERYMEN	18	7.00 A	3.50 AB	3.67 A	4.06 AB	7.11 A	72.38 AB
DESIGNER/ARCH	29	7.86 A	3.55 AB	3.55 A	4.03 AB	6.76 A	73.99 AB
BOTANIST	18	7.78 A	4.06 B	3.78 A	4.50 B	7.56 A	79.04 B
HORTICULTURIST	18	7.22 A	2.94 A	3.00 A	4.78 A	6.33 A	66.50 A

* Form, flower, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 23. Native vines versus exotic vines group comparisons for environmental scores

	TRANSPLANT*		LIFESPAN*		PROPAGATE*		CLEANLINESS*		TEXTURE*		PH*		DROUGHT*	
TOTAL	29	4.66	31	4.39	22	4.64	32	3.47	17	4.06	12	4.00	21	3.33
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	15	4.73 A	17	4.47 A	11	4.82 A	18	3.39 A	10	4.10 A	7	4.14 A	12	3.50 A
EXOTIC	14	4.57 A	14	4.29 A	11	4.46 A	14	3.57 A	7	4.00 A	8	2.38 A	11	4.09 A

	FLOOD*		TEMPERATURE*		LIGHT*		WIND*		INSECT*		DISEASE*	
TOTAL	17	2.34	23	4.44	22	3.86	20	3.95	12	3.95	15	4.33
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	9	2.11 A	12	4.75 A	12	4.17 A	11	3.90 A	11	4.00 A	9	4.89 B
EXOTIC	10	3.50 A	9	4.00 A	9	3.89 A	9	4.00 A	9	3.89 A	6	3.50 A

* Scores for Transplant, lifespan, propagate, cleanliness, texture, pH, drought, flood temperature, light, wind, insect, disease are based on perfect scores of 5.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 24. Native deciduous trees versus exotic deciduous trees group comparisons for aesthetic scores

CODE	N	FORM*	N	FLOWER*	N	FRUIT*	BARK*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	131	8.21	109	3.71	131	3.82	4.30	4.20	8.35	81.60
NATIVE	90	8.00 A	41	3.35 A	90	3.47 A	4.37 A	4.04 A	8.00 A	78.46 A
EXOTIC	41	8.68 B	68	4.29 B	41	4.61 B	4.15 A	4.54 B	9.12 B	88.48 B

* Form, flower, fruit, bark, leaf and seasonal scores are based upon a perfect score of 10, 5, 5, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 25. Evaluator group comparisons for deciduous tree aesthetic scores

CODE	N	FORM*	N	FLOWER*	N	FRUIT*	BARK*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	131	8.21	109	3.82	131	4.298	4.20	4.20	8.35	81.60
NURSERYMEN	28	7.86 A	23	3.87 AB	28	3.81 AB	4.21	4.25 A	8.79 BC	82.31 AB
DESIGNER/ARCH	45	8.44 A	27	3.49 AB	45	3.84 AB	4.27 A	4.20 A	8.04 AB	80.98 AB
BOTANIST	27	8.67 A	22	4.31 B	27	4.30 B	4.56 A	4.41 A	9.11 C	88.27 B
HORTICULTURIST	31	7.81 A	27	3.37 A	31	3.39 A	4.19 A	3.97 A	7.74 A	76.05 A

* Form, flower, fruit, bark, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 26. Native deciduous trees versus exotic deciduous trees group comparisons for environmental scores

	TRANSPLANT*		LIFESPAN*		PROPAGATE*		CLEANLINESS*		TEXTURE*		PH*		DROUGHT*	
TOTAL	58	4.03	61	2.98	30	4.40	62	3.32	25	3.48	19	3.32	32	2.41
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	38	3.92 A	40	2.75 A	19	4.26 A	41	3.34 A	16	3.56 A	11	3.64 A	22	2.23 A
EXOTIC	20	4.25 A	21	3.43 B	11	4.64 A	21	3.29 A	9	3.33 A	8	2.88 A	10	2.80 A

	FLOOD*		TEMPERATURE*		LIGHT*		WIND*		INSECT*		DISEASE*	
TOTAL	30	3.17	33	4.30	30	3.20	29	3.76	46	3.28	47	3.06
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	20	3.50 A	21	4.43 A	19	3.16 A	19	3.63 A	31	3.36 A	33	3.18 A
EXOTIC	10	2.50 A	12	4.08 A	11	3.27 A	10	4.00 A	15	3.13 A	14	2.79 A

* Scores for Transplant, lifespan, propagate, cleanliness, texture, pH, drought, flood temperature, light, wind, insect, disease are based on perfect scores of 5

NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 27. Native deciduous and broadleaved evergreen shrubs versus exotic deciduous and broadleaved evergreen shrubs for aesthetic scores

CODE	N	FORM*	FLOWER*	FRUIT*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	250	7.63	4.01	3.11	3.94	7.36	74.44
NATIVE	137	7.33 A	3.93 A	3.15 A	4.01 A	7.55 A	74.12 A
EXOTIC	113	8.00 B	4.12 A	3.05 A	3.86 A	7.12 A	74.84 A

* Form, flower, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 28. Evaluator group comparisons for deciduous and broadleaved evergreen shrub aesthetic scores

CODE	N	FORM*	FLOWER*	FRUIT*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	250	7.63	4.01	3.11	3.94	7.36	74.44
NURSERYMEN	55	7.13 A	4.09 A	2.93 A	3.78 A	7.26 A	71.74 A
DESIGNER/ARCH	84	7.24 A	3.88 A	3.16 AB	3.88 A	7.14 A	72.48 A
BOTANIST	53	8.72 B	4.26 A	3.53 B	4.42 B	8.38 B	83.72 B
HORTICULTURIST	58	7.69 A	3.90 A	2.83 A	3.74 A	6.83 A	71.37 A

* Form, flower, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

Table 29. Native deciduous and broadleaved evergreen shrubs versus exotic deciduous and broadleaved evergreen shrubs for environmental scores

	TRANSPLANT*		LIFESPAN*		PROPAGATE*		CLEANLINESS*		TEXTURE*		PH*		DROUGHT*	
TOTAL	87	4.13	86	3.85	50	4.08	91	3.86	36	3.69	28	3.68	51	3.41
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	41	3.59 A	43	3.86 A	23	3.96 A	43	4.30 B	15	3.87 A	9	4.11 A	22	3.00 A
EXOTIC	46	4.61 B	43	3.84 A	27	4.19 A	48	3.46 A	21	3.57 A	19	3.47 A	29	3.96 A

	FLOOD*		TEMPERATURE*		LIGHT*		WIND*		INSECT*		DISEASE*	
TOTAL	45	1.98	52	3.87	52	3.23	49	4.39	58	4.10	60	4.17
CODE	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS	N	MEANS
NATIVE	21	1.71 A	22	3.77 A	22	2.86 A	21	4.76 B	25	4.64 B	26	4.46 A
EXOTIC	24	2.21 A	30	4.00 A	30	3.50 A	28	4.11 A	33	3.70 A	34	3.94 A

* Scores for Transplant, lifespan, propagate, cleanliness, texture, pH, drought, flood temperature, light, wind, insect, disease are based on perfect scores of 5.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Least Significant Differences.

Table 30. Evaluator group comparison for juniper shrub aesthetic scores

CODE	N	FORM*	FRUIT*	LEAF*	SEASONAL*	OVERALL AESTHETIC**
TOTAL	47	8.51	3.77	3.87	8.49	82.05
NURSERYMEN	9	6.89 A	3.56 A	3.56 A	6.78 A	68.89 A
DESIGNER/ARCH	16	8.88 B	3.63 A	3.94 A	8.75 B	83.95 B
BOTANIST	10	8.60 AB	4.30 A	4.10 A	9.20 B	87.33 B
HORTICULTURIST	12	9.17 B	3.67 A	3.83 A	8.83 B	85.00 B

* Form, fruit, leaf, and seasonal scores are based upon a perfect score of 10, 5, 5, and 10 respectively.

** Overall scores are presented as a percent scores, using the formula on page 31.

NOTE: Means followed by the same letter are not significantly different at the .05 level for Tukey's Studentized Range

APPENDIX E

THE ENVIRONMENTAL SCORECARD

The Environmental Scorecard

The following Appendix presents information related to the Environmental Scorecard. In order of appearance are:

1) The evaluator request letter and matrix;
2) An example Scorecard, illustrating the content and format of the Scorecards received by evaluators;
3) A list of evaluators who participated in the scoring process;
4) Species information.

The species information pages contain information sent to the evaluators, evaluator comments gleaned from returned Scorecards (referenced by evaluator names as listed on Page 139), and additional information compiled on the native species. This additional material includes information on current use and value, sources of description, availability (referenced to addresses appearing in Appendix C), habitat types, and native ranges.

Where information available from the literature is not presented, it was not listed in the references reviewed by this research. Evaluator comments are listed only when they were written on returned Scorecards. No verbal comments are included.

Evaluator Request Letter

January 28, 1985

Shelly Bruce
P&SS Dept., Leon Johnson Hall
Montana State University
Bozeman, Montana

Dear Sir/Madam:

I am a graduate student at Montana State University pursuing a research project which evaluates the ornamental potential of a number of plant species native to Montana. With the increased awareness and interest in native plants which has taken place during the past decade, there has been an increased demand for natives at the retail level. Here in Montana certain native species have become very popular and are commonly available, often in improved forms: Green Ash (Fraxinus pennsylvanica), Quaking Aspen (Populus tremuloides), Shrubby cinquefoil (Potentilla fruticosa) and Red Twig Dogwood (Cornus sericea). But the selection of other native species for exposure seems to be a very arbitrary and subjective process. A species one author or researcher thinks has good ornamental potential may be another's "trash tree".

The problem I hope to resolve is this subjective method of plant selection. Through the use of two complementary ornamental scorecards, one on aesthetic qualities, the other on environmental factors, a sound, objective basis for the selection of desirable species will be presented.

I am currently assembling a panel of professional evaluators to assist me with my Environmental Scorecard. This system will evaluate 44 different plant species on various cultural requirements, cultural problems, and adaptations, using a numeric scale. Approximate time commitment would vary with the number of plants and categories you evaluate. The project will run from now through September, 1985.

Enclosed is a matrix including the 44 species that I am evaluating. Included are species native to the northwest which have potential as ornamentals and species which are currently popular in the Montana retail market. Each species will be scored in each of 11 categories. These categories are described on the enclosed sheet titled Instructions and Guidelines for Evaluation. If you (or someone with your organization), has experience with any of these plants or a closely related plant in any of the categories, and would like to participate in this project, please check those species in those

categories you feel personally qualified to evaluate. Do not check species or categories that you have not had personal experience with. Remember, you are not scoring at this time. You will be sent the actual scorecard for those plants and categories that you check here at a later date.

When you have checked each species in each category please return the matrix to me using the enclosed envelope. Thank you for your time and for sharing your knowledge with me. I'll be glad to share the final results with you if you are interested.

I feel this is an exciting opportunity to share and compile much information on several of our native species. It is this type of information that is needed to enable growers to propagate and grow these species in order to make them available on the retail market.

Sincerely,

Shelly E. Bruce

NAME:
PHONE:

Check only those species categories you are to score.

	TRANSPLANTABILITY	LIFESPAN	PROPAGATION	MAINTENANCE/ CLEANLINESS	SOIL:PH AND TEXTURE	MOISTURE REGIME ADAPTABILITY	EXPOSURE	INSECTS	DISEASE
EVERGREEN TREES									
Abies grandis									
Abies lasiocarpa									
Picea engelmannii									
Pinus contorta v. latifolia									
Abies concolor									
Picea glauca v. densata									
Picea pungens									
Pinus sylvestris									
EVERGREEN SHRUBS									
Juniperus communis									
Juniperus chinensis 'Pfitzeriana'									
DECIDUOUS TREES									
Acer glabrum									
Alnus incana									
Betula occidentalis									
Larix occidentalis									
Populus tremuloides									

	TRANSPLANTABILITY	LIFESPAN	PROPAGATION	MAINTENANCE/ CLEANLINESS	SOIL:PH AND TEXTURE	MOISTURE REGIME ADAPTABILITY	EXPOSURE	INSECTS	DISEASE
Acer ginnala									
Larix siberica									
Sorbus aucuparia									
DECIDUOUS SHRUBS									
Ceanothus velutinus									
Cercocarpus ledifolius									
Philadelphus lewisii									
Purshia tridentata									
Rhus trilobata									
Ribes aureum									
Berberis aquifolium									
Philadelphus x virginalis									
Ribes alpinum									
Syringa vulgaris									
Viburnum trilobum 'Compacta'									
GROUNDCOVERS									
Anaphalis margaritacea									
Antennaria rosea									
Artemisia cana									

	TRANSPLANTABILITY	LIFESPAN	PROPAGATION	MAINTENANCE/ CLEANLINESS	SOIL:PH AND TEXTURE	MOISTURE REGIME ADAPTABILITY	EXPOSURE	INSECTS	DISEASE
Artemisia frigida									
Eriogonum umbellatum									
Spiraea betulifolia									
Ajuga reptans									
Cerastium tomentosum									
Potentilla tabernaimontanii									
Sedum spurium									
Vinca minor									
VINES									
Clematis ligusticifolia									
Parthenocissus quinquefolia									
Humulus Lupulus									
Lonicera sempervirens									

Shelly E. Bruce
P&SS Dept., Leon Johnson Hall
Montana State University
Bozeman, Montana 59717

Dear Sir/Madam:

A few months ago I contacted you concerning an Environmental scorecard evaluating several plant species native to Montana and several other species commonly used as ornamentals in Montana landscapes. You agreed to act as an evaluator for this scorecard. Some problems arose which delayed the release of the scorecard until now. I apologize for any inconvenience this may have caused you.

Enclosed are evaluation sheets on each plant you agreed to score. Each sheet lists each category you checked on the matrix for each species you felt qualified to evaluate. Information I have compiled from available literature has been outlined on each category. Please give each species your own personal score in each category highlighted using the attached quidelines. The literature information is made available only as a reference for your additional comments. Any extra information and input you can contribute is welcomed and greatly appreciated. It is your valuable experience that will make this a successful and valuable tool. I, in turn, am happy to share any information and sources I have available on any of these species with you. The bibliography is enclosed for your information and is yours to keep.

When you have scored each species in each category please return the sheets to me using the enclosed envelope. I would appreciate its return by July 3 if at all possible. Thank you for your time and for sharing your knowledge with me. I'll be glad to share the final results with you if you are interested.

Sincerely,

Shelly E. Bruce

Instructions and guidelines for evaluation:

Evaluate each species on the following qualities as defined below. A species will be rated 1, 2, 3, 4, or 5 as described below.

You will be scoring only those categories highlighted in yellow. These are the categories you checked in the original matrix. Remember, I am looking for your own personal evaluation of each species based on your experience and knowledge. The information from the literature is provided only to clarify what your score should be based on and to act as a reference for your additional comments. This information is based on several common, reliable plant references. When no information is provided this indicates a lack of reference material on this particular subject. It is in these cases that your additional comments will be particularly valuable.

Described below are the categories each species will be scored on. Please review these definitions and explanations carefully so as to make evaluations consistent with those of my other professional evaluators.

TRANSPLANTABILITY: Ease and success of transplanting.

0=No knowledge of this species.
1=Poor success. Difficult to transplant.
2=
3=Moderate success.
4=
5=Excellent success. Easily transplanted.

LIFESPAN: Life of quality ornamental characteristics for this type of plant. (Life expectancies vary according to plant type: tree vs. shrub vs. groundcover. Score each species according to plant type. Do not compare different types.)

0=No knowledge of this species.
1=Short lifespan.
2=
3=Moderate lifespan.
4=
5=Long lifespan.

PROPAGATION: Ease of sexual and/or asexual propagation.

0=No knowledge of this species.
1=Poor success. Difficult to propagate.
2=
3=Moderate success.
4=
5=Excellent success. Easy to propagate.

MAINTENANCE/CLEANLINESS: Amount of labor required to maintain the specimen in satisfactory condition. This includes the chemical control of insects and disease. Amount of litter created by the plant (fruit, branches etc.), and ability to compete with weeds during establishment of groundsovers.

0=No knowledge of this species.
1=High maintenance requirements and/or high litter.
2=
3=Moderate maintenance requirements and/or moderate litter.
4=
5=Low maintenance requirements and/or low litter. Care free.

SOIL ADAPTABILITY:

Texture: Clay vs. sandy, gravelly.

0=No knowledge of this species.
1=Narrow range of adaptability. Extreme soil amendment required for plant survival.
2=
3=Moderate range of adaptability.
4=
5=Wide range of adaptability. Little or no soil amendment required for plant survival.

pH: Acidic vs. alkaline.

0=No knowledge of this species.
1=Narrow range of adaptability. Extreme soil amendment required for plant survival.
2=
3=Moderate range of adaptability.
4=
5=Wide range of adaptability. Little or no soil amendment required for plant survival.

MOISTURE REGIME ADAPTABILITY

Drought Tolerance: Survival of plant in hot dry environment.

Hightshoe references to urban drought-heat resistance correlate to drought tolerance.

0=No knowledge of this species.
1=Not tolerant. Poor survival in dry conditions.
2=
3=Moderate tolerance.
4=
5=Very tolerant. Good survival in dry conditions.

Flood Tolerance: Survival of plant in wet, boggy conditions.

0=No knowledge of this species.
1=Not tolerant. Poor survival in wet, boggy conditions.
2=
3=Moderate tolerance.
4=
5=Very tolerant. Good survival in wet, boggy conditions.

EXPOSURE:

Temperature: Survival of plant in extreme temperatures. Survival of plant in extreme exposures and range of exposure a plant is adapted to. Hightshoe, Dirr, and Hortus III use the U.S.D.A. Hardiness Zones. Reilly and Wyman use the Arnold Arboretum Hardiness Zones. References from Casement refer to adaptability of this plant for use in the Brooks, Alberta area. The similarity of climate between the Brooks region and parts of Montana and the many ornamental plants common to both regions allow us to use these Brooks, Alberta recommendations as a reference guide to new species for Montana landscapes. Elevation information from Van Dersal may provide some indication as to the range of climatic conditions to which this plant is tolerant.

0=No knowledge of this species.
1=Poor survival in extreme temperatures. Narrow range of adaptability.
2=
3=Moderate survival in extreme temperatures.
4=
5=Good survival in extreme temperatures. Wide range of temperature adaptability.

Light: Survival of plant in extreme light conditions. Hightshoe shade index values are defined as 8-10 very tolerant of shade; 6-7.9 tolerant; 4-5.9 intermediate; 2-3.9 intolerant; 0-1.9 very intolerant.

0=No knowledge of this species.
1=Narrow adaptive range to different light levels.
2=
3=Moderate adaptive range to different light levels.
4=
5=Wide adaptive range to different light levels.

Wind: Susceptibility to wind damage.

0=No knowledge of this species.
1=Extremely susceptible to wind damage.
2=
3=Moderately susceptible to wind damage.
4=
5=Extreme resistance to wind damage.

INSECTS: Susceptibility of the species to insect problems.

0=No knowledge of this species.
1=Species is susceptible to insect problems. Insect control requirements are high.
2=
3=Species has moderate resistance to insect problems.
4=
5=Species is resistant to insect problems. Insect control requirements are low.

DISEASE: Susceptibility of the species to disease problems.

0=No knowledge of this species.
1=Species is susceptible to disease problems. Disease control requirements are high.
2=
3=Species has moderate resistance to disease problems.
4=
5=Species is resistant to disease problems. Disease control requirements are low.

EXAMPLE SCORECARD

Scientific Name: Abies concolor (Gord. & Glend.) Lindl. ex Hildebr.

Common Name(s): Concolor Fir, White Fir

Transplantability:

Information available from the literature: Good success when transplanting young trees. Larger old trees are subject to desiccation (Sutton,1974). Transplants readily as small B&B tree in spring (Hightshoe, 1978).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Lifespan:

Information available from the the literature: Long-lived (Sutton,1974; Van Dersal,1938; Hightshoe, 1978).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Propagation:

Information available from the literature: Seeds; hormonal, vegetative (Sutton, 1974). Minimum seed bearing age is 40. Seeds are produced every 2 to 4 years (Schopmeyer, 1979; Van Dersal, 1938). Fruit ripens in September-October, seed dispersal in September-October. Cone ripe with a specific gravity of .85. Seeds require cold, moist stratification at 34 to 41F for 14-28 days

(Schopmeyer, 1979). Stratification for 30 days at 41 F (Dirr, 1983). Germination is epigeal. Usually sown in spring. Seedlings may be protected by a mulch of peat or straw 1/2-2" deep. Seedlings outplanted at 2-3 years (Schopmeyer,1979). Cuttings taken in December treated with 100 ppm IBA/24 hr. soak followed by Phygon XL-talc, 1:1. Cuttings taken in January treated with .8% IBA talc. Cuttings taken in March treated with 100 ppm IBA 24 hr. soak (Dirr, 1983).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Maintenance/Cleanliness:

Information available from the literature: Low maintenance requirements (Sutton, 1974). Cone shatters soon after maturing in September (Van Dersal, 1938).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Soil Adaptability:

Texture:

Information available from the literature: Dislikes heavy clay soils (Dirr, 1983; Hightshoe, 1978). Moderately coarse to moderately fine; gravelly and sandy loams, medium loams (Hightshoe, 1978).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

pH:

Information available from the literature: Prefers acidic soils; pH 4.0-6.5 (Hightshoe, 1978).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Moisture Regime Adaptability: 10-20" annual rainfall (Van Dersal, 1972). Moist to dry (Hightshoe, 1978).

Drought Tolerance:

Information available from the literature: Moderate to good if well established (Sutton, 1974). Good (Van Dersal, 1938). Intermediate drought-heat resistance (Hightshoe, 1978).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Flood Tolerance:

Information available from the literature: Intolerant (Hightshoe, 1978).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Exposure:

Temperature:

Information available from the literature: Zone 4-5 (Van Dersal, 1972). Zone 4a (Hightshoe, 1978). Zone 4 (Hortus, 1976). Range from 7,500-10,000´ in Colorado (Kelly, 1970).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Light:

Information available from the literature: Tolerant of shade in youth, but prefers sun (Sutton, 1974). Will tolerate some shade (Van Dersal, 1972). Sun or shade (Van Dersal, 1938).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Wind:

Information available from the literature: Subject to windfall, frequent damage (Hightshoe, 1978).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Insects:

Information available from the literature: 19+ on species (Sutton, 1974). None serious (Dirr, 1983). Infrequent susceptibility (Hightshoe, 1978).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Disease:

Information available from the literature: Mistletoe, heart rot (Preston, 1968). 24+ on species (Sutton, 1974). None serious (Dirr, 1983). Infrequent susceptibility-few problems (Hightshoe, 1978).

Does your experience agree with the above information?

Comments?

Your personal score (circle one): 1 2 3 4 5

Environmental Scorecard Evaluators

1. Mr. Clayton Berg
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4. Dr. George Evans
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16. Mrs. Shelly Engler Bruce
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17. Literature score*

* All species were given a score based on the information available from the literature for each category

SPECIES INFORMATION

SCIENTIFIC NAME: Abies concolor (Gord. and Glend.) Lindl. ex Hildebr.

Common Name(s): Concolor Fir, White Fir

Transplantability:

Information available from the literature: Good success when transplanting young trees. Larger old trees are subject to desiccation (Sutton, 1974). Transplants readily as small B and B tree in spring (Hightshoe, 1978).

Evaluator's Comments: Younger trees are transplanted easily; older trees do not move as well (Pohl, 1985).

Lifespan:

Information available from the the literature: Long-lived (Sutton, 1974; Van Dersal, 1938; Hightshoe, 1978).

Evaluator's Comments: Older specimens in Bozeman, Montana (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds; hormonal, vegetative (Sutton, 1974). Minimum seed bearing age is 40. Seeds are produced every 2 to 4 years (Schopmeyer, 1979; Van Dersal, 1938). Fruit ripens in September-October seed dispersal in September-October. Cone ripe with a specific gravity of .85. Seeds require cold, moist stratification at 34 to 41F for 14-28 days (Schopmeyer, 1979). Stratification for 30 days at 41 F (Dirr, 1983). Germination is epigeal. Usually sown in spring. Seedlings may be protected by a mulch of peat or straw 1/2-2" deep. Seedlings outplanted at 2-3 years (Schopmeyer,1979). Cuttings taken in December treated with 100 ppm IBA/24 hr. soak followed by Phygon XL-talc, 1:1. Cuttings taken in January treated with .8% IBA talc. Cuttings taken in March treated with 100 ppm IBA 24 hr. soak (Dirr, 1983).

Evaluator's Comments: Seed do not store very well (Watson, 1985).

Maintenance/Cleanliness:

Information available from the literature: Low maintenance requirements (Sutton, 1974). Cone shatters soon after maturing in September (Van Dersal, 1938).

Evaluator's Comments: Susceptible to spruce weevil (Evans, 1985). When lower branches are retained, tree provides weed control for itself (Metcalf, 1985). Minimal maintenance required (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Dislikes heavy clay soils (Dirr, 1983; Hightshoe, 1978). Moderately coarse to moderately fine; gravelly and sandy loams, medium loams (Hightshoe, 1978).

Evaluator's Comments: Appear to survive reasonably well in heavy soils (Evans, 1985). Does not do well in wet soil situations (Metcalf, 1985).

pH:

Information available from the literature: Prefers acidic soils; pH 4.0-6.5 (Hightshoe, 1978).

Evaluator's Comments: No adverse affects from pH values of 7 to 8 (Evans, 1985).

Moisture Regime Adaptability: 10-20" annual rainfall (Van Dersal, 1972). Moist to dry (Hightshoe, 1978).

Drought Tolerance:

Information available from the literature: Moderate to good if well established (Sutton, 1974). Good (Van Dersal, 1938). Intermediate drought-heat resistance (Hightshoe, 1978).

Evaluator's Comments: Appears to grow well under irrigated situations, but not likely to thrive on dryland/plains (Metcalf, 1985). Will tolerate drought only after well established (Watson, 1985).

Flood Tolerance:

Information available from the literature: Intolerant (Hightshoe, 1978).

Evaluator's Comments: Requires good soil drainage (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 4-5 (Van Dersal, 1972). Zone 4a (Hightshoe, 1978). Zone 4 (Bailey and Bailey, 1976). Range from 7,500-10,000' in Colorado (Kelly, 1970).

Evaluator's Comments: Can experience terminal bud damage, nearly annually at Bozeman, Montana altitude and conditions (Evans, 1985). Young trees have occasionally suffered some tipkill in Bozeman, Montana (Metcalf, 1985). Would most likely grow well in Zone 3, except for winter burn problem (Pohl, 1985). No hardy strains known (Lackschewitz, 1985).

Light:

Information available from the literature: Tolerant of shade in youth, but prefers sun (Sutton, 1974). Will tolerate some shade (Van Dersal, 1972). Sun or shade (Van Dersal, 1938).

Evaluator's Comments: Glaucous color will develop best in well-lighted sites (Metcalf, 1985). Will grow best in full sun; otherwise become leggy and poorly branched (Pohl, 1985).

Wind:

Information available from the literature: Subject to windfall, frequent damage (Hightshoe, 1978).

Evaluator's Comments: Branches are fairly flexible; breakage mostly from mechanical means (Evans, 1985).

Insects:

Information available from the literature: 19+ on species (Sutton, 1974). None serious (Dirr, 1983). Infrequent susceptibility (Hightshoe, 1978).

Evaluator's Comments: Spruce weevil only insect problem (Evans, 1985). Witnessed budworm effects inducing multiple tops (Metcalf, 1985).

Disease:

Information available from the literature: Mistletoe, heart rot (Preston, 1968). 24+ on species (Sutton, 1974). None serious (Dirr, 1983). Infrequent susceptibility-few problems (Hightshoe, 1978).

SCIENTIFIC NAME: Abies grandis (Dougl. ex D. Don) Lindl.

Common Name: Grand Fir

Transplantability:

Lifespan:

Information available from the literature: Long; 250-300 years maximum (Arno and Hammerly, 1977).

Propagation: Fruit ripens August, seed dispersal is in late August to early October. Minimum seed bearing age is 20 years, bears heavy seed every 2-3 years. Cone is ripe when a specific gravity of .9 is reached, seeds are detached from scales, and when seed wing color changes from purple to brown (on green colored cones only). Seed requires a cold, moist stratification at 34 to 41 F for 21-28 days. Seed is sown in spring 1/4 -3/8" deep. Seedlings are outplanted at 2-3 years old. Germination is epigeal (Schopmeyer, 1979).

Maintenance/Cleanliness:

Soil Adaptability:

Texture:

Information available from the literature: Rich soils (Arno and Hammerly, 1977).

pH:

Evaluator's Comments: Many soils in the Flathead area have higher pH readings than one might anticipate.

Moisture Regime Adaptability: 25" + aap (Arno and Hammerly, 1977).

Drought Tolerance:

Evaluator's Comments: Grows best with both adequate soil water and relatively high atmospheric humidity (e.g. "coastal" as opposed to "continental" climates). Needles brown and shed in drought conditions (Rumely, 1985). Naturally grows in soils with good water-holding capacity, or where the water table is not much below the surface (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Tree will occur on floodplains, but do not withstand standing water at base for longer than a few days; and doesn't withstand excess ground water (Rumely, 1985). Natural habitat suggests this species may be less intolerant of poorly drained soils than some other species of Abies (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 6 (Bailey, 1977). Semi-hardy to frost (Mathias et al, 1977). Range from 2,000-6,000' (Arno and Hammerly, 1977).

Evaluator's Comments: Occurs at sea level on west coast; but ranges from 2000-6000' only under coastal, not continental climates. Frost-cracks in bole occur when exposed to continental winters (Rumely, 1985). Adaptability to temperature probably limits use in Montana to moister, lower valleys west of Continental Divide (Metcalf, 1985).

Light:

Information available from the literature: Shade tolerant (Arno and Hammerly, 1977).

Evaluator's Comments: Shade tolerant when young, not shade tolerant when mature (Rumely, 1985).

Wind:

Evaluator's Comments: This is a forest tree, normally growing in dense stands. Individuals that are exposed to wind may have tops or large limbs broken. Tops are especially brittle (Rumely, 1985).

Insects:

Disease:

Information available from the literature: Fungus rot (Arno & Hammerly, 1977).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current use and value: Wildlife utilization (Van Dersal, 1938). Schmidt (1980) recommends for use in large scale landscaping. Kruckeberg (1982) recommends. Wilson (1984) recommendation.

Sources of description:

Technical: Dorn (1984); Hitchcock and Cronquist (1981); Bailey (1949).

Non-technical: Arno and Hammerly (1977); Phillips (1978); Kruckeberg (1982).

Availability: Callahan-Seeds; Clifty View Nursery; Northplan; Plants of the Wild.

Habitat Types and Range: Douglas Fir series, Grand Fir series, Western Red Cedar series, Western Hemlock, Alpine Fir series forest habitat types (Pfister et al, 1977). Subalpine Fir/ Douglas Fir/ Grand Fir Climax, Western Redcedar/ Western Hemlock Climax, Grand Fir/Douglas Fir Climax (Ross and Hunter, 1976).

SCIENTIFIC NAME: Abies lasiocarpa (Hook.) Nutt.

Common Name(s): Subalpine Fir, Alpine Fir

Transplantability:

Information available from the literature: Good when young, to 15´; larger older trees subject to shock desiccation (Sutton, 1974). Transplants readily as small B and B tree in spring (Hightshoe, 1978).

Evaluator´s Comments: Very young seedlings transplant readily with proper watering (Pohl, 1985). Found frequently in Bozeman, Montana; were transplanted from the wild as young trees (Metcalf, 1985).

Lifespan:

Information available from the literature: Moderate (Van Dersal, 1938). Long (Sutton, 1974). Long, 200 years + (Hightshoe, 1978). 250 years maximum; short-lived for an evergreen tree (Arno and Hammerly, 1977).

Evaluator´s Comments: May depend on ecology of site to which it is transplanted (e.g. many species of Abies do not thrive in the eastern U.S.)(Metcalf, 1985).

Propagation:

Information available from the literature: Seeds; layers readily (Sutton, 1974). Fruit ripens in August, seed dispersal begins in early to mid-September. Minimum seed bearing age is 20 with heavy cone crops every 2-4 years. Seed requires cold, moist stratification at 34-41 F for 14 to 28 days. Germination is epigeal (Schopmeyer, 1979). Layering (Arno and Hammerly, 1977).

Maintenance/Cleanliness:

Information available from the literature: Little maintenance, clean (Sutton, 1974).

Evaluator´s Comments: Very clean (Pohl, 1985). Will provide own weed control if lower branches are retained. Does not grow out scale as rapidly as Picea pungens (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Rocky to medium texture, high organic matter, well-drained (Sutton, 1974). Moderately coarse to medium, gravelly or sandy loams, medium loams, and silt loams, moderately poor to well-drained (Hightshoe, 1978). Tolerates poor soils (Smyser, 1982).

Evaluator's Comments: Has grown well in silt loams near Bozeman, MT (Metcalf, 1985).

pH:

Information available from the literature: 5.5-7.0 (Sutton, 1974). 4.0-6.5 (Hightshoe, 1978).

Evaluator's Comments: Many soils in Bozeman, Montana are approximately pH 7.0 or slightly above, with no problems encountered by specie (Metcalf, 1985).

Moisture Regime Adaptability: Moist to dry (Hightshoe, 1978). Tolerates a broad range of moisture conditions (Arno and Hammerly, 1977). Wet to dry (Smyser, 1982).

Drought Tolerance:

Information available from the literature: Poor (Sutton, 1974). Drought-heat intermediate (Hightshoe, 1978).

Evaluator's Comments: In alpine sites, may often be stressed, but at lower elevations this tends to grow on shady sites of canyons (Metcalf, 1985). Is favored by cool sites (north slopes in mountains, or high elevations, or streamvalleys at low elevations). Can establish on dry sites if in cool night-climate, but life-forms are distorted (as compared with "normal" form on cool, moist sites) (Rumely, 1985).

Flood Tolerance:

Information available from the literature: Intolerant (Hightshoe, 1978).

Evaluator's Comments: Prefers moist, but well-drained sites (Metcalf, 1985). Can establish and do well on streamsides, islands in streams and floodplains where there is cold air drainage. Cannot withstand standing water at base for more than a few days and then excess water must drain (Rumely, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 2-3a (Hightshoe, 1978). Cool temperatures (Smyser, 1982). Elevation range from 9,500 to 11,500´ (Arno and Hammerly, 1977). Zone 3 (Bailey and Bailey, 1976).

Evaluator´s Comments: Very tolerant of extremes in temperature (Pohl, 1985). Insolation may be intense in subalpine sites, but nights will virtually always be cool (Metcalf, 1985). Can withstand extremes in temperature, but requires cool nights to grow best. Requires much watering if in a warm climate (even in damp climate) (Rumely, 1985).

Light:

Information available from the literature: Shade intolerant in youth, sun in age (Sutton, 1974). Very tolerant; index range 8.0 to 10.0 (Hightshoe, 1978). Shade tolerant (Arno and Hammerly, 1977).

Evaluator´s Comments: Mature trees rise above surrounding vegetation, but seedlings often in shaded situations (Metcalf, 1985). Winter sun can be a problem for young trees, but has a wide range of tolerance (Pohl, 1985). Agree with Sutton that shade tolerant in youth, sun when mature (Rumely, 1985).

Wind:

Information available from the literature: Good in groups, poor in thinned mature stands (Sutton, 1974). Frequent susceptibility to wind damage-subject to wind fall (Hightshoe, 1978).

Evaluator´s Comments: There is better resistance to wind damage when dense growing (Metcalf, 1985). Agree that growth better in groups, poor in thinned mature stands and subject to wind damage (Rumely, 1985).

Insects:

Information available from the literature: Six insects on the species (Sutton, 1974). Infrequent susceptibility to insect damage-spruce budworm, black headed budworm (Hightshoe, 1978). Western budworm (Arno and Hammerly, 1977).

Disease:

Information available from the literature: Many pathogens on the genus (Sutton, 1974). Infrequent susceptibility to disease- Balsam Fir rust, several root rots (Hightshoe, 1978). Rots,snowmolds (Arno and Hammerly, 1977).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Kruckeberg (1982) recommendation. Animal food (Sutton, 1974). Sutton (1974) recommendation. Wildlife utilization (Van Dersal, 1938). Wilson (1984) recommendation. Highshoe (1978) recommendation.

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dorn (1984); Hitchcock and Cronquist (1981); Highshoe (1978).

Non-technical: Arno and Hammerly (1977); Kruckeberg (1982); Phillips (1978); Kelly (1970); Nelson (1979).

Availability: Callahan-Seeds, Clifty View Nursery, Nature's Garden Woodland and Rock Plants, Northplan, Native Plants, Inc., Dean Swift Seed Co.

Habitat Types: Spruce/fir, Aspen/lodgepole pine (Sutton, 1974). Scree, Spruce/fir, lodgepole pine, Douglas fir, Western Red Cedar, Western Hemlock (Pfister et al, 1977). Subalpine Fir/Douglas Fir/Ponderosa Pine Climax Forests, Grand Fir Climax, Subalpine Fir Climax Forests. Rockland and mixed high elevation vegetation (Ross and Hunter, 1976).

Range: Washington to Montana, south to New Mexico and Oregon. Range Colorado 8,500-11000'. Southern range: 11,000', Northern range: 3,500'; Utah 4,600' (Sutton, 1974).

SCIENTIFIC NAME: Acer ginnala Maxim.

Common Name(s): Amur Maple; Ginnala Maple

Transplantability:

Information available from the literature: Easy (Dirr, 1983).

Evaluator's Comments: Wide availability and use in the Plains suggests easy transplantability (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Probably of moderate lifespan under landscape situations (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds. Fruit ripens August-September, dispersal September-January. Minimum seed bearing age is 5, with crops every year. Mechanical rupture of the pericarp is recommended before stratification. Warm, moist stratification at 68-86 F for 30-60 days, then cold stratification at 41 F for 90-150 days (Dirr, 1983; Schopmeyer, 1979). Germination is epigeal. Sow seed 1/4-1" deep, 15-30/sq. ft.. Shade during seedling establishment. Plant out as 1-0, 2-0, or 2-2 plants (Schopmeyer, 1979). Softwood cuttings taken in June rooted in peat: perlite under mist with 1000 ppm IBA treatment; one of the easiest maples for root cuttings (Dirr, 1983).

Maintenance/Cleanliness:

Evaluator's Comments: Few maintenance problems; weed-eater damage to lower trunk should be avoided as bark is rather thin (Metcalf, 1985). Considered very clean, but can suffer some storm damage (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Quite adaptable; best in moist, well-drained soil (Dirr, 1983).

Evaluator's Comments: Appears to grow well in many soils, but subject to lime chlorosis (Metcalf, 1985).

pH:

Information available from the literature: Quite adaptable (Dirr, 1983).

Evaluator's Comments: Subject to lime chlorosis; Canadians have been seeking lime-tolerant selections (Metcalf, 1985).

Moisture Regime Adaptability: 10-20" annual rainfall (Howard, 1972).

Drought Tolerance:

Evaluator's Comments: Suited to precipitation patterns in the Great Plains (Metcalf, 1985). Considered very drought tolerant (Pohl, 1985).

Flood Tolerance:

Evaluator's Comments: Probably requires good root aeration conditions (Metcalf, 1985). Has wide adaptation to various moisture regimes (Pohl, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 2 to 8 (not as well in 7 and 8) (Dirr, 1983). Zone 3 to 7 (Howard, 1972). Zone 5 (Bailey and Bailey, 1976). Recommended for general planting in the Brooks, Alberta area (Casement, 1984).

Evaluator's Comments: Reported as quite hardy in much of Montana (Metcalf, 1985).

Light:

Information available from the literature: Full sun or light shade (Dirr, 1983).

Evaluator's Comments: Brilliant autumn coloration will be best if grown in full sun (Metcalf, 1985). Prefers sun (Pohl, 1985).

Wind:

Evaluator's Comments: Snow and ice storms will be damaging, particularly if they occur at times when trees are in leaf and have full load of samaras (Metcalf, 1985).

Insects:

Information available from the literature: Relatively insect free (Dirr, 1983).

Disease:

Information available from the literature: Relatively disease free (Dirr, 1983).

SCIENTIFIC NAME: Acer glabrum Torr.

Common Name: Rocky Mountain Maple

Transplantability:

Information available from the literature: Poor with wildings (Sutton, 1974). Poor, better with older (2-0 or 2-2) plants (Wasser, 1982).

Evaluator's Comments: May best be handled as canned stock (Metcalf, 1985). Small plants are transplanted easily from the wild (Pohl, 1985). Good transplants if container grown, or if grown in field under good nursery practices (Watson, 1985).

Lifespan:

Information available from the literature: Moderate (Sutton, 1974).

Evaluator's Comments: Maples often are abused in landscape situations, losing leader and suffering bark damage to lower trunk from lawnmowers, weed-eaters (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds; easy to grow (Sutton, 1974). Fruit ripens August-October, dispersal in September-February. Bears crops every 1-3 years. Seed requires warm stratification at 68-86 F for 180 days then a 180 day, 37-41 F cold moist stratification. Sow in fall or stratified seed in spring, 1/4-1" deep (Schopmeyer, 1979; Wasser, 1982). Germination is epigeal (Wasser, 1982). Shade during seedling establishment (Schopmeyer, 1979). 1- 0, 2-0 or 2-2 stock is planted out (Wasser, 1982).

Evaluator's Comments: Poor success from cuttings. Graft to seedlings (Evans, 1985).

Maintenance/Cleanliness:

Information available from the literature: Little maintenance, prune if desired; clean (Sutton, 1974).

Evaluator's Comments: May need pruning to keep within bounds (Evans, 1985). Thin-barked, requires protection of lower trunk from abrasions (Metcalf, 1985). Reverts to multiple stem/shrub

habit and suckers freely; minimal maintenance required (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Medium, well-drained, moist, poorer soils, organic matter if possible (Sutton, 1974). Silty to sandy or gravelly and rocky, well-drained soils (Wasser, 1982). Good soil, seldom found on hot, dry slopes (Kelly, 1970).

Evaluator's Comments: Naturally occurs along stream banks where alluvium may be deep and well watered (Metcalf, 1985). Watch carefully for heavy clay soils (Watson, 1985).

pH:

Information available from the literature: 6.0-7.0 (Sutton, 1974). Moderately acidic to neutral or slightly basic (Wasser, 1982).

Evaluator's Comments: Slightly acid soil (Evans, 1985). Will likely prefer soils that are well-supplied with bases (Metcalf, 1985).

Moisture Regime Adaptability: 12 to 25"+ annual rainfall (Wasser, 1982).

Drought Tolerance:

Information available from the literature: Poor to fair (Sutton, 1974). Weak to moderate (Wasser, 1982).

Evaluator's Comments: Poor drought tolerance (Evans, 1985). Use likely restricted to irrigated streamside situations (Metcalf, 1985).

Flood Tolerance:

Information available from the literature: Tolerant (Wasser, 1982).

Evaluator's Comments: May be best suited for roots near water table (Evans, 1985). Prefers wet soils (Pohl, 1985).

Exposure:

Temperature:

Information available from the literature: Good winter hardiness (Wasser, 198 2). Zone 5 (Bailey and Bailey, 1976). Elevation range 6,000´ to 10,000´ in the Colorado Rockies (Kelly, 1970).

Evaluator´s Comments: A Montana species, found primarily where winter snowfall is heavy (Metcalf, 1985). Best in Zone 3 with plenty of moisture (Pohl, 1985).

Light:

Information available from the literature: Sun or shade (Sutton, 1974). Moderate shade tolerance (Wasser, 1982).

Evaluator´s Comments: Natural habitat is often shaded, at least part of the day (Metcalf, 1985). Wide adaptability (Pohl, 1985).

Wind:

Information available from the literature: Wind firm (Sutton, 1974).

Evaluator´s Comments: Unlikely to suffer from windthrow (Metcalf, 1985).

Insects:

Information available from the literature: 49 insects of the genus Acer (Stark, 1966).

Disease:

Information available from the literature: 7 diseases on the species (Stark, 1966).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Species used to limited extent for wildlife plantings and native landscaping in mountains or adjacent areas.

Considerable attractiveness of foliage cover values (Wasser, 1982). Animal food (Sutton, 1974). Sutton (1974) recommendation. Wildlife utilization (Van Dersal, 1938). Schmidt (1980) recommendation. Kruckeberg (1982) recommendation. Wilson (1984) recommendation.

Sources of Description:

Technical: Arnow (1980); Dorn (1984); Morris et al (1962).

Non-technical: Arno and Hammerly (1977); Huddleston and Hussey (1975); Kelly (1970); Kruckeberg (1982); Nelson (1977).

Availability: Callahan-Seeds; Clifty View Nursery; Native Plants, Inc.; Northplan; Plants of the Wild; Old Farm Nursery, Inc.

Habitat Types: Aspen/lodgepole pine, Douglas Fir/white fir, Upper Uinta Sage, Chaparral (Sutton, 1974); Scree, Douglas fir, Grand fir, Western Red Cedar, Western Hemlock, Alpine fir forest habitat types (Pfister, 1977); Douglas fir climax forest (Ross and Hunter, 1976).

Range: Native to western United States (Wasser, 1982); Washington to Montana, south to New Mexico and California (Sutton, 1974).

SCIENTIFIC NAME: Ajuga reptans L.

Common Name(s): Carpet Bugleweed, Ajuga

Transplantability:

Evaluator's Comments: Transplants readily (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Spreads rapidly and rejuvenates itself (Evans, 1985). Stoloniferous habit tends to assure continuity of a colony (Metcalf, 1985).

Propagation:

Information available from the literature: Seed, or by division in spring or fall (Still, 1982; Voight et al, 1983; Wyman, 1973). Divisions in spring (Vanstone, 1982).

Evaluator's Comments: Division in spring and early fall (Evans, 1985). Readily multiplied by division (Metcalf, 1985).

Maintenance/Cleanliness:

Information available from the literature: May become invasive (Still, 1982).

Evaluator's Comments: Requires hand weeding to keep clean (Evans, 1985). Removal of passe' flower stalks may be only maintenance required (Metcalf, 1985). Invades, but eliminates weed competition. Flower stalks need to be trimmed once per year (Pohl, 1985). Tends to become weedy (Lackschewitz, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Tolerates poor soil (Still, 1982). Any moist, well-drained soil (Voight et al, 1983).

Evaluator's Comments: Probably not suitable for dryland situations (Metcalf, 1985).

pH:

Information available from the literature: Tolerates some alkalinity (Kelly, 1980).

Evaluator's Comments: Will display iron chlorosis in pH levels over 7.5 (Evans, 1985).

Moisture Regime Adaptability:

Drought Tolerance:

Information available from the literature: Not drought tolerant (Voight et al, 1983).

Evaluator's Comments: Best suited for mesic situations (Metcalf, 1985). Survives, but is not vigorous under minimal irrigation (Pohl, 1985).

Flood Tolerance:

Evaluator's Comments: Moist but well-drained sites are suitable (Metcalf, 1985). Grows well in wet soils (Pohl, 1985).

Exposure:

Temperature:

Information available from the literature: Tolerates some heat (Kelly, 1980). Zone 4 (heat stress in zone 8) (Still, 1982). Zone 4 (Wyman, 1973).

Evaluator's Comments: Seems to prefer cooler soils (Evans, 1985). Suffers from extreme winter temperatures, or if iced over (Metcalf, 1985).

Light:

Information available from the literature: Sun or shade (Still, 1982; Voight et al, 1983; Wyman, 1973). Sun or shade, prefers semi-shade (Kelly, 1980).

Evaluator's Comments: Grows very slowly in dense shade, alright in partial shade (Evans, 1985). Will suffer from sunscald in exposed sites in winter, Bozeman, Montana. Prefer partial shade (Metcalf, 1985).

Wind:

Information available from the literature: Protect from winter winds or suffers winter burn (Voight et al, 1983).

Evaluator's Comments: Winter desiccation above snow level (Evans, 1985). Not structurally damaged by wind, i.e. plants are windfirm (Metcalf, 1985). Requires snow cover and shade (Pohl, 1985).

Insects:

Information available from the literature: Root nematodes (Voight et al, 1983).

Disease:

Information available from the literature: Crown rot, fungus (Voight et al, 1983).

Evaluator's Comments: Slugs can be damaging in the garden (Metcalf, 1985).

SCIENTIFIC NAME: Alnus incana Nutt.

Common Name(s): White Alder, Thinleaf Alder

Transplantability:

Information available from the literature: Good when young (Sutton, 1974).

Evaluator's Comments: Easily moved (Pohl, 1985). Transplants well if grown in nursery (Watson, 1985).

Lifespan:

Information available from the literature: Short (Sutton, 1974).
Evaluator's Comments: Does not tolerate damage (cuts, carvings) well, but if undamaged can develop sizable trunk diameters (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds, cuttings, layering (Sutton, 1974). Fruit ripens in August-September. Collect fruit when bracts start to seperate on the earliest strobiles. No stratification requirements with fresh seed. Dried seed requires stratification for 180 days at 41 F. Sow in spring at a depth of 1/8-1/4". Germination is epigeal (Schopmeyer, 1979).

Maintenance/Cleanliness:

Information available from the literaure: Weak wood, clean, train to small tree (Sutton, 1974).

Evaluator's Comments: Does not produce much trash (Metcalf, 1985). Suckers freely and suffers some storm damage (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Medium, black loam, high organic matter, well-drained with periods of standing water (Stark, 1966). Nitrogen fixing (Kelly, 1970).

Evaluator's Comments: Requires good moisutre supply; not suited for dryland sites (Metcalf, 1985).

pH:

Information available from the literature: 6.0-7.0 (Sutton, 1974).

Moisture Regime Adaptability: Moist to wet (Sutton, 1974).

Drought Tolerance:

Information available from the literature: Poor (Sutton, 1974).

Evaluator's Comments: Good for streamside, or even marshy plantings (Metcalf, 1985).

Flood Tolerance:

Information available from the literature: Periods of standing water (Sutton, 1974). Often a seep, spring indicator (Arno and Hammerly, 1977).

Evaluator's Comments: Witnessed a large alder swamp alongside Montana Route 35 East of Polson; this is very wet much of the year, with a skunk-cabbage understory (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Elevation range 5,000-10,000' in the Colorado Rockies (Kelly, 1970).

Evaluator's Comments: Prefers cool sites (Metcalf, 1985).

Light:

Information available from the literature: Sun (Van Dersal, 1938). Shade when young, sun when mature (Sutton, 1974).

Wind:

Information available from the literature: Wind firm (Sutton, 1974).

Evaluator's Comments: Free-standing trees might be subject to windthrow but mass plantings will likely not blow over easily (Metcalf, 1985).

Insects:

Information available from the literature: 3 insects on the species (Stark, 1966).

Disease:

Information available from the literature: 27 diseases on the species (Stark, 1966).

Evaluator's Comments: Light rust problems in wet areas (Riesselman, 1985).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Nitrogen-fixing, wildlife utilization (Van Dersal, 1938). Animal habitat, erosion control (Stark, 1966). Schmidt (1980) recommendation. Sutton (1974) recommendation.

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dirr (1983); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Arno and Hammerly (1977); Kelly (1970); Nelson (1977); Phillips (1978); Simon and Schuster (1978).

Availability: Callahan-Seeds; Native Plants, Inc.; Northplan; Plants of the Wild; Old Farm Nursery, Inc.

Habitat Types: Chaparral, Upper Uinta Sage, Aspen/Lodgepole pine, Douglas fir/white fir (Preston, 1968; Sutton, 1974). Spruce, alpine fir (Pfister, 1977).

Range: Colorado 5,000-10,000'; Utah 5,000-8,500' (Sutton, 1974).

SCIENTIFIC NAME: Anaphalis margaritacea (L.) B.and H.

Common Name: Pearly-Everlasting

Transplantability:

Evaluator's Comments: Easily transplanted by reason of rhizomatous habit (Metcalf, 1985). Is transplanted easily (Pohl, 1985).

Lifespan:

Evaluator's Comments: Long lived perennial (Metcalf, 1985). Center dies back (Pohl, 1985).

Propagation:

Information available from the literature: Sow outdoors in late fall or early spring, or indoors at 55-65 F during germination which takes 10-14 days (Reilly, 1978).

Evaluator's Comments: Propagation by division is probably easier than from seed (Metcalf, 1985). Have had poor success with outdoor sowing, good in greenhouse (Pohl, 1985).

Maintenance/Cleanliness:

Evaluator's Comments: Would benefit from an annual spring cleanup (Metcalf, 1985). Seed stalks are ornamental, but benefit from cleanup once per year (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Open, but finer textured soils (Stark, 1974). Well-drained, light soils (Reilly, 1978).

Evaluator's Comments: Has grown well in silt loams at Bozeman, Montana (Metcalf, 1985).

pH:

Information available from the literature: 4.0-5.0 (Stark, 1974).

Evaluator's Comments: Wider range (Pohl, 1985).

Moisture Regime Adaptability:

Drought Tolerance:

Information available from the literature: Will tolerate cool, dry soil (Reilly, 1978).

Evaluator's Comments: Knowledge of irrigated cultivation only (Metcalf, 1985). Grows best in "open shade" (not deep shade, not full sun); in which case it seems to tolerate aridity fairly well. Grew well in 1985, despite severe drought. (Rumely, 1985).

Flood Tolerance:

Evaluator's Comments: Probably intolerant to flooding (Metcalf, 1985). Cannot withstand very moist conditions (Rumley, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 3 (Reilly, 1978).

Evaluator's Comments: Hardy plant (Metcalf, 1985). Can withstand hot, exposed sites but requires cool nights (Rumely, 1985).

Light:

Information available from the literature: Full sun (Reilly, 1978).

Evaluator's Comments: Full sun only (Pohl, 1985). As a perennial, plant does best in full sun or "open shade" but persists (without flowering) in forest shade. Relatively narrow range (Rumely, 1985).

Wind:

Evaluator's Comments: Wind resistant (Metcalf, 1985). Wind is not significant with respect to this taxon. It is of low stature and not in especially exposed sites. The fact that this taxon does not grow in exposed locations may indicate that it is rapidly dehydrated by too much wind (Rumely, 1985).

Insects:

Disease:

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Kelly (1980) recommendation. Kruckeberg (1982) recommendation.

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dorn (1984); Hitchcock and Cronquist (1981).

Non-technical: Kruckeberg (1982); Nelson (1977); Taylor (1978).

Availability: Nichols Herb and Rare Seeds.

Habitat Types:

Range:

SCIENTIFIC NAME: Antennaria rosea Greene

Common Name: Pink Pussytoes

Transplantability:

Lifespan:

Evaluator's Comments: Center of plot tends to die back (Pohl, 1985).

Propagation:

Information available from the literature: A. nitida and A. ubrinella propagated by stolon divisions (Van Dyke and Currah, 1983). Seed, division, cuttings (Rock, 1977).

Evaluator's Comments: Seed germinate easily in greenhouse; division anytime (Pohl, 1985).

Maintenance/Cleanliness:

Evaluator's Comments: Should be a low-maintenance plant; perhaps an annual cleanup would be all that is required (Metcalf, 1985). Annual plot cleanup required (Pohl, 1985). Perhaps the least attractive foliage of most plants. "Prairie pussytoes (Antennaria parvifolia Nutt) makes a much better carpet, also Antennaria alpina (Lackschewitz, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Poor soils preferred (Kelly, 1980).

Evaluator's Comments: Naturally occupies impoverished sites (Metcalf, 1985).

pH:

Moisture Regime Adaptability:

Drought Tolerance:

Information available from the literature: Likes drought and heat (Kelly, 1980). Can withstand dry conditions (Huddleston & Hussey, 1975).

Evaluator's Comments: Observation of natural stands suggests strong drought tolerance (Metcalf, 1985). Certainly can withstand drought. It can also grow well in medium-moist grasslands (e.g. "Foothills grassland", Festuca type) (Rumely, 1985).

Flood Tolerance:

Evaluator's Comments: Likely intolerant to more than seasonal flooding (Metcalf, 1985). Grows well on dry to medium-moist sites; poorly on wet sites (Rumely, 1985).

Exposure:

Temperature:

Evaluator's Comments: Probably quite hardy (Metcalf, 1985). Can withstand very hot, arid conditions and cold Montana winters (Rumely, 1985).

Light:

Information available from the literature: Full sun to shade, may need protection while establishing if in full sun (Huddleston & Hussey, 1975).

Evaluator's Comments: Found in partial shade to full sun (Metcalf, 1985). Full sun only (Pohl, 1985). Grows in full sun (Rumely, 1985).

Wind:

Evaluator's Comments: Probably little affected by wind (Metcalf, 1985). Certainly resistant to wind-desiccation (Rumely, 1985).

Insects:

Disease:

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Kelly (1980) recommendation.

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Hitchcock and Cronquist (1981).

Non-technical: Huddleston and Hussey (1975); Nelson (1977); Taylor (1978).

Availability: Little Valley Wholesale Nursery; Native Plants, Inc.; Old Farm Nursery, Inc.

Habitat Types: Scree, Limber Pine, Ponderosa Pine, Douglas Fir, Alpine Fir, Lodgepole Pine (Pfister, 1977); Agropyron spicatum grassland series (Mueggler and Handl, 1974).

Range:

SCIENTIFIC NAME: Artemisia cana Pursh.

Common Name: Silver Sage

Transplantability:

Information available from the literature: Yes may be transplanted (Sutton, 1974).

Evaluator's Comments: Can be transplanted successfully from the wild (Metcalf, 1985).

Lifespan:

Information available from the literature: Short (Sutton, 1974). Regenerating by root sprouts (Harvey and Weaver, 1979).

Evaluator's Comments: Suffrutescent habit tends to insure continuity of a clone or colony (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds (Sutton, 1974). Plant seeds on surface, better germination with light and at 50-86 F. Plant seed anytime. Hardwood cuttings (Wasser, 1982). Hardwood cuttings in October and dipped in 'Rootone' (Harvey and Weaver, 1979).

Evaluator's Comments: Softwood cutting (Evans, 1985). Clumps can probably be divided successfully (Metcalf, 1985).

Maintenance/Cleanliness:

Information available from the literature: Care free, clean (Sutton, 1974).

Evaluator's Comments: Annual cleanup only is required (Metcalf, 1985).

Soil Adaptability:

Texture:

Information vailable from the literature: Coarse, dry, no organic matter, well-drained (Sutton, 1974). Not dense clays, but most other oil classes (Wasser, 1982).

Evaluator's Comments: Adaptable (Metcalf, 1985).

pH:

Information available from the literature: 6.5-8.5. Tolerant of weakly acid to moderately basic and weakly saline soils (Wasser, 1982). Slightly saline-alkaline (Stark, 1966).

Moisture Regime Adaptability: 8"+ annual rainfall (Wasser, 1982).

Drought Tolerance:

Information available from the literature: Good (Sutton, 1974; Wasser, 1982).

Evaluator's Comments: Naturally requires persistent (deep) moisture (Lackschewitz, 1985).

Flood Tolerance:

Information available from the literature: Tolerant (Wasser, 1982).

Evaluator's Comments: Grows poorly under regular irritation (Evans, 1985). Can tolerate temporary flooding, but not a permanently high water table or boggy conditions (Rumely, 1985).

Exposure:

Temperature:

Information available from the literature: Strong winter hardiness (Wasser, 1982).

Evaluator's Comments: Withstands northern Great Plains continental-type winters, with no or very little protection. Also survives hot continental summers (Rumely, 1985).

Light:

Information available from the literature: Sun (Sutton, 1974). Full sun, intolerant of shade (Wasser, 1982).

Evaluator's Comments: Full sun only (Pohl, 1985). Full sun, except that seedlings need "nursery-type" shade when establishing (Rumely, 1985).

Wind:

Information available from the literature: Wind firm (Sutton, 1974).

Evaluator's Comments: Grows naturally in very wind-scoured sites (Rumely, 1985).

Insects:

Information available from the literature: 9 insects on the genus (Stark, 1974). Ants and Aroga moth (Wasser, 1982).

Evaluator's Comments: Problem with leaf beetles (Jensen, 1985).

Disease:

Information available from the literature: 30 diseases on the genus (Stark, 1974). No serious pathogens known (Wasser, 1982).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Big game range restoration, highway stabilization and beautification and to restore semi-original vegetation on disturbed lands (Wasser, 1982). Animal food (Sutton, 1974). Wildlife utilization (Van Dersal, 1938). Potential for use in range seeding mixtures and for soil stabilization (USDA, 1982).

Sources of Description:

Technical: Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Kelly (1970).

Availability: Big Sky Wholesale Seeds, Inc.; Native Plants, Inc.; Northplan; Plants of the Wild.

Habitat Types: Upper Uinta Sage, Pinyon/juniper, Douglas fir/white fir, Chaparral (Sutton, 1974).

Range: Washington to Montana, south to New Mexico and California. Colorado 5,000-10,000´ (Sutton, 1974); Native to the Intermountain West and adjacent Northern Great Plains (Wasser, 1982); silty range and clayey range sites (Ross and Hunter, 1976).

SCIENTIFIC NAME: Artemisia frigida Willd.

Common Name: Fringed Sagewort

Transplantability:

Information available from the literature: Good (Sutton, 1974).

Lifespan:

Information available from the literature: Short (Sutton, 1974).

Evaluator's Comments: Should be long-lived if not overwatered (Metcalf, 1985). Centers tend to die out (Pohl, 1985).

Propagation:

Information available from the literature: Seeds, wildlings (Sutton, 1974). Seed on surface (light improves germination) if soil moisture adequate, otherwise seed at 4 x seed diameter. Sow when soil temperature is greater than 50 F in late fall or early spring (Wasser, 1982).

Maintenance/Cleanliness:

Information available from the literature: Carefree, clean (Sutton, 1974).

Evaluator's Comments: Annual removal of old tops should be all that is required (Metcalf, 1985). Requires annual cleanup (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Fine to coarse, dry, no organic matter, well-drained (Sutton, 1974). Adapted to wide range of soils, coarse to medium texture, well-drained, often thin, rocky or gravelly (Wasser, 1982).

Evaluator's Comments: Wide adaptability (Pohl, 1985).

pH:

Information available from the literature: 7.0 (Sutton, 1974). Tolerant of weakly acidic to moderately basic and weak salinity (Wasser, 1982).

Moisture Regime Adaptability: Great range of moisture tolerance, 8-20+ aap (Wasser, 1982).

Drought Tolerance:

Information available from the literature: Moderate to good (Sutton, 1974). Good (Wasser, 1982).

Flood Tolerance:

Evaluator's Comments: Does not grow well in wet soils, and even languishes from overwatering if in a garden (Rumely, 1985).

Exposure:

Temperature:

Information available from the literature: Range up to 10,000' in Colorado (Kelly, 1970).

Evaluator's Comments: Hardy plant (Metcalf, 1985). Occurs over a very wide latitudinal and altitudinal range (Rumely, 1985).

Light:

Information available from the literature: Sun (Sutton, 1974). Fair shade tolerance (Wasser, 1982).

Evaluator's Comments: Probably rather intolerant of shade (Metcalf, 1985). Full sun only (Pohl, 1985). Thought of a heliophyte. If overgrown it languishes, but this may be an allelopathic problem as well as shading (Rumely, 1985).

Wind:

Information available from the literature: Wind firm (Sutton, 1974).

Insects:

Information available from the literature: 9 pests present on the genus (Stark, 1966). May be very a very insect resistant species (Wasser, 1982).

Disease:

Information available from the literature: 30 pests present on the genus (Stark, 1966). Two major fungi reported on foliage. May be a very disease resistant species (Wasser, 1982).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Game range seeding, highway seeding and landscaping (Wasser, 1982). Sutton (1974) recommendation. Wildlife utilization (Van Dersal, 1938). Kruckeberg (1982) recommendation. Kelly (1980) recommendation.

Sources of Description:

Technical: Bailey (1949); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Kelly (1970); Nelson (1977).

Availability: Big Sky Wholesale Seeds, Inc.; Little Valley Wholesale Nursery; Native Plants, Inc.; Northplan, Old Farm Nursery, Inc.; Plants of the Wild; Dean Swift Seed Co.

Habitat Types: Chaparral, Pinyon/juniper, Douglas fir/white fir, Spruce/fir, Upper Uinta sage, Ponderosa Pine (Sutton, 1974). Scree, Limber Pine, Ponderosa Pine, Douglas Fir (Pfister et al, 1977). Stipa comata series grassland type (Mueggler and Handl, 1974). Silty range site (Ross and Hunter, 1976).

Range: Oregon to Montana, south to New Mexico and Arizona. Colorado 4,500-10,000´ (Sutton, 1974); Native to western North America and to Eurasia (Wasser, 1982).

SCIENTIFIC NAME: Betula occidentalis Hook

Common Name: Water Birch

Transplantability:

Information available from the literature: Only in May when young and buds are green (Kelly, 1970).

Evaluator's Comments: Could perhaps be handled as canned stock (Metcalf, 1985).

Lifespan:

Information available from the literature: Short (Van Dersal, 1938).

Evaluator's Comments: Tends to be multi-stemmed; individual stems may not live forever, but new ones will arise in their place (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds (Sutton, 1974; Van Dersal, 1938). Cuttings (Sutton, 1974). Seed collected August-September when strobiles are still green enough to hold together and dried. Seed should be stored at 36 to 38 F. Seed usually sown in late summer or fall soon after collection, but may be sown in spring after stratification for 4 to 8 weeks. Seed lightly covered (1/16" to 3/16"). Epigeal germination. Seedlings require light shade for 2 to 3 months during the first summer. Field planted as 1-0 or 2-0 seedlings (Schopmeyer, 1979).

Evaluator's Comments: Propagation not very successful from cuttings. Best from seed (Evans, 1985).

Maintenance/Cleanliness:

Information available from the literature: Weak branches; Clean (Sutton, 1974).

Evaluator's Comments: Older branches often will break (Evans, 1985). Little trash, flowing strobiles, winter stem color and autumn leaf coloration make cleanuup worthwhile.

Soil Adaptability:

Texture:

Information available from the literature: Medium, loam, moist to wet, no organic matter, well-drained (Sutton, 1974).

Evaluator's Comments: Will tolerate somewhat low moisture levels with well drained soil (Evans, 1985). Often found at streamside and in old beaver marshes, so does prefer alluvial soils (Metcalf, 1985).

pH:

Information available from the literature: 6.5-7.0 (Sutton, 1974).

Moisture Regime Adaptability: Moist to wet (Sutton, 1974). Moist (Kelly, 1970).

Drought Tolerance:

Information available from the literature: Good (Sutton, 1974).

Evaluator's Comments: Will be best restricted to irrigated or naturally wet sites (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Probably tolerates at least seasonal flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 4 (Dirr, 1983). Range up to 9,000' in Colorado Rockies (Kelly, 1970). Recommended for general planting in Brooks, Alberta area (Casement, 1984).

Evaluator's Comments: Hardy plant (Metcalf, 1985).

Light:

Information available from the literature: Sun (Preston, 1968; Van Dersal, 1938).

Evaluator's Comments: Grows well in full exposure, provided water is available (e.g. along Dupyer Creek in Pondera/Teton counties) (Metcalf, 1985). Wide range, but does best in sun (Pohl, 1985).

Wind:

Information available from the literature: Yes wind firm (Sutton, 1974).

Evaluator's Comments: Older stems may fall if rotted at the base (Metcalf, 1985). Frequent storm damage (Pohl, 1985).

Insects:

Information available from the literature: 20 insects present on the genus (Stark, 1966).

Disease:

Information available from the literature: Many pests on the genus only (Stark, 1966).

Evaluator's Comments: Check rust index for disease problems (Riesselman, 1985).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Animal food (Sutton, 1974). Wildlife utilization (Van Dersal, 1938). Schmidt (1980) recommendation for use as specimen. Kruckeberg (1982) recommendation.

Sources of Description:

Technical: Arnow (1980); Dirr (1983); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Arno and Hammerly (1977); Kelly (1970); Nelson (1977); Phillips (1978).

Availability: Callahan-Seed; Native Plants, Inc.; Northplan; Old Farm Nursery, Inc.; Plants of the Wild.

Habitat Types: Riparian vegetation type (Sutton, 1974).

Range: Washington to Montana, south to New Mexico and California (Sutton, 1974); Colorado 5,000-9,000´, Utah 5,000-8,000´ (Sutton, 1974).

SCIENTIFIC NAME: Ceanothus velutinus Dougl.

Common Name: Snowbrush

Transplantability:

Information available from the literature: Taproot makes it nearly impossible (Van Dersal, 1938). Vigorous seedlings (Monsen and Christensen, 1975).

Evaluator's Comments: Difficut to transplant (Metcalf, 1985). Seedling success 50%; field dug success 5% (Pohl, 1985).

Lifespan:

Information available from the literature: Moderate (Sutton, 1974).

Evaluator's Comments: A persistent weedy species in forests; Van Dersal states that it is impossible to eliminate by overgrazing with goats (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds (Sutton, 1974). Collect seed only from vigorous plants by tying cloth bags securely over clusters of green seed pods. Seed-pod clusters should not be cut as seed will not ripen properly. Seed is apparently long-lived. Store in sealed containers around 40 F. Ripens August 10 - September 10. Dormancy must be broken by hot water soak at 175 to 212 F for 5 minutes or until cool plus cold, moist stratification at 34 to 41 F for 60-90 days. Heat has direct effect on germination and may account for abundant germination of C. velutinus after wildfire. Seed is sown in 5:4:3 loam:peat:sand at depth 2x diameter of seed. Sterilized soil is necessary to prevent damping off. Germination is epigeal. Root crowns must not be moist (Schopmeyer, 1978). Seed, fall sowing (Monsen and Christensen, 1975).

Evaluator's Comments: Is believed to require soil inoculation with nitrogen-fixing bacteria (Lackschewitz, 1985). Very difficult to propagate, although worthy of additional research (i.e. tissue culture) (Pohl, 1985).

Maintenance/Cleanliness:

Information available from the literature: Top subject to desiccation when exposed above snow; clean (Sutton, 1974). Contains saponin, a poison (Stark, 1966).

Evaluator's Comments: Requires virtually annual renewal pruning when grown away from forests with heavy snowcover (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Medium to coarse, dry, no organic matter, well-drained (Sutton, 1974). Well-drained (Kelly, 1970).

Evaluator's Comments: Will grow in soils suitable for pines (Metcalf, 1985).

pH:

Information available from the literature: 5.5-7.0 (Sutton, 1974). Acid (Kelly, 1970).

Moisture Regime Adaptability: Mesic (U.S.D.A., 1981). Moderate-dry (Spurr, 1978).

Drought Tolerance:

Information available from the literature: Moderate if well-established (Sutton, 1974).

Evaluator's Comments: Probably adapted to spring wet/summer dry sites (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Likely to be intolerant of flooding, requires good drainage (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Susceptible to freeze-kill (Furniss, 1971). Range 6,000-10,000' in

north-central Colorado (Kelly, 1970). Zone 5 (Bailey and Bailey, 1976).

Evaluator's Comments: Basically a snow-dependent species. Not suitable for landscapes where chinooks occur (Metcalf, 1985). Requires snow cover for winter protection (Pohl, 1985).

Light:

Information available from the literature: Sun (Van Dersal, 1938). Sun or shade (Spurr, 1978).

Evaluator's Comments: Coriaceous, velutinous leaves suggest adaptation to strong light (Metcalf, 1985).

Wind:

Information available from the literature: Yes wind firm (Sutton, 1974).

Evaluator's Comments: Forms a chaparral which is quite windfirm, but may be susceptable to fire (Metcalf, 1985).

Insects:

Information available from the literature: 33 insects on the genus (Stark, 1966). Tortoise shell butterfly, western tussock moth (Furniss, 1971).

Evaluator's Comments: Susceptable to aphids (Jensen, 1985).

Disease:

Information available from the literature: 30 pathogens on the genus (Stark, 1966). Root-rotting fungus, Armillaria (Furniss, 1971).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Nitrogen-fixing, fair wildlife utilization (Van Dersal, 1938). Sutton (1974) recommendation. Deer browse, potential for use in soil stabilization plantings (USDA, 1982). Kruckeberg (1982) recommendation.

Sources of Description:

Technical: Arnow (1980); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Arno and Hammerly (1977); Kelly (1970); Kruckeberg (1982); Nelson (1977); Spurr (1978); Taylor (1978).

Availability: Callahan-Seeds; Native Plants, Inc.; Northplan; Old Farm Nursery, Inc.; Plants of the Wild.

Habitat Types: Chaparral, Douglas fir/white fir, Aspen/lodgepole pine, Spruce/fir, Ponderosa pine, Upper Uinta Sage (Sutton, 1974); Subalpine Fir/Douglas Fir/Grand Fir Climax (Ross and Hunter, 1976); Scree, Douglas fir (Pfister, 1977).

Range: Washington to Montana, south to New Mexico and California. Colorado 6,500-9,000´, 6,000-10,000´ (Sutton, 1974). Black Hills of South Dakota and from British Columbia south to Colorado and California (USDA, 1982).

SCIENTIFIC NAME: Cerastium tomentosum L.

Common Name: Snow-in-summer

Transplantability:

Evaluator's Comments: Transplants readily from divisions of old plants (Metcalf, 1985).

Lifespan:

Evaluator's Comments: A long-lived perennial (Metcalf, 1985).

Propagation:

Information available from the literature: Seed, division, cuttings. Seeds germinate easily in 2-4 weeks at 68 F. Division can be done in spring or fall if care is taken to keep soil ball around roots when transplanting. Softwood cuttings can be taken in early summer (Still, 1982). Sow seed outdoors in spring or summer up to 2 months before frost, or indoors at 70-75 F medium temperature during germination. Germination takes 5-10 days (Reilly, 1978).

Evaluator's Comments: Easy to propagate (Metcalf, 1985).

Maintenance/Cleanliness:

Information available from the literature: Annual division often needed to keep plant in check. Trim back to encourage new growth (Still, 1982). Can get weedy (Kelly, 1980). Invasive (Voight et al, 1983).

Evaluator's Comments: Tendency to become weedy (Lackschewitz, 1985). Requires annual spring cleanup and occational restraint (Metcalf, 1985). Invasive. Requires mowing 1-2 times per year (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Dry soils, low fertility, spreads rampantly of moist, fertile soils (Still, 1982). Average, well-drained soils (Reilly, 1978). Any well-drained soil (Voight et al, 1983).

Evaluator's Comments: Responds vigorously on fertile, well-irrigated soils (Metcalf, 1985).

pH:

Moisture Regime Adaptability:

Drought Tolerance:

Information available from the literature: Does well in hot, dry and poor soils (Reilly, 1978).

Evaluator's Comments: Rampant when irrigated (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Likely intolerant of flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 4 (Still, 1982). Zone 2 (Wyman, 1973).

Evaluator's Comments: A very hardy plant (Metcalf, 1985). Fully hardy with wide tolerance (Pohl, 1985).

Light:

Information available from the literature: Full sun (Still, 1982; Voight et al, 1983).

Evaluator's Comments: Probably inefficient in use of light energy (Metcalf, 1985). Sun only (Pohl, 1985).

Wind:

Evaluator's Comments: Generally forms a wind-resistant mound (Metcalf, 1985).

Insects:

Information available from the literature: Spider mites (Still, 1982). None serious (Voight et al, 1983).

Disease:

Information available from the literature: None serious (Voight et al, 1983).

SCIENTIFIC NAME: Cercocarpus ledifolius Nutt.

Common Name: Curlleaf Mountain-mahogany

Transplantability:

Information available from the literature: Difficult to transplant mature plants (Sutton, 1974).

Evaluator's Comments: Very difficult to collect from wild (Pohl, 1985). Alright if container grown (Watson, 1985).

Lifespan:

Information available from the literature: Long-lived (Preston, 1968).

Evaluator's Comments: Natural stands appear to hold their own very well (Metcalf, 1985).

Propagation:

Information available from the literature: Seed (Sutton, 1974). Fruit ripens May to August (Blauer et al, 1975). Minimum fruit producing age 10 to 15 years at regular intervals ranging from 1 to 10 years. Fruit is collected in late summer ot early fall. Seed with moisture content of 7 to 10 % can be stored in cloth sacks in dry ventilated locations for up to 5 years. Seed should be kept moist at 32 to 38 F for 36 days or at outside temperatures from November to March, or stratified in moist sand or peat 30 to 90 days at 41 F. Acid soak may increase germination. Seed is usually sown in fall. If entire seed is sown a 30 minute soak is required. Seed beds should be kept moist until germination begins. Sow at 1/4-1/2" at 20 to 25 seedlings per square foot. Seedlings outplanted at 1-2 years (Schopmeyer, 1979).

Maintenance/Cleanliness:

Information available from the literature: Pruning tolerant; clean (Sutton, 1974). Prune in late April, early May or mid to late September, pruning at other times can result in complete mortality (Blauer et al, 1975).

Soil Adaptability:

Texture:

Information available from the literature: Coarse to rocky, sandy loam. No organic matter, well-drained soils. Grows on wide range of soils, common on limestone ridges (U.S.D.A., 1981).

Evaluator's Comments: Well-developed on the Madison limestone (Metcalf, 1985).

pH:

Information available from the literature: 6.0-7.0 (Stark, 1966).

Moisture Regime Adaptability: Dry, 12"+ annual precipitation (Sutton, 1974).

Drought Tolerance:

Information available from the literature: Good (Sutton, 1974). Drought resistant (U.S.D.A., 1981).

Evaluator's Comments: Natural inhabitant of dry, hot rocky slopes (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Probably intolerant (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Range 2,000 to 4,500'+, in northern part of range 9,000'. Tolerates high temperatures (U.S.D.A., 1981).

Evaluator's Comments: In Montana, often (or mostly) found in Upper Sonoran Zone (Metcalf, 1985).

Light:

Information available from the literature: Sun (Huddleston and Hussey, 1975; Preston, ;Sutton, 1974; Van Dersal, 1938).

Evaluator's Comments: Probably intolerant of shade when mature (Metcalf, 1985). Requires full sun; leggy in shade (Pohl, 1985).

Wind:

Information available from the literature: Very wind firm (Sutton, 1974). Withstands some exposure to wind (Huddleston and Hussey, 1975).

Evaluator's Comments: Tends to form a wind-resistant chaparral in native stands (Metcalf, 1985).

Insects:

Information available from the literature: 4 insects on the genus (Sutton, 1974). None (Stark, 1966). Relatively free from attack. Sucking bugs, looper, bark beetle (Furniss, 1971). Aphids (Labadie, 1978).

Disease:

Information available from the literature: 9 pathogens on the genus (Stark, 1966). Leaf spot, relatively free from attack (Furniss, 1971).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: A valuable wildlife browse and cover plant (Wasser, 1982). Animal food (Sutton, 1974). Wildlife utilization (Van Dersal, 1938). Potential for soil stabilization (USDA, 1982). Schmidt (1980) recommendation. Kruckeberg (1982) recommendation. Wilson (1984) recommendation. Labadie (1978) recommendation.

Sources of Description:

Technical: Arnow (1980); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Huddleston and Hussey (1975); Kelly (1970); Kruckeberg (1982); Labadie (1978); Nelson (1977); Taylor (1978).

Availability: Callahan-Seeds; Native Plants, Inc.; Northplan; Old Farm Nursery, Inc.; Plants of the Wild.

Habitat Types: Chaparral, Pinyon/juniper, Upper Uinta Sage, Douglas fir/White fir, Aspen, lodgepole pine, Spruce/fir Sutton, 1974); Cercocarpus ledifolius series (Mueggler and Handl, 1974); Rocky Mountain juniper/Ponderosa pine climax forest (Ross and Hunter, 1976).

Range: Washington to Montana, south to New Mexico and California. Colorado 6,500-9,000´ (Sutton, 1974); Eastern Washington to California, northern Arizona and north to Colorado and Montana, 2,000-4,500´ in northern part of range and up to 9,000´ in southern part (USDA, 1982).

SCIENTIFIC NAME: Clematis ligusticifolia Nutt.

Common Name(s): Western Clematis, Western Virgin´s-bower

Transplantability:

Information available from the literature: Yes (Sutton, 1974).

Evaluator´s Comments:

Lifespan:

Information available from the literature: Short (Sutton, 1974).

Evaluator´s Comments: Plants become quite large under natural conditions. Comparatively long-lived for herbaceous vine (Evans, 1985). In nature, appears to be long-lived; seldom seen in cultivation (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds (Van Dersal, 1938). Cuttings (Stark, 1966). Seeds are brown when ripe (October-December). Seed requires prechilling at 33 to 40 F in moist sand, peat or mix for 60 to 180 days. Untreated seed is sown in fall or spring sowing of seed stratified over winter (Schopmeyer, 1979). Sow 2-4 x seed diameter. Moist chill at 33-41 F for 2-6 months (Wasser, 1982).

Maintenance/Cleanliness:

Information available from the literature: Will overtop shrubs; clean (Sutton, 1974).

Evaluator s Comments: Very agressive. Must prune to keep from other desirable shrubs (Evans, 1985). "Clean" may not be accurate, as abundant "fluff" from seedheads can be messy (Metcalf, 1985). Very invasive and rampant (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Rocky loam, well-drained, moist, organic matter (Sutton, 1974). Coarse, rocky, sandy, well-drained soils (Wasser, 1982).

Evaluator's Comments: Well drained soils - sandy, rocky, no clay (Evans, 1985). Commonly found on sites that prospectively have soils with good moisture retention (Metcalf, 1985).

pH:

Information available from the literature: 7.0 (Sutton, 1974).

Evaluator's Comments: pH may be a problem (Riesselman, 1985).

Moisture Regime Adaptability: 12-20" annual precipitation (Wasser, 1982).

Drought Tolerance:

Information available from the literature: Poor (Sutton, 1974). Once established can withstand dry conditions (Huddleston and Hussey, 19750. Weakly moderate drought resistance (Wasser, 1982).

Evaluator's Comments: Resistant to drought when well established (Evans, 1985). The genus as a whole is adapted to mesic situations - "Thrive with cool root-run, but head in the sun" (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Good if not submerged for great lengths of time (Evans, 1985). Probably only a limited tolerance (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Not frost sensitive (Wasser, 1982). Recommended for general planting in the Brooks, Alberta area (Casement, 1984).

Evaluator s Comments: Tops may suffer some dieback in severe winters, but roots are generally hardy and provide continuity (Metcalf, 1985).

Light:

Information available from the literature: Sun (van Dersal, 1938). Appears more productive in partial shade or

bordering shade. Moderate shade tolerance (Wasser, 1982). Full sun or partial shade (Huddleston and Hussey, 1975).

Evaluator's Comments: Appears to prefer cool soil in shaded areas, much like other Clematis species (Evans, 1985).

Wind:

Information available from the literature: No (Sutton, 1974).

Evaluator's Comments: Attached tenaciously to support plants (Evans, 1985). Wiry architecture of the plant provides wind-firmness (Metcalf, 1985). Climbing ability hampered by winds (Pohl, 1985).

Insects:

Information available from the literature: 3 insects on genus (Stark, 1966). 4 insects on species (Essig).

Disease:

Information available from the literature: 39 pathogens on the genus (Stark, 1966). Leaf spots, rusts, downy mildew (Wasser, 1982).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Game range improvement, rehabilitation of disturbed soils (Wasser, 1982). Animal food (Sutton, 1974). Minor wildlife utilization (Van Dersal, 1938). Shows promise for use in soil stabilization plantings on mowed lands and other disturbed areas. Cultivated as an ornamental (USDA, 1982). Kelly (1980) recommendation.

Sources of Description:

Technical: Bailey (1949); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Huddleston and Hussey (1975); Kelly (1970); Nelson (1977).

Availability: Crifty View Nursery; Little Valley Wholesale Nursery; Native Plants, Inc.; Northplan.

Habitat Types: Riparian (Sutton, 1974).

Range: Washington to Montana, south to New Mexico and California. Colorado 5,000-8,500´. Nevada 7,000´ and below (Sutton, 1974). Western Canada and North Dakota, south to New Mexico, Arizona and California. Native to western United States (Wasser, 1982).

SCIENTIFIC NAME: Eriogonum umbellatum Torr.

Common Name: Sulfurflower, Sulfur Buckwheat

Transplantability:

Information available from the literature: Poor (Sutton, 1974). Vigorous seedlings (Monsen and Christensen, 1975).

Evaluator's Comments: Eriogonums generally are not easy to transplant from the wild. Best to raise from seed (Metcalf, 1985). Fine from seedlings but very difficult to transplant from wild (Pohl, 1985).

Lifespan:

Information available from the literature: Short (Sutton, 1974).

Evaluator's Comments: Not easily grown in cultivation (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds (Sutton, 1974). Stratify seeds at 32 F (Stark, 1966).

Evaluator's Comments: Germination may be slow (Metcalf, 1985). Easily progagated from seed in greenhouse (Pohl, 1985).

Maintenance/Cleanliness:

Information available from the literature: Spread is not too vigorous; clean (Sutton, 1974).

Evaluator's Comments: Plants may accumulate trash that blows from other plants (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Fine to coarse, well-drained, no organic matter (Sutton, 1974). Adapted to harsh, rocky soils (Monsen and Christensen).

pH:

Information available from the literature: 7.0 (Sutton, 1974).

Moisture Regime Adaptability: Dry, 6-10"+ annual precipitation (Sutton, 1974).

Drought Tolerance:

Information available from the literature: Good (Sutton, 1974).

Flood Tolerance:

Evaluator's Comments: Probably limited flood tolerance (Metcalf, 1985).

Exposure:

Temperature:

Evaluator's Comments: Reasonably hardy (Metcalf, 1985). Very hardy - prefers snow cover (Pohl, 1985). Occurs on exposed sites where temperatures vary to extremes (Rumely, 1985).

Light:

Information available from the literature: Sun (Van Dersal, 1938).

Evaluator s Comments: Sun only (Pohl, 1985). Always found in the open. Languishes and disappears if vegetation grows over and shades it (and affects it in other ways)(Rumely, 1985).

Wind:

Information available from the literature: Yes wind firm (Sutton, 1974).

Evaluator s Comments: Withstands strong, desiccating air movement on ridgetops (Rumely, 1985).

Insects:

Information available from the literature: 1 insect on the genus (Stark, 1966).

Disease:

Information available from the literature: 14 pathogens on the genus (Stark, 1966).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Animal food (Sutton, 1974); Promise for use in soil stabilization. Livestock and game utilization (USDA, 1982; Kruckeberg (1982) recommendation. Kelly (1980) recommendation.

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dorn (1984); Hitchcock and Cronquist (1981).

Non-technical: Nelson (1977); Taylor (1978).

Availability: Clyde Robin Seed Co.; Little Valley Wholesale Nursery; Native Plants, Inc.; Northplan; Old Farm Nursery, Inc.; Dean Swift Seed Co.

Habitat Types: Chaparral, Pinyon/juniper, Douglas fir/white fir, Upper Uinta sage, Ponderosa pine, Aspen/lodgepole pine (Sutton, 1974). Douglas Fir (Pfister, 1977). Festuca scabrella series (Mueggler and Handl, 1974). Artemesia spp. (Ross and Hunter, 1976).

Range: Washington to Montana, south to New Mexico and California. Colorado 5,000-10,500 (Sutton, 1974). Wyoming to Washington and south to California and northern Arizona (USDA, 1982). Clayey range sites (Ross and Hunter, 1976).

SCIENTIFIC NAME: Humulus Lupulus L.

Common Name: Hop Vine

Transplantability:

Evaluator's Comments: Since hops is used extensively, it is assumed that transplantability is good (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Observations in Bozeman indicate an extended lifespan (Metcalf, 1985). Very long lifespan for a vine (Pohl, 1985).

Propagation:

Evaluator's Comments: Propagated by cuttings of underground stems (Metcalf, 1985). Have had minimal success with seeds (Pohl, 1985).

Maintenance/Cleanliness:

Evaluator's Comments: Grown as a screen vine, requires only annual removal of previous season's stems (Metcalf, 1985). Requires annual cleaning as a half hardy perennial (Pohl, 1985).

Soil Adaptability:

Texture:

Evaluator s Comments: Probably grows best on soils with good moisture retention (Metcalf, 1985).

pH:

Moisture Regime Adaptability:

Drought Tolerance:

Evaluator's Comments: Likely intolerant of drought (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Unlikely to be tolerant of flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Recommended for general planting in the Brooks, Alberta area (Casement, 1984).

Evaluator's Comments: Long-time hardiness evident in Bozeman, Montana (Metcalf, 1985).

Light:

Evaluator's Comments: Half to full sun (Metcalf, 1985). Full sun only (Pohl, 1985).

Wind:

Evaluator's Comments: Have never witnessed wind damage on this species (Metcalf, 1985). Strong winds prohibit climbing ability (Pohl, 1985).

Insects:

Evaluator s Comments: Leafhoppers (Metcalf, 1985).

Disease:

SCIENTIFIC NAME: Juniperus chinensis L. 'Pfitzeriana'

Common Name: Pfitzer Juniper

Transplantability:

Information available from the literature: Ball and Burlap or container (Dirr, 1983).

Evaluator's Comments: Handled mostly by canned stock (Metcalf, 1985). By container (Riesselman, 1985).

Lifespan:

Evaluator s Comments: Long-lived species, growing in some forms to large tree size in native habitats in China (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds gathered in fall as soon as cones ripen. Seeds removed from fruit and then treated with sulfuric acid for 30 minutes, then stratified for 4 months at 40 F or 2 to 3 months at 70-85 F or summer planting instead of acid. Winter cuttings (taken after parent exposed to subfreezing temperatures) rooted in greenhouse. Late summer or early fall cuttings for rooting in outdoor cold frame. Light wounding and IBA may help. 1:1 perlite/peat or medium-coarse sand is good medium. 60 F for 4-6 weeks, humidity but not wet cuttings and high light intensity. Bottom heat of 80 F will aid rooting (Dirr, 1983).

Evaluator's Comments: Good success from December - January cuttings and 10,000 ppm IBA (Evans, 1985).

Maintenance/Cleanliness:

Evaluator's Comments: Judicious pruning/clipping will help to maintain attractiveness (Metcalf, 1985). In thick stands, undergrowth requires pruning (Riesselman, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Moist, well-drained (Dirr, 1983).

Evaluator's Comments: Some establishment/survival problems reported for harsh sites on the High Line (Metcalf, 1985).

pH:

Information available from the literature: Adaptable, quite tolerant of calcareous soils (Dirr, 1983).

Evaluator's Comments: Will probably thrive in soils that are well supplied with calcium (Metcalf, 1985).

Moisture Regime Adaptability: 10-20" annual precipitation (Howard, 1972).

Drought Tolerance:

Evaluator's Comments: Most commonly grown under irrigation (Metcalf, 1985). Tolerant to drought if established (Watson, 1985).

Flood Tolerance:

Evaluator's Comments: Probably rather intolerant of flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 3-9 (Dirr, 1983). Zone 3-7 (Howard, 1972). Zone 4 (Wyman, 1974). Zone 4 (Bailey, 1976).

Evaluator's Comments: Some establishment survival problems reported for harse sites on High Line (Metcalf, 1985). Zone 4 (Riesselman, 1985).

Light:

Information available from the literature: Full sun (Wyman, 1974).

Evaluator's Comments: Best growth and vigorous where light is bright (Metcalf, 1985). Full sun (Riesselman, 1985). Full sun (Watson, 1985).

Wind:

Evaluator's Comments: Relatively wind-resistant (Metcalf, 1985). Some wind burn and desiccation during winter (Riesselman, 1985).

Insects:

Information available from the literature: Rocky Mountain Juniper aphid, bagworm, juniper midge, scale, web worm, red cedar bark beetle, mites (Dirr, 1983).

Evaluator's Comments: Spittle bug present; not much else in this area (Evans, 1985). Insect problems negligible (Riesselman, 1985).

Disease:

Information available from the literature: Phomopsis blight (kills young shoots, prevalent in early spring and wet weather), cedar apple rust, wilt (Dirr, 1983).

Evaluator's Comments: No sign of cedar apple rust in this species (Evans, 1985). Much more resistant to cedar apple rust than J. scopulorum and should be planted in preference to that species in most landscapes (Metcalf, 1985). Diseases negligible; rust has very weak pathogenicity (Riesselman, 1985).

SCIENTIFIC NAME: Juniperus communis L.

Common Name(s): Common Juniper, Mountain Juniper

Transplantability:

Information available from the literature: Poor on wildings (Sutton, 1974). Readily (Dirr, 1983).

Evaluator's Comments: Good transplant following nursery cultivation. Not as successful as most other Junipers (Evans, 1985). Landscape sizes likely best handled as B&B stock (Metcalf, 1985). Difficult to transplant from wild (Pohl, 1985). Transplant alright if container grown (Watson, 1985).

Lifespan:

Information available from the literature: Long-lived (Van Dersal, 1938).

Evaluator's Comments: Examples on MSU campus that have thrived after some 35 years (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds, cuttings (Sutton, 1974). Fruit ripens August to October (second to third year) when it turns from red to bluish to black, glaucous, persists for two seasons. drops at regular intervals. Collected in fall. Seeds may be dried with pulp on or cleaned. Store at 20 to 40 F in dry sealed containers. Seeds need warm stratification at 68 F night and 86 F day for 45 to 90 days, followed by cold stratification at 41 F for 90+ days. Sow in spring or fall 1/4" deep beds should be mulched and provide light shade. Plant out as 2-1 stock (Schopmeyer, 1979).

Evaluator's Comments: Good success with summer softwood or winter hardwood cuttings (Evans, 1985).

Maintenance/Cleanliness:

Information available from the literature: Can winterburn if exposed; clean (Sutton, 1974).

Evaluator's Comments: Windburn not as common on the species as it is on certain upright cultivars (Evans, 1985). Spreading forms may become open-centered over time. Judicious pruning should help overcome this tendency (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Fine to coarse, deep, dry to moist, organic matter if possible, well-drained (Sutton, 1974). Dry sterile soils, grows on the worst land possible, rock outcroppings and waste lands (Dirr, 1983).

Evaluator's Comments: Sutton and Dirr's comments probably apply to eastern forms. Montana type is more often seen in partially shaded situations or among rocks where root-runs are cool (Metcalf, 1985). Soil cannot be too wet (Watson, 1985).

pH:

Information available from the literature: 7.0 Sutton, 1974). Tolerant of calcareous soils, will tolerate neutral or slightly acid soils (Dirr, 1983).

Evaluator's Comments: Junipers are often indicators of limestone substrates (Metcalf, 1985).

Moisture Regime Adaptability: 10 to 20" annual precipitation (Howard, 1972). Mesic (U.S.D.A., 1981)

Drought Tolerance:

Information available from the literature: Good if well-established (Howard, 1972).

Evaluator's Comments: This may depend largely on the provenance of the plant (Evans, 1985). Less well-adapted to moisture stressed sites than J. oligosperma or J. scopulorum (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Probably intolerant of flooding (Metcalf, 1985). All Junipers have low flood tolerance (Riesselman, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 2 + 6 (7) (Dirr, 1983). Zone 4 to 7 (Howard, 1972). Zone 2 (Wyman, 1974). Zone 3 (Bailey, 1976).

Evaluator's Comments: Quite hardy, but perhaps less so than J. sabina (Metcalf, 1985). Hardy (Riesselman, 1985).

Light:

Information available from the literature: Sun or shade (Huddleston and Hussey, 1975; Sutton, 1974). Shade (Howard, 1972).

Evaluator's Comments: A better choice for shaded sites than many other Junipers (Metcalf, 1985).

Wind:

Information available from the literature: Yes wind tolerant (Sutton, 1974).

Evaluator's Comments: Low growing forms are quite wind resistant (Metcalf, 1985).

Insects:

Information available from the literature: 10 pests on the genus (Stark, 1966). Spider mites (Schopmeyer, 1979).

Evaluator's Comments: Have never observed spider mites in this species (Evans, 1985). Spider mites and spittle bugs often encountered (Jensen, 1985).

Disease:

Information available from the literature: 10 pests on the genus (Stark, 1966). Juniper blight (Dirr, 1983). Phomopsis blight (Schopmeyer, 1979).

Evaluator's Comments: No apparent problem in our area (Evans, 1985). Juniper Hawthorn Rust severe (Mathre, 1985). Diseases rare (Riesselman, 1985).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Planted less commonly, despite good cover and ornamental value (Wasser, 1982). Animal food (Sutton, 1974). Sutton (1974) recommendation. Wildlife utilization (Van Dersal, 1938). Shows promise for use in soil stabilization plantings. Low-growing forms are commonly used in landscaping (USDA, 1982) Kruckeberg (1982) recommendation. Wilson (1984) recommendation.

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dirr (1983); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Huddleston and Hassey (1975); Kelly (1970); Kruckeberg (1982); Nelson (1977); Phillips 1978); Simon and Schuster (1978).

Availability: Callahan-Seeds; Mitsch Nursery, Inc.; Native Plants, Inc.; Old Farm Nursery, Inc.

Habitat Types: Aspen/lodgepole pine, Spruce/fir, Ponderosa Pine (Sutton, 1974) (Pfister et al, 1977). Douglas fir/Ponderosa Pine Climax Forests, Spruce/Douglas-fir Climax (Ross and Hunter, 1976).

Range: Colorado 5,000-7,000´. Circumpolar in cool places (Sutton, 1974).

SCIENTIFIC NAME: Larix occidentalis Nutt.

Common Name: Western larch

Transplantability:

Information available from the literature: Easily (Kruckeberg, 1982).

Lifespan:

Information available from the literature: Very long (500 years) (Arno and Hammerly, 1978).

Propagation:

Information available from the literature: Fruit ripens August to September. Collect in fall as soon as ripe. Minimum seed bearing age is 25 years, 1-10 year intervals between large seed crops. Ripe when cone turns from green to brown to purple (specific gravity of 1.025). Heat opens cones. Kiln 7 to 9 hours at 110 F. Store at 0 to 50 F in dry sealed containers. Long storage life. Sow in fall (or spring using stratified seed) 1/8 to 1/4" deep. Fall beds should be mulched. Germination is epigeal. Sow 30 to 35 seedlings/square foot. Outplant as 1-0 (Schopmeyer, 1979).

Maintenance/Cleanliness:

Evaluator's Comments: Annual needle-fall and cones in crop years must be cleaned (Metcalf, 1985). Needles and some cones shed annually. Most cones remain on tree "indefinitely". Winds break off branches rather easily (Rumely, 1985).

Soil Adaptability:

Texture:

pH:

Moisture Regime Adaptability:

Drought Tolerance:

Evaluator's Comments: Grows on north clines in the Mission Mountains, suggesting a higher moisture requirement than e.g. Ponderosa Pine (Metcalf, 1985). Not as drought tolerant as P. contorta latifolia or P. Ponderosa, but much more so than Picea or Abies (Rumely, 1985).

Flood Tolerance:

Evaluator's Comments: Probably much less tolerant of flooding than some other species in the genus (Metcalf, 1985). Sometimes this occurs in swamps (this is not characteristic). Suspect "lowland" and "upland" races (genetic)(Rumely, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 5 (Bailey, 1976).

Evaluator's Comments: Restricted in nature to the west side of the Divide, where Montana has 80% of the merchantable larch timber in the U.S. Seldom seen in landscapes (Metcalf, 1985). Able to withstand hot-cold regimes if cool nights. Prefers coastal climate (higher humidity) more than continental climate (Rumely, 1985).

Light:

Information available from the literature: Extremely intolerant of shade (Arno and Hammerly, 1978).

Evaluator's Comments: Definitely heliophytic. Establishes well (west of Continental Divide) on burns or clearcuts. "Never" occurs as good stands of seedlings under established forest cover. Early successional species, persisting only as old, mature tall trees (Rumely, 1985).

Wind:

Evaluator's Comments: Branches and tops of trees seem to break easily. Brittle. But tall boles "give" with the wind, sway and rock but remain. Only the branches and tips break (Rumely, 1985).

Insects:

Information available from the literature: Weevils, spruce budworm (Schopmeyer, 1979). Larch casebearer (Arno and Hammerly, 1978).

Evaluator's Comments: Larch casebearer is a recent pest in Montana, from an initial infestation in Idaho several years ago. Long-known on other spp. in Eastern U.S. (Metcalf, 1985).

Disease:

Information available from the literature: Dwarf mistletoe, quinine conk fungus (Arno and Hammerly, 1978).

Evaluator's Comments: If Dwarf Mistletoe is a "disease", then it can be included as a serious detriment to the growth of Western Larch.

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Wildlife utilization (Van Dersal, 1938).

Sources of Description:

Technical: Arnow et al (1980); Dorn (1980); Hitchcock and Cronquist (1973).

Non-technical: Arno and Hammerly (1977); Kruckeberg (1982).

Availability: Callahan-Seeds; Clifty View Nursery; Northplan.

Habitat Types: Douglas Fir Series, Grand Fir Series, Spruce Series, Western Hemlock Series, Alpine Fir (Pfister et al, 1977).

Range: Southern British Columbia, southeast along the Cascade Mountains to Oregon, east to Idaho and Montana (Hitchcock and Cronquist, 1973).

SCIENTIFIC NAME: Larix sibirica Ledeb.

Common Name: Siberian Larch

Transplantability:

Evaluator's Comments: Apparently transplants well, as used extensively in field shelterbelts in Saskatchewan and other Prairie Provinces of Canada (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Presumably long-lived, as with many other gymnosperms (Metcalf, 1985).

Propagation:

Information available from the literature: Fruit ripens September to November. Collect in late fall as soon as ripe. Minimum seed bearing age 12 years, 3 to 5 year intervals. Ripe when brown. Heat opens cones. Store at 34 to 38 F, 6 to 8% moisture, in dry sealed containers. Long storage life. Cold, moist stratification for 21 to 60 days at 32 to 41 F (Schopmeyer, 1979). Seed ripens early to mid-September. No stratification. Sow in spring or fall (Vanstone et al, 1982).

Maintenance/Cleanliness:

Evaluator's Comments: Can become double-topped if owls/crows use main leader for perch (Metcalf, 1985). Annual needlefall and cones following crop years.

Soil Adaptability:

Texture:

Evaluator's Comments: Extensive use in shelterbelts/windbreaks suggests fairly wide adaptability to various textured soils (Metcalf, 1985).

pH:

Moisture Regime Adaptability: 10 to 20" annual rainfall (Howard, 1972).

Drought Tolerance:

Evaluator's Comments: Probably quite tolerant (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Unlikely to tolerate flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 3 (Howard, 1972). Recommended for general planting in Brooks, Alberta area (Casement, 1984). Zone 2 (Bailey, 1976).

Evaluator's comments: A hardy species (Metcalf, 1985)

Light:

Evaluator's Comments: Probably rather intolerant of shade (Metcalf, 1985).

Wind:

Evaluator's Comments: Use in windbreaks suggests species is quite windfirm (Metcalf, 1985).

Insects:

Evaluator's Comments: Susceptibility to Larch Casebearer is unknown to me (Metcalf, 1985).

Disease:

SCIENTIFIC NAME: Lonicera sempervirens L.

Common Name: Trumpet Honeysuckle

Transplantability:

Evaluator's Comments: Transplant readily (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Tops may die back annually, but root systems perenniate well (Metcalf, 1985).

Propagation:

Evaluator's Comments: Soft or hardwood stem cuttings (Evans, 1985). Easy propagation from cuttings (Metcalf, 1985). Roots readily from cuttings (Pohl, 1985).

Maintenance/Cleanliness:

Evaluator's Comments: Best handled by cutting back to near ground level each spring (Metcalf, 1985).

Soil Adaptability:

Texture:

Evaluator's Comments: Appears to be quite adaptable, but will likely thrive best on soils with good moisture retention potential (Metcalf, 1985).

pH:

Moisture Regime Adaptability: 10 to 20" annual rainfall (Howard, 1972).

Drought Tolerance:

Evaluator's Comments: Probably has a low tolerance for drought (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Likely rather intolerant of flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 4 to 9 (Dirr, 1983). Zone 3 to 5 (Howard, 1972). Zone 3 (Wyman, 1974). Zone 4 (Bailey, 1976).

Evaluator's Comments: Tops less hardy than root system, will often die back annually (Metcalf, 1985).

Light:

Evaluator's Comments: Grows well in both sun and half shade (Metcalf, 1985). Fairly wide adaptability (Pohl, 1985).

Wind:

Evaluator's Comments: Twines tightly to support (i.e. is resitant to wind damage)(Evans, 1985). Wiry habit renders it quite windfirm (Metcalf, 1985). Wind may limit climbing ability (Pohl, 1985).

Insects:

Information available from the literature: Plant lice (Wyman, 1974).

Evaluator's Comments: None observed, some aphids (Evans, 1985). Few insect problems (Metcalf, 1985).

Disease:

SCIENTIFIC NAME: Mahonia aquifolium (Pursh) Nutt.

Common Name: Oregongrape

Transplantability:

Evaluator's Comments: A common plant of nurseries in areas milder than Montana (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Suckering habit contributes to lifespan (Metcalf, 1985).

Propagation:

Information available from the literature: Seed stratified 90 days at 41 F. Dry seed after collected. Softwood and hardwood cuttings root well, and division of the parent plant. Cuttings taken in November, treat with .8 to 1.0 % IAA (Dirr, 1983). Fruit ripens in late July to early August. Seed should be dried superficially and either sown or stored in sealed containers at temperatures slightly above frezing. Fall sown seeds should be covered with 1/2" or 1/8" soil plus 1/4" sand. Germination is epigeal. Field planted as 2-0 stock (Schopmeyer, 1979). Cuttings from May to August, seeds, layering, suckers (Spurr, 1978). Divisions or root cuttings (Wyman, 1973).

Maintenance/Cleanliness:

Information available from the literature: Very subject to winterburn (Huddleston and Hussey, 1975).

Evaluator's Comments: In most of Montana, will require annual removal of winterinjured stems (Metcalf, 1985). Winterburn common above snowline (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Moist, well-drained; avoid hot, dry soils (Dirr, 1983).

pH:

Information available from the literature: Acid; Chlorosis in high pH soils (Dirr, 1983).

Evaluator's Comments: Probably intolerant of high pH and saline soils (Metcalf, 1985).

Moisture Regime Adaptability: Moderate to dry (Spurr, 1978).

Drought Tolerance:

Information available from the literature: Not tolerant (Dirr, 1983; Huddleston and Hussey, 1975). Moderate (Mathias, 1977).

Evaluator's Comments: Requires a moist site (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Likely intolerant (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 4 to 5 to 8 (Dirr, 1983). Zone 5 (Wyman, 1973). To 0 F (Labadie, 1978). Susceptible to frost (Mathias et al, 1977).

Evaluator's Comments: Plant will be lost at least by second winter. It is not hardy anywhere in Montana. The native B. repens must have some winter-wind protection, shade protection or snow cover to avoid burned leaves (Lackschewitz, 1985). Not hardy enough for most of Montana (Metcalf, 1985). Marginally hardy (Pohl, 1985). Zone 3-4 (Riesselman, 1985).

Light:

Information available from the literature: Sun or shade (Spurr, 1978). Best in partial shade (Huddleston and Hussey, 1975; Labadie, 1978; Mathias et al, 1977).

Evaluator's Comments: Definitely requires shady site in Montana (Metcalf, 1985). Prefers shade and winter wind/sun protection (Pohl, 1985).

Wind:

Information available from the literature: Not wind tolerant (Dirr, 1983). Browns if not protected (Dirr, 1983; Huddleston and Hussey, 1975).

Evaluator's Comments: Readily suffers desiccation (Metcalf, 1985).

Insects:

Information available from the literature: Barberry aphid, scale, whitefly (Dirr, 1983). Mealybug, barberry looper (Labadie, 1978).

Disease:

Information available from the literature: Leaf rusts, leaf spots (Dirr, 1983). Marked resistance to black stem rust of wheat (Schopmeyer, 1979). Incomplete resistance to black stem rust (Wasser, 1982).

Evaluator's Comments: Affected by some leaf spotting fungi (Riesselman, 1985).

SCIENTIFIC NAME: Parthenocissus quinquefolia (L.) Planch.

Common Name: Virginia Creeper, Engelman Ivy

Transplantability:

Information available from the literature: Grown in containers and moved to final location (Dirr, 1983).

Evaluator's Comments: Transplanting is more difficult with mature plants (Evans, 1985). Transplants are slow to become established (Pohl, 1985).

Lifespan:

Information available from the literature: Hard to kill (Dirr, 1983).

Propagation:

Information available from the literature: Seed has a dormant embryo and cool, moist stratification in sand or peat for 30 to 60 days at 41 F is recommended; softwood cuttings collected in August rooted 90% in 20b days with no treatment; very easy to root from June, July or August cuttings (Dirr, 1983). Collect seed after fruit has turned bluish-black (ripe in July- August). Seeds or whole fruit should be dried for storage at 41 F in sealed containers. Germination is epigeal. Moist, cold stratification at 41 F for 60 days or outdoor stratification. Sow in fall or treated seed in spring, at 3/8" deep. Also hardwood layerings (Schopmeyer, 1979). Layers, seed in February or March (Wyman, 1973).

Evaluator's Comments: Softwood cuttings. Semi-softwood vine (multi-node) sections (Evans, 1985). No experience from seed; propagated easily vegetatively (Metcalf, 1985).

Maintenance/Cleanliness:

Information available from the literature: Needs no support (Dirr, 1983). Can become invasive and weedy (Kelly, 1980). Berries may be poisonous (Kingsbury, 1964).

Evaluator's Comments: Only the Engelmann form has holdfasts; others may clamber, but do not climb (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Tolerates any kind of soil (Dirr, 1983).

pH:

Moisture Regime Adaptability: 10 to 20" annual rainfall (Howard, 1972).

Drought Tolerance:

Evaluator's Comments: Adaptable to extreme drought (Evans, 1985). Favored by irrigation and runoff from roofs (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: May be reasonably tolerant of seasonal flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 3 to 9 (Dirr, 1983). Zone 3 to 7 (Howard, 1972). Recommended for general planting in Brooks, Alberta area (Casement, 1984). Zone 4 (Bailey & Bailey, 1976).

Evaluator's Comments: Know of severe winter kill-back in Bozeman (Metcalf, 1985).

Light:

Information available from the literature: Full sun or full shade (Dirr, 1983). Shade tolerant (Howard, 1972).

Evaluator's Comments: Adaptable to shade; fall color diminishes in shade (Evans, 1985). Autumn color will be superior when grown in full sun (Metcalf, 1985).

Wind:

Information available from the literature: Yes wind tolerant (Dirr, 1983).

Evaluator's Comments: On some surfaces, holdfasts may blow loose and need additional support (Evans, 1985). Vines can be torn from support by very severe winds (Metcalf, 1985). Wind may limit climbing (Pohl, 1985).

Insects:

Information available from the literature: Beetles, eight-spotted forester, leafhoppers, scales and several other insects (Dirr, 1983).

Evaluator's Comments: Leafhopper is the greatest insect problem noted in Bozeman (Evans, 1985). Leafhoppers often kill vines (Jensen, 1985). Leafhoppers appear to be commonest pest in Montana; but also greenhouse whitefly infestations in Bozeman, Montana (Metcalf, 1985).

Disease:

Information available from the literature: Cankers, powdery mildew, leaf spots, downy mildew, wilt (Dirr, 1983).

Evaluator's Comments: None observed in Bozeman (Evans, 1985).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Wildlife utilization (Van Dersal, 1938).

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dirr (1983); Morris et al (1962).

Non-technical: Kelly (1970).

Availability: Commonly available.

Habitat Types:

Range:

SCIENTIFIC NAME: Philadelphus Lewisii Pursh.

Common Name: Lewis Mockorange

Transplantability:

Evaluator's Comments: No problem with transplanting young stock (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Probably long-lived (Metcalf, 1985).

Propagation:

Information available from the literature: Fruit matures in late summer and is dispersed in September or October. Seed should be stratified for 8 weeks at 41 F in coarse sand then placed in coarse sand medium at 72 to 79 F. Do not fully expose to light or keep in complete darkness (Schopmeyer, 1979). Cuttings in August to September, or suckers (Spurr, 1978). Seed ripe in mid- September, lightly cover. Softwood cuttings under mist. Hardwood cuttings with light frequent irrigation (Vanstone, 1982).

Maintenance/Cleanliness:

Evaluator's Comments: Occasional renewal pruning will prove beneficial (Metcalf, 1985).

Soil Adaptability:

Texture:

Evaluator's Comments: Probably not particular about soil texture (Metcalf, 1985).

pH:

Moisture Regime Adaptability: 10-20" annual rainfall (Howard, 1972). Moderately dry (Spurr, 1978).

Drought Tolerance:

Information available from the literature: No. Needs frequent watering (Mathias et al, 1977).

Evaluator's Comments: Grows on walls of well-drained canyon slopes, but ground water supply or natural precipitation may be good (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Probably intolerant of flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 4-5 (Howard, 1972). Recommended for general planting in Brooks, Alberta area (Casement, 1984). Frost hardy (Mathias et al, 1977). Zone 5 (Bailey & Bailey, 1976).

Evaluator's Comments: Hardy, but note that it is a natural inhabitant of sites having heavy winter snowfall (Metcalf, 1985). Probably hardier than it may appear (Pohl, 1985).

Light:

Information available from the literature: Sun or shade (Spurr, 1978). Best in part shade (Mathias et al, 1977).

Evaluator's Comments: Commonly grows where light exposure is good, but may not be in full sun all day (Metcalf, 1985).

Wind:

Evaluator's Comments: Unlikely to suffer much wind damage, but might break down in ice storms (Metcalf, 1985).

Insects:

Disease:

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Wildlife utilization (Van Dersal, 1938). Kruckeberg (1982) recommendation.

Sources of Description:

Technical: Bailey (1949); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Kruckeberg (1982); Nelson (1977); Spurr (1978); Taylor (1978).

Availability: Northplan; Plants of the Wild.

Habitat Types: Scree, Ponderosa Pine, Douglas fir, Grand fir (Pfister, 1977)

Range:

Scientific Name: Philadelphus x virginalis Rehd.

Common Name: Virginal Mockorange

Transplantability:

Information available from the literature: Readily (Dirr, 1983).

Evaluator's Comments: Wide availability in nursery trade indicates this (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Where hardy, will be long-lived (Metcalf, 1985).

Propagation:

Information available from the literature: Seed directly sown; softwood suttings taken in June or July, and treated with 1000 ppm IBA-quick dip or talc root readily (Dirr, 1983).

Evaluator's Comments: Softwood cutting in July (Evans, 1985). Easily propagated from cuttings (Watson, 1985).

Maintenance/Cleanliness:

Evaluator's Comments: Some pruning needed of twigs damaged by periodic winter injury (Evans, 1985). Requires occasional renewal pruning (Metcalf, 1985). Becomes leggy and out of control (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Prefer moist, well-drained soil with organic matter (Dirr, 1983).

Evaluator's Comments: Not suitable for dryland sites on droughty soils (Metcalf, 1985).

pH:

Moisture Regime Adaptability: 10 to 20" annual rainfall (Howard, 1972).

Drought Tolerance:

Evaluator's Comments: Requires irrigation (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Probably intolerant (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 5 (Bailey and Bailey, 1976; Dirr, 1983; Wyman, 1974). Zone 5-7 (Howard, 1972).

Evaluator's Comments: Hardier species are available (Metcalf, 1985).

Light:

Information available from the literature: Full sun or light shade (Dirr, 1983).

Evaluator's Comments: Will be scraggly if grown in full shade (Metcalf, 1985).

Wind:

Evaluator's Comments: Windfirm, but can be damaged by ice storms (Metcalf, 1985).

Insects:

Information available from the literature: Aphids, leaf miner and nematodes, none serious (Dirr, 1983).

Disease:

Information available from the literature: Canker, leaf spots, powdery mildew, rust, none serious (Dirr, 1983).

SCIENTIFIC NAME: Picea engelmannii Parry ex Engelm.

Common Name: Engelmann Spruce

Transplantability:

Information available from the literature: Good when young (older trees subject to desiccation) (Sutton, 1974). Transplants readily, small B and B in early spring (Hightshoe, 1978).

Evaluator's Comments: Good transplantability, expecially if from non-native sites (Evans, 1985). Most of the many examples of this specie in Bozeman, Montana were transplanted from local mountains (Metcalf, 1985). Transplants well in October during dormancy. Spring transplants must be done before buds open to produce new growth (Riesselman, 1985).

Lifespan:

Information available from the literature: Long (Hightshoe, 1978; Sutton, 1974).

Evaluator's Comments: 80 to 100 years is not uncommon (Evans, 1985). There are numerous examples of well-aged trees in Bozeman, Montana (Metcalf, 1985). Over 100 years (Riesselman, 1985).

Propagation:

Information available from the literature: Seeds, layering (U.S.D.A., 1960). Seeds (Dirr, 1983). Minimum seed bearing age is 16-25, at 2-3 year intervals. Ripens August-September and must be harvested promptly. Mature when turn from green tinged with crimson to shining brown. Cones should be air dried, store in sealed containers at 33-38 F. Germination is epigeal. Seeds sown in spring after 24-30 hour soak, placed in plastic bag for cold stratification at 34 F for 21-42 days. 40 seedlings per square foot, 3/8" deep with 1/2" mulch. Planted out as 2-0, 2-1 (Schopmeyer, 1979). Sow 1/4-3/8" deep in spring. Germinate at 68 F night, 86 F day. Plant out as 2-0, 3-0, 2-1, or 3-1 (Wasser,1982).

Evaluator's Comments: No stratification period needed (USDA Handbook No. 450) (Evans, 1985).

Maintenance/Cleanliness:

Information available from the literature: Carefree; heavy needle fall (Sutton, 1974).

Evaluator's Comments: Agree that it is carefree (Evans, 1985). If lower limbs are retained, no great litter problem, other than of heavy cone crop years (Metcalf, 1985). Spruce budworm and Spruce gall aphid can be problems (Riesselman, 1985). Heavy needle fall and cone scattering. Perhaps one could expect a needle-mulch to build up under this species. It scatters cones widely (Rumely, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Medium, well-drained, dry or moist soil (25"+) (Van Dersal, 1938). Organic matter (Sutton, 1974). Best in deep, rich, loamy soils of high moisture content (Dirr, 1983). Medium to medium-fine; best on silt and clay loams, poor on sands, gravels or heavy clay. Well to moderately-well drained, moist to average (Hightshoe, 1978). Deep medium to medium-fine, silty to clay loams, also rocky medium to shallow depths (Wasser, 1982).

Evaluator's Comments: Has grown well in silty soils in Bozeman, but probably not as well adapted to droughty soils as the Black Hills Spruce (Metcalf, 1985).

pH:

Information available from the literature: 6.0-7.0 (Sutton, 1974). 4.6-6.5 (Hightshoe, 1978). Tolerant of moderately acid to mild basic but not saline soils (Wasser, 1982).

Evaluator's Comments: Agree that pH level should be 4.6-6.5 (Evans, 1985). No known problems with near-neutral soils (Metcalf, 1985).

Moisture Regime Adaptability: 10-20" annual rain (Howard, 1972). 25-40"+ annual rain (Wasser, 1982). Moist to average (Hightshoe, 1978).

Drought Tolerance:

Information available from the literature: Poor (Sutton, 1974). Drought-heat sensitive (Hightshoe, 1978). Weak (Wasser, 1982).

Evaluator's Comments: Agree that species is drought-heat sensitive (Evans, 1985). Well adapted to irrigated conditions in Bozeman (Metcalf, 1985). Established trees are fairly drought tolerant (Riesselmen, 1985). P. engelmannii and A. lasiocarpa share or alternate cool-moist sites on northern slopes, or at high elevations, or along streamsides at low elevations. Neither does well on other than cool, moist sites. If established on arid sites, the habit is distorted (as compared with "normal" dense-forest habits) (Rumely, 1985).

Flood Tolerance:

Information available from the literature: Intolerant (Hightshoe, 1978). Somewhat tolerant of imperfectly drained and moderate and high water tables, but not of saturated soils (Wasser, 1982).

Evaluator's Comments: Naturally occuped well-drained slopes. In cultivation in Bozeman, it has done well on native soils with good internal drainage (Metcalf, 1985). "Spring flooding" for a few days can be tolerated, but not boggy sites (Rumely, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 2 (Dirr, 1983). Zone 3 to 5 (Howard, 1972). Zone 2 (Hightshoe, 1978). Range 8,500-12,000' elevation in Colorado (Kelly, 1970). Recommended for general planting in the Brooks, Alberta area (Casement, 1984). Zone 3 (Bailey & Bailey, 1976).

Evaluator's Comments: No hardiness problems for Bozeman, Montana (Metcalf, 1985). Very hardy, some winter injury during bad years (Riesselman, 1985). Does not do well in hot, dry or even hot, moist areas. Best suited for cool, moist areas (moisture can be subsurface)(Rumely, 1985).

Light:

Information available from the literature: Shade tolerant when young, sun when older (Sutton,1974). Shade (Van Dersal, 1938). Shade tolerant- index value 6.0-7.9 (Hightshoe, 1978). Established plant sun tolerant, seedlings need shade (Wasser, 1982).

Evaluator's Comments: Seedlings need shade. They tend to be obligatively seiophytic when very young (Rumely, 1985).

Wind:

Information available from the literature: Not wind firm if pure stands are thinned (Sutton, 1974). Frequent susceptibility to wind throw (Hightshoe, 1974).

Evaluator's Comments: Likely windfirm (Metcalf, 1985). If well established, wind is no problem. Stake young trees for 1-2 years (Riesselman, 1985).

Insects:

Information available from the literature: 13 insects on the species (Stark, 1966). Frequent-spruce bark beetle, spruce budworm (Hightshoe, 1978). Spruce bark beetle epidemics infrequent but devastating. Spruce budworm potentially dangerous (Wasser, 1982). Aphid gall (Arno and Hammerly, 1977).

Evaluator's Comments: Cooley Spruce gall-aphid is also a problem, although resistance should be sought in native stands (Metcalf, 1985).

Disease:

Information available from the literature: 74 pathogens on the genus (Stark, 1966). Frequent susceptibility-wood rot, brown rot, spruce brown rust (Hightshoe, 1978). Wood rotting fungi (Wasser, 1982).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Reforestation and reclamation (Wasser, 1982). Animal food (Sutton, 1974). Wildlife utilization (Van Dersal, 1938). Kruckeberg (1982) recommendation. Wilson (1984) recommendation. Hightshoe (1979) recommendation.

Sources of Description:

Technical: Dorn (1984); Hitchcock and Cronquist (1981); Bailey (1949); Arnow (1980); Dirr (1983); Hightshoe (1978).

Non-technical: Arno and Hammerly (1977); Phillips (1978); Kelly (1970); Nelson (1977).

Availability: Callahan-Seeds; Clifty View Nursery; Nature´s Garden Woodland and Rock Plants; Dean Swift Seed Co.

Habitat Types: Spruce fir (climax type) (Sutton, 1974). Spruce, fir, douglas fir, lodgepole pine, Western Red Cedar, Western Hemlock forest habitat types (Pfister, 1977). Subalpine Fir, Douglas-fir, Ponderosa Pine Climax Forest, Subalpine fir/Douglas-fir Climax, Subalpine fir/Douglas fir/Grand fir Climax. (Ross & Hunter, 1976)

Range:

Washington to Montana, south to New Mexico and Arizona; Colorado 8,500-12,000´; Utah 7,000´ to timberline. Native to high mountains of Western United States (Wasser, 1982).

SCIENTIFIC NAME: Picea glauca (Moench) Voss v. densata

Common Name: Black Hills Spruce

Transplantability:

Information available from the literature: Readily (Dirr, 1983). Transplants readily as B and B in early spring (Hightshoe, 1978).

Evaluator's Comments: Readily tranplanted as 2-0 seedlings to shelterbelts, bare-root (Metcalf, 1985).

Lifespan:

Information available from the literature: Long (Hightshoe, 1978).

Evaluator's Comments: Many well-aged trees in Bozeman (Metcalf, 1985).

Propagation:

Information available from the literature: Seed requires no pretreatment; cuttings collected in late July best (Dirr, 1983). Minimum seed bearing age 30, at 2-6 year intervals. Ripens mid-August and must be harvested promptly (color changes from green to pale brown-shining brown). Germination is epigeal. Seeds sown in spring 1/4" deep with 1/2" sand, 1/2" sawdust mulch over pine needles. Planted out as 2-0 (Schopmeyer, 1979). (Above information for the species).

Maintenance/Cleanliness:

Evaluator's Comments: Sheds a multitude of cones (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Species is best on moist loam or alluvial soils (Dirr, 1983). Moderately coarse gravelly or sandy loams, medium loams to fine clays, moderately poor to well-drained, moist to average (Hightshoe, 1978).

Evaluator's Comments: Widely adapted (Evans, 1985). Extensively used on a variety of soils for shelterbelts in the Great Plains area of Montana (Metcalf, 1985).

pH:

Information available from the literature: 4.6-6.5 (Hightshoe, 1978).

Moisture Regime Adaptability: 10-20" annual rain (Howard, 1972). Moist to average (Hightshoe, 1978).

Drought Tolerance:

Information available from the literature: Yes drought tolerant (Dirr, 1983). Drought-heat resistant (Hightshoe, 1978).

Evaluator's Comments: Likely the most drought tolerant Spruce commonly planted in Montana (Metcalf, 1985).

Flood Tolerance:

Information available from the literature: Intolerant (Hightshoe, 1978).

Evaluator's Comments: Requires good drainage (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 2-6 for species (Dirr, 1983). Zone 4-5 (Howard, 1972). Zone 2 (Hightshoe, 1978). Recommended for general planting in the Brooks, Alberta area (Casement, 1984). Zone 3 (Bailey and Bailey, 1976).

Evaluator's Comments: The hardiest, commonly available Spruce (Metcalf, 1985).

Light:

Information available from the literature: Full sun, but will tolerate some shade (Dirr, 1983). Shade (Howard, 1972). Shade tolerant index range 6.0-7.9 (Hightshoe, 1978).

Evaluator's Comments: Requires freedom from weed competition when young (i.e. newly planted) (Metcalf, 1985).

Wind:

Information available from the literature: Yes wind firm (Dirr, 1983). Infrequent wind-ice susceptibility (Hightshoe, 1978).

Evaluator's Comments: Withstands high winds on the Plains (Metcalf, 1985).

Insects:

Information available from the literature: Spruce bagworm, European sawfly, red spiders on species (Dirr, 1983). Frequent susceptibility to spider mite, spruce gall aphid, bagworms (Hightshoe, 1978).

Evaluator's Comments: Appears to be less affected by Gall Wasps than other species (Lackschewitz, 1985). Spruce budworm also a problem (Metcalf, 1985). Mites are also a problem (Riesselman, 1985).

Disease:

Information available from the literature: Trunk and root rot on species (Dirr, 1983). Frequent susceptibility to needle rusts, needle casts, canker (Cytospora), pine needle scale (Hightshoe, 1978).

SCIENTIFIC NAME: Picea pungens Engelm.

Common Name: Colorado Spruce

Transplantability:

Information available from the literature: When young, older trees subject to desiccation (Sutton, 1974). More difficult to transplant than other spruce, B and B early spring (Hightshoe, 1978).

Evaluator's Comments: Tranplants well during dormancy (Riesselman, 1985).

Lifespan:

Information available from the literature: Long to very long (Sutton, 1974; Hightshoe, 1978).

Evaluator's Comments: Grows more slowly than all other evergreen trees in this area (Lackschewitz, 1985). Well aged specimens in Bozeman, Montana (Metcalf, 1985).

Propagation:

Information available from the literature: Seed requires no pretreatment. Cuttings can be rooted and are best taken in winter although cuttings taken in April rooted 80% in 8 weeks after treatment with 100 ppm IBA/ 24 hour soak. Grafting onto seedling understocks is done in January and February in the greenhouse and lined out in spring (Dirr, 1983). Minimum seed bearing age is 20 years, 1-3 year crop intervals. Fruit ripens in fall and must be harvested promptly. Color changes from green tinged with red to pale shining brown when mature. Germination is epigeal. Seeds sown in spring in sand or vermiculite after 40 days of 34-41 F. Seed 100 seedlings per square foot. 3/8" deep. Outplant as 2-2 (Schopmeyer, 1979).

Maintenance/Cleanliness:

Information available from the literature: Carefree; heavy needle fall (Sutton, 1974).

Evaluator's Comments: Spruce gall aphid, weevil, two spotted spider mite (Evans, 1985). Cone fall following heavy cone crop years (Metcalf, 1985). Spider gall aphid warrants control

(Riesselman, 1985). Cones are large and clog drains badly (Rumely, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Medium, moist, well-drained soil with organic matter (Sutton, 1974). Prefers rich, moist soil (Dirr, 1983). Moderately coarse to moderately fine; best on silt and clay loams, tolerates sandy loams, heavy clay. Moderately poor to well-drained, prefers moist to average soils, most tolerant spruce for dry sites (Hightshoe, 1978).

Evaluator's Comments: Probably not very tolerant of salinity (Metcalf, 1985).

pH:

Information available from the literature: 7.0 (Sutton, 1974). 4.6-6.5 (Hightshoe, 1978).

Moisture Regime Adaptability: 10-20" annual rain (Howard, 1972). Prefers moist to average soils, most tolerant spruce for dry sites (Hightshoe, 1978).

Drought Tolerance:

Information available from the literature: Poor (Sutton, 1974). More drought tolerant than other Picea (Dirr, 1983). Drought-heat sensitive (Hightshoe, 1978).

Evaluator's Comments: Does well in irrigated sites (Metcalf, 1985). Does well on arid sites provided nights are cool. But at the margins of its range, it requires much irrigation (Rumely, 1985).

Flood Tolerance:

Information available from the literature: Intolerant (Hightshoe, 1978).

Evaluator's Comments: Requires good drainage (Metcalf, 1985). Will tolerate some flooding, grows naturally along river and streambanks (Riesselman, 1985). Cannot stand indefinite or prolonged bogginess, but it can withstand a "spring runoff" which saturates soil and has above surface water for several days (Rumely, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 2-7 (Dirr, 1983). Zone 3-6 (Howard, 1972). Zone 2 (Hightshoe, 1978). Range 7,000-9,500´ elevation in the Colorado Rockies (Kelly, 1970). Recommended for general planting in the Brooks, Alberta area (Casement, 1984). Zone 3 (Bailey and Bailey, 1976).

Evaluator´s Comments: Generally dependable (Metcalf, 1985). Very hardy, depends on seed source and nursery location (Riesselman, 1985).

Light:

Information available from the literature: Takes shade when young, sun when older (Sutton, 1974). Full sun (Dirr, 1983). Shade (Howard, 1972). Intermediate shade tolerance; index range 4.0-5.9 (Hightshoe, 1978).

Evaluator´s Comments: Will make open growth if grown in shade (Metcalf, 1985).

Wind:

Information available from the literature: Not if stands are thinned (Sutton, 1974). Infrequent wind-ice susceptibility (Hightshoe, 1978).

Evaluator´s Comments: Cone-laden tops will snap out in high winds (Metcalf, 1985). Wind is no problem (Riesselman, 1985).

Insects:

Information available from the literature: 13 insects on the genus (Stark, 1974). Spruce gall aphid, spruce budworm, spider mite (Dirr, 1983). Frequent susceptibility- spruce gall aphid, Cooley spruce gall aphid, bagworms, spider mites, spruce budworm (Hightshoe, 1978).

Evaluator´s Comments: Spruce weevil also a problem (Evans, 1985). Spruce budworm causes most damage (Riesselman, 1985).

Disease:

Information available from the literature: 74 pathogens on the genus (Stark, 1966). Cytospora canker may infect lower branches (Dirr, 1983). Frequent susceptibility- canker, needle casts, needle rust, wood decay (Hightshoe, 1978).

SCIENTIFIC NAME: Pinus contorta v. latifolia Engelm.

Common Name: Lodgepole Pine

Transplantability:

Information available from the literature: Yes, when young, older trees subject to desiccation (Sutton, 1974). Tap root makes it difficult from wild, but if properly root pruned B and B stock is easily transplanted (Dirr, 1983).

Lifespan:

Information available from the literature: Long (Sutton, 1974). 150-200 years (Arno and Hammerly, 1978).

Evaluator's Comments: Capable of attaining great age (Metcalf, 1985).

Propagation:

Information available from the literature: Cones ripen in August-September, disperse September-October. Minimum seed bearing age 5-10, crops every year. Ripe cones light brown in color (fire opens cones). Ripe cones have specific gravity of .43-.89. Dry cones immediately, then boil 30-60 seconds and dry 2-30 days or kiln dry 6-8 days at 140 F. Fresh seed requires no stratification. Seed can be stored at 33-41 F for 30-56 days. Sow in fall or spring with presowing treatment of 28-35 days. Sow 48 seedlings per square foot, 1/8" deep with sawdust mulch 1/2". Outplant as 2-0 (Schopmeyer, 1979). Sow seed 1/8" deep in fall and mulch, or sow in spring. Moist stratification for 30-56 days at 33-41 F recommended. Plant out as 2-0. Germination is epigeal (Wasser, 1982).

Maintenance/Cleanliness:

Information available from the literature: Carefree; heavy needle fall; sunscald (Sutton, 1974). Dense needle litter (Wasser, 1982).

Evaluator's Comments: Since cones tend to be held on tree for long periods, litter is less than from other pines (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Coarse, well-drained, dry to moist soil (Sutton, 1974). Moist well-drained, sandy or gravelly soils (Dirr, 1983). Medium to coarse texture, well-drained (Wasser, 1982).

Evaluator's Comments: Not frequently cultivated, but appears to be adaptable to a reasonable landscape situation (Metcalf, 1985).

pH:

Information available from the literature: 6-7 (Sutton, 1974).

Moisture Regime Adaptability: 18"+ (Sutton, 1974). 18-25" (Wasser, 1982).

Drought Tolerance:

Information available from the literature: Good if well-established (Sutton, 1974).

Evaluator's Comments: Natural habitat has long summer dry periods (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Probably intolerant of flooding (Metcalf, 1985). Easily and quickly killed by prolonged flooding (Rumely, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 5 (Dirr, 1983). Requires high elevations and cool sites (Wasser, 1982). Elevation range of 6,000-11,000' in Colorado (Kelly, 1970). Recommended for general planting in the Brooks, Alberta area (Casement, 1984). Can with stand 15 F when actively growing (Arno and Hammerly, 1977). Zone 4 (Bailey and Bailey, 1976).

Evaluator's Comments: Occurs at middle elevations in Montana mountains (Metcalf, 1985). Grows best on cool sites, but

it certainly can do well on hot southern exposures of mountainsides (Rumely, 1985). Grows better in cold than hot habitat (Watson, 1985)

Light:

Information available from the literature: Sun (Sutton, 1974). More shade intolerant than other pines (Wasser, 1982).

Evaluator's Comments: Grows often in dense even-aged stands, where light competition (intra-species) must be intense (Metcalf, 1985). Full sun (Pohl, 1985). Heliophytic at all ages (Rumely, 1985).

Wind:

Information available from the literature: No (Preston, 1968). May be wind firm if grown under windy conditions (Sutton, 1974).

Evaluator's Comments: Wind damage not often seen in nature (Metcalf, 1985). Becomes wind-trained. Dense stands susceptible to blow-down because of shallow and poorly developed root systems. Normal spaced stands can withstand high winds. High resistance to wind damage unless grown in overcrowded stands (Rumely, 1985).

Insects:

Information available from the literature: 19 insects on the species (Stark, 1966). Mountain Pine Beetle most serious insect pest. Lodgepole needle miner, lodgepole sawfly, spruce budworm (Wasser, 1982).

Evaluator's Comments: Mountain Pine Beetle very bad problem in some areas (Jensen, 1985).

Disease:

Information available from the literature: 44 pathogens on the species (Stark, 1966). Dwarf mistletoe (Arno and Hammerly, 1977; Wasser, 1982).

Evaluator's Comments: Blue stain problem (Riesselmen, 1985).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Reforestation, windbreaks, Christmas trees, landscaping (Wasser, 1982). Animal food (Sutton, 1974). Sutton (1974) recommendation. Kruckeberg (1982) recommendation. Wilson (1984) recommendation.

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dirr (1983); Dorn (1984); Hitchcock and Cronquist (1981).

Non-technical: Arno and Hammerly (1977); Kelly (1980); Nelson (1977); Phillips (1978).

Availability: Callahan-Seeds; Clifty View Nursery; Native Plants, Inc.; Northplan; Dean Swift Seed Co.

Habitat Types: Aspen/Lodgepole pine (disclimax), Spruce/fir (Sutton, 1974). Scree, Pine, douglas fir, Spruce, fir, lodgepole pine (Pfister et al, 1977).

Range: Washington to Montana, south to New Mexico and Arizona. Colorado 6,000-11,000´ (Sutton, 1974). Native to central and northern Rocky Mountains and to Sierra-Nevada-Cascade Mountains and northern Pacific Coast (Wasser, 1982).

Scientific Name: Pinus sylvestris L.

Common Name(s): Scotch Pine, Scots pine

Transplantability:

Information available from the literature: Transplants easily B and B if root pruned (Dirr, 1983).

Evaluator's Comments: Bare root seedlings used extensively in shelterbelts and Christmas tree plantations (Metcalf, 1985).

Lifespan:

Information available from the literature: Long (Dirr, 1983).

Evaluator's Comments: There are a few well-aged trees in Bozeman (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds have no dormancy and will germinate without stratification (Dirr, 1983). Cones ripen in September-October, disperse in December-March. Minimum seed bearing age is 5, at 4-6 year crop intervals. Dull tawny-yellow, greyish or dull brown, or cinnamon brown ripe color, with specific gravity of .88-1.00. Dry immediately 3-7 days or 10-16 hours at 120 F. No stratification for fresh seed, stored seed should be stratified 15-90 days at 33-41 F. Sow in fall or spring with presowing treatment of 2-60 days. Sow 30-60 seedlings per square foot, 1/8-1/2" with peat (optional) 1/4-1/2" deep. Out plant as 1-0, 2-0, 2-1, or 2-2 (Schopmeyer, 1979).

Maintenance/Cleanliness:

Evaluator's Comments: Fallen cones may be a nuisance (Metcalf, 1985). Moderate needle drop. Pine aphids and scale can be a problem (Riesselman, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Variety of soils if well-drained (Dirr, 1983).

Evaluator's Comments: Grows well on the Plains and in sandy soils (Metcalf, 1985). Do not overwater (Watson, 1985).

pH:

Information available from the literature: Prefers acid soils (Dirr, 1983).

Evaluator's Comments: May show chlorisis in heavy soils (Watson, 1985).

Moisture Regime Adaptability: 10-20" annual rain (Howard, 1972).

Drought Tolerance:

Information available from the literature: Yes drought tolerant; adapted to poor, dry sites (Dirr, 1983).

Evaluator's Comments: Good species for dryland shelterbelts (Metcalf, 1985). Doubtful if this species is any more drought tolerant than Spruce (Riesselman, 1985).

Flood Tolerance:

Information available from the literature: No (Dirr, 1983).

Evaluator's Comments: Requires well drained sites (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 2 to 8 (not well-adapted in 8) (Dirr, 1983). Zone 3 to 7 (Howard, 1972). Recommended for general planting in the Brooks, Alberta area (Casement, 1984). Zone 3, one of the hardiest pines (Bailey and Bailey, 1976).

Evaluator's Comments: Temperature tolerance may vary with provenance of seedstocks (Metcalf, 1985). In Zone 2, absolutely not tolerant. In Zone 3, this is marginal (Riesselman, 1985).

Light:

Information available from the literature: Full sun (Dirr, 1983).

Evaluator's Comments: Probably makes inefficient use of light, therefore requires well lighted sites (Metcalf, 1985).

Wind:

Evaluator's Comments: Adapted to windy sites on the Great Plains (Metcalf, 1985). Needle scorch and desiccation during winter (Riesselman, 1985).

Insects:

Evaluator's Comments: Pine scale may be troublesome (Metcalf, 1985). Scale and Pine aphids (Riesselman, 1985).

Disease:

Evaluator's Comments: Very little disease problem (Riesselman, 1985).

SCIENTIFIC NAME: Populus tremuloides Michx.

Common Name: Quaking Aspen

Transplantability:

Information available from the literature: When young, not in leaf (Sutton, 1974). Transplant bareroot or B and B early spring or autumn (Hightshoe, 1978).

Evaluator's Comments: Easily transplanted at nearly any age (Evans, 1985). Reportedly not easy to establish from wild-collected material (Metcalf, 1985). Have transplanted over 100 Aspen; can transplant during early leaf stage in late spring and through June 15 at higher elevations (Riesselman, 1985).

Lifespan:

Information available from the literature: Short (regenerating rootstocks) (Sutton, 1974). short (deteriorates rapidly after 50-60 years, rarely survives 100 years) (Hightshoe, 1978).

Evaluator's Comments: May suffer from Cytospora Canker (Evans, 1985). Not a prime landscape subject (Metcalf, 1985). Normal lifespan in this area appears to center around 25-30 years; individuals over 60 years are rare (Rumely, 1985).

Propagation:

Information available from the literature: Cuttings (Sutton, 1974). Seeds ripen May 9-June 10. Collect when light straw colored, can be brought in on branches and set in water to let open. Seeds must be dried 3-8 days at 70-77 F if they are to be stored. Store at 41 F (Schopmeyer, 1979). Sow on surface and keep moist. Fresh seed is best (special storage requirements). Germination is epigeal. Germinate at 68/86 F night/day (Wasser, 1982).

Evaluator's Comments: Cuttings (softwood)(Evans, 1985). Experience shows that fresh seed is critical. Dried seed is not viable at all. In this region, germination is the same year as production. Seed does not remain viable after summer-drought. Easy to propagate from rhizome or sucker base cuttings (Rumely, 1985).

Maintenance/Cleanliness:

Information available from the literature: Dead branches provide entry for disease; suckers; clean (Sutton, 1974). Windthrow (Hightshoe, 1978).

Evaluator's Comments: Naturally a sopse-former; may shed many small twigs and male catkins in spring (Metcalf, 1985). Diseases start at 5-15 years and tree is distorted and unsightly at 25 years in this region. Leaf-fall is "normal and expected" for a deciduous tree. Young staminate trees are attractive. After 10-15 years should be replaced, or else much care is required (Rumely, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Most soil textures; more production in deep, well-drained, moderately sandy loams to silt loam and least adapted to coarse sands and dense clays (Wasser, 1982).

Evaluator's Comments: Shallow roots allow good growth on heavy or poorly drained soil (Evans, 1985). Found where moisture-holding capacity of soil is good (Metcalf, 1985).

pH:

Information available from the literature: 4.8-6.5 (Hightshoe, 1978). Moderately basic to weakly acid (Wasser, 1982).

Moisture Regime Adaptability: 15-30" annual rain (Wasser, 1982). Demands wet to moist (Hightshoe, 1978).

Drought Tolerance:

Information available from the literature: Intermediate drought-heat tolerance (Hightshoe, 1978).

Evaluator's Comments: Trees prefer sites with moisture most of year. Irrigate if planted (Metcalf, 1985). Requires much water for at least 2-3 years after transplant (Riesselman, 1985).

Flood Tolerance:

Information available from the literature: Intolerant (Hightshoe, 1978).

Evaluator's Comments: Tolerates wet soil but not saturated soil (Evans, 1985). Requires soil aeration along with a good moisture supply (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 1 Dirr, 1983). Zone 2 (Hightshoe, 1978). Recommended for general planting in the Brooks, Alberta area (Casement, 1984). Ranges from 6,000 - 10,000' in the Colorado Rockies (Kelly, 1970). Zone 1 (Bailey and Bailey, 1976).

Evaluator's Comments: One of the hardiest woody plants in North America (Metcalf, 1985). Hardy (Riesselman, 1985). As with most species in North America having extreme North-South ranges, P. tremuloides consists of many geographic races (genetic). Local stock or regional stock is suitable (Rumely, 1985).

Light:

Information available from the literature: Sun (Van Dersal, 1938). Very shade intolerant; index .7 (Hightshoe, 1978). Shade intolerant (Wasser, 1982).

Evaluator's Comments: Possibly tolerant while young (Evans, 1985). Intolerant, but often grows on north clines where insolation is reduced (Metcalf, 1985). Excessive shade produces a spindly tree (Riesselman, 1985).

Wind:

Information available from the literature: Good tolerance if open grown, poor if older stand overthinned (Sutton, 1974). Frequent susceptibility-windthrow, brittle limbs damage easily (Hightshoe, 1978).

Evaluator's Comments: Species susceptible to wind (Metcalf, 1985).

Insects:

Information available from the literature: 12 insects on the genus (Stark, 1966). Frequent susceptibility to poplar borer, poplar gall, scale, red humped caterpillar (Hightshoe, 1978). Cutworms and willow shoot sawfly attack suckers, poplar borer and forest tent caterpillar cause serious damage (Wasser, 1982).

Evaluator's Comments: Leaf miner damage common to this species (Evans, 1985). Borers a problem (Jensen, 1985). Leaf miner must be controlled anually (Riesselman, 1985). Susceptible to damage from Insects, Fungi and birds (Rumely, 1985).

Disease:

Information available from the literature: 25 pathogens on the species (Stark, 1966). Frequent susceptibility - Cytospora canker, Hypoxylon canker, leaf spot, shoot blight, other cankers (Hightshoe, 1978). Shoot dieback on suckers. Wood rotting fungi and cankers economically significant (Wasser, 1982).

Evaluator's Comments: Cankers frequently disfigure the trees and materially shorten the life span (Metcalf, 1985). Cytospora a major problem (Riesselman, 1985). Taxon is very susceptible in this region (Rumely, 1985).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Chief current use largely for landscaping in near mountain towns and rest stops and parks. Species considered promising for high altitude revegetation and wildlife habitat improvement and of lower potential for critical site stabilization and roadside planting, probably partly due to its high palatability (Wasser, 1982). Animal food (Sutton, 1974).

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dirr (1983); Dorn (1984); Hightshoe (1978); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Arno and Hammerly (1977); Huddleston and Hussey (1975); Kelly (1970); Nelson (1977); Phillips (1978); Simon and Schuster (1978).

Availability: Clifty View Nursery, Inc.; Native Plants, Inc.; Northplan; Old Farm Nursery, Inc.; Plants of the Wild.

Habitat Types: Chaparral vegetation type, Douglas fir/white fir, ponderosa pine, Spruce/fir (disclimax, Upper Uinta Sage, Aspen/lodgepole pine (Sutton, 1974); Scree, Douglas fir, Spruce, Alpine fir (Pfister et al, 1977).

Range: Washington to Montana, south to New Mexico and California (Sutton, 1974); Colorado 6,000-10,000´ (Sutton, 1974); Native to cooler, moist, northern and western mountain areas of United States (Wasser, 1982).

SCIENTIFIC NAME: Potentilla tabernaemontani Asch.

Common Name: Spring Cinquefoil

Transplantability:

Lifespan:

Propagation:

Information available from the literature: Division in early spring. Seed sown in sandy soil and overwintered in cold frame (Voight et al, 1983).

Maintenance/Cleanliness:

Evaluator's Comments: Requires annual cleanup (i.e. mow low to remove dead growth from previous year)(Pohl, 1985). Low maintenance (Riesselman, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Any well-drained, not extremely fertile soil (Voight et al, 1983).

Evaluator's Comments: Good plant on any soil (Riesselman, 1985).

pH:

Information available from the literature: Neutral to alkaline; tolerant of slightly acidic soils (Voight et al, 1983).

Moisture Regime Adaptability:

Drought Tolerance:

Information available from the literature: Somewhat tolerant (Voight et al, 1983).

Flood Tolerance:

Exposure:

Temperature:

Light:

Information available from the literature: Prefers sun (Kelly, 1980). Tolerates full sun but prefers partial shade (Voight et al, 1983).

Evaluator's Comments: Prefers full sun (Pohl, 1985).

Wind:

Insects:

Information available from the literature: Not seriously affected (Voight et al, 1983).

Disease:

Information available from the literature: Not seriously affected (Voight et al, 1983).

SCIENTIFIC NAME: Purshia tridentata (Pursh) DC.

Common Name: Antelope bitter-brush

Transplantability:

Information available from the literature: Poor (Kelly, 1970). Vigorous seedlings (Monsen and Christensen, 1975).

Evaluator's Comments: Transplantability is poor from the wild (Pohl, 1985).

Lifespan:

Information available from the literature: Moderate (Sutton, 1974).

Evaluator's Comments: Natural stands suggest life span may relate to severity of browsing (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds (Stark, 1966). Seed ripens in July or early August and should be collected immediately. Color shanges from light or dark red to gray when mature. Cool dry storage. Short stratification of 2-7 weeks. Pretreatment with 3% solution of thiourea for 3 to 5 minutes followed by air drying effectively breaks dormancy (Shopmeyer, 1979). Sow 1" deep, late fall/early winter or treated seed in spring (35 F for 1-3 months). Cuttings-hardwood in October dipped in Rootone (Harvey and Weaver, 1979).

Maintenance/Cleanliness:

Information available from the literature: Carefree (pruning tolerant); clean (Sutton, 1974). Can sustain severe pruning (Blauer et al, 1975).

Soil Adaptability:

Texture:

Information available from the literature: Rocky, dry (2-25") no organic matter, well-drained (Sutton, 1974). Adapted to wide range of soils; tolerant to most textures but thrives in moderate to deep, well-drained, medium to coarse soils

(Wasser, 1982). Dry well-drained soils (Kelly, 1970). Sands to clays (U.S.D.A., 1981).

pH:

Information available from the literature: 6.0-7.5 (Stark, 1966). pH 8.0+, tolerant of alkaline soils (Howard, 1972). Tolerant of moderate acid to moderate basic but non-saline soils (Wasser, 1982).

Moisture Regime Adaptability: < 10"-20" (Howard, 1972). 8-20" (Wasser, 1982). 10-25" (U.S.D.A., 1981).

Drought Tolerance:

Information available from the literature: Good (Sutton, 1974; Wasser, 1982). Dry (Kelly, 1970).

Evaluator's Comments: Literature suggests minimum of 10" precipitation; showing not extremely drought tolerant (Metcalf, 1985).

Flood Tolerance:

Information available from the literature: Not tolerant (Kelly, 1970).

Evaluator's Comments: Agree with Kelly (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 4-7 (Howard, 1972). Cold tolerant (Wasser, 1982). Range of 3,500-9,000 (U.S.D.A., 1981), 6,000-9,000 in Colorado (Kelly, 1970). Zone 6 (Bailey and Bailey, 1976).

Light:

Information available from the literature: Sun (Van Dersal, 1938). Weakly shade tolerant, more thrifty in full sun (Wasser, 1982).

Evaluator's Comments: Appears to prefer full sun exposure (Metcalf, 1985).

Wind:

Information available from the literature: Yes wind tolerant (Sutton, 1974).

Evaluator's Comments: Natural habit lends itself to wind tolerance (Metcalf, 1985).

Insects:

Information available from the literature: None (Stark, 1966). Great Basin tent caterpillar, mountain mahogany looper, western tussock moth on foliage. Thrips, seed midge and leaf tiers on seed. Cutworms and false wireworms kill seedlings (Furniss, 1971; Wasser, 1982). Many insects and mites on the species (80) but most cause no conspicuous damage (Furniss, 1971).

Disease:

Information available from the literature: None (Stark, 1966). Crown-diebacks, footrots and damping-off disease occasionally occur (Furniss, 1971); Wasser, 1982).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Revegetation, reclamation (Wasser, 1982). Wildlife habitat, animal food (Sutton, 1974). High wildlife utilization (Van Dersal, 1938). Valuable for controlling soil erosion and important livestock and big game browse (USDA, 1982). Schmidt (1980) recommendation. Kruckeberg (1982) recommendation. Wilson (1984) recommendation.

Sources of Description:

Technical: Arnow (1980); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Kelly (1970); Kruckeberg (1982); Nelson (1977); Taylot (1978).

Availability: Clyde Robin Seed Co.; Native Plants, Inc.; Northplan; Old Farm Nursery, Inc.; Plants of the Wild.

Habitat Types: Chaparral, Pinyon/juniper, Ponderosa pine, Upper Uinta Sage (Sutton, 1974). Purshia tridentata (Mueggler and Handl (1974). Ponderosa Pine, Douglas Fir (Pfister, 1977).

Range: Washington to Montana, south to New Mexico and California. Colorado 5,000-8,000´ (Sutton, 1974). New Mexico and Colorado, west through northern Arizona to California and north to Idaho, Montana and British Columbia (USDA, 1982). Native to Intermountain West and adjacent areas. Common between 4,000-8,000´ (Wasser, 1982).

SCIENTIFIC NAME: Rhus trilobata Nutt.

Common Name: Skunkbrush Sumac

Transplantability:

Information available from the literature: Yes (Sutton, 1974).

Evaluator's Comments: Not easily dug and transplanted from wild (Pohl, 1985).

Lifespan:

Information available from the literature: Moderate (Sutton, 1974).

Evaluator's Comments: Long lifespan if not over irrigated (Evans, 1985). Natural stands appear to be long-lived. Probably susceptible to damage by fire (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds, cuttings (Sutton, 1974). Collect late in fall (red in color). Seed must be soaked 1 hour in sulfuric acid at room temperature and stratified in moist sand or peat. Fall sowing provides cold treatment necessary. sow 1/2" deep. Also root cuttings (Schopmeyer, 1979). Sow 1/4-1/2" deep in fall or winter or scarify by bleaching in sulfuric acid or moist-prechill for 30-90 days in spring. Germination is epigeal (Wasser, 1982).

Maintenance/Cleanliness:

Information available from the literature: Carefree; clean (Sutton, 1974).

Evaluator's Comments: Observation of wild stands suggests a low-maintenance shrub (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Medium to coarse, deep, well-drained, moist or dry (3-5"+) (Suton, 1974).

Tolerant of most soil textures. Often found on hot, dry, shallow, rocky soils. Thrives in well-drained soils (Wasser, 1982).

Evaluator's Comments: Well drained, drought areas (Evans, 1985). Observation suggests adaptability to Upper Sonoran Zone conditions (Metcalf, 1985).

pH:

Information available from the literature: 6.5-7.5 pH (Sutton, 1974).

Moisture Regime Adaptability: 10-20" annual rainfall (Howard, 1972; Wasser, 1982). For arid sites (U.S.D.A., 1981). Dry (Kelly, 1970).

Drought Tolerance:

Information available from the literature: Good (Sutton, 1974). Moderately strong (Wasser, 1982). Very drought resistant (Huddleston and Hussey, 1975).

Evaluator's Comments: Naturally inhabits dry sites (Metcalf, 1985).

Flood Tolerance:

Information available from the literature: Intolerant (Wasser, 1982).

Evaluator's Comments: Usually on well-drained sites (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 4 (Dirr, 1983). Zone 3 to 7 (Howard, 1972). Range < 8,000' in Colorado (Kelly, 1970). Recommended for general planting in the Brooks, Alberta area (Casement, 1984).

Evaluator's Comments: Zone 3-4 (Evans, 1985). Should probably be planted below the Canadian Life Zone (Metcalf, 1985).

Light:

Information available from the literature: Shade, sun (Van Dersal, 1938). Tolerant of partial shade, but thriftier in

full sun (Wasser, 1982). Best in full sun, but will grow in partial shade (Huddleston and Hussey, 1975).

Evaluator's Comments: Best in full sun (Evans, 1985). Usually seen on sunny sites; roots may be in a cool run under rocks, boulders, etc (Metcalf, 1985).

Wind:

Information available from the literature: Yes, wind tolerant (Sutton, 1974). Withstands full exposure to wind (Huddleston and Hussey, 1975).

Evaluator's Comments: Tolerant of canyon winds (Metcalf, 1985).

Insects:

Information available from the literature: 14 insects on the genus (Stark, 1966).

Evaluator's Comments: No known problems here (Evans, 1985).

Disease:

Information available from the literature: 7 pathogens on the species (Stark, 1966). Alternate host for pinyon blister rust (Sutton, 1974). Generally disease resistant (Wasser, 1982).

Evaluator's Comments: None if grown under limited irrigation (Evans, 1985).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Game range revegetation, mineland reclamation (Wasser, 1980). Sutton (1974) recommendation. Wildlife utilization (Van Dersal, 1938). Good big game browse. Has value for wildlife, soil stabilization and windbreak plantings (USDA, 1982). Schmidt (1980) recommendation. Wilson (1984) recommendation.

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dirr (1983); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Huddelston and Hussey (1975); Kelly (1970); Nelson (1977).

Availability: Big Sky Wholesale Seeds, Inc.; Native Plants, Inc.; Northplan; Old Farm Nursery, Inc.; Plants of the Wild.

Habitat Types: Upper Uinta Sage, Pinyon/juniper, Ponderosa pine, Douglas fir/White fir, Aspen/lodgepole pine (Sutton, 1974); Cercocarpus ledifolius (Mueggler and Handl, 1974); Sandy range sites, Ponderosa Pine forest (Ross and Hunter, 1976).

Range: Washington to Montana, south to New Mexico and California. Colorado 3,500-9,000´ (Sutton, 1974); Illinois to Nebraska and west to Oregon, California and New Mexico (USDA, 1982); Native to Great Plains, Intermountain and southwestern United States (Wasser, 1982).

SCIENTIFIC NAME: Ribes alpinum

Common Name: Alpine Currant

Transplantability:

Information available from the literature: Easily, best handled as container plant (Dirr, 1983).

Evaluator's Comments: Common availability in nursery trade indicates this is good (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Appears to be long-lived (Metcalf, 1985).

Propagation:

Information available from the literature: Fruit ripen in July-August. Let fruit ferment in piles for a few days. Store with low initial moisture content. Germination is epigeal. Cold stratify if spring planting (32-50 F for 9+ days), or fall sowing. Hardwood cutings in fall (Schopmeyer, 1979).

Evaluator's Comments: Cuttings in mid-July (Evans, 1985). Species is dioecious, so male plants assured only via asexual propagation (Metcalf, 1985). Easiest to propagate from cuttings (Watson, 1985).

Maintenance/Cleanliness:

Evaluator's Comments: Little care required unless maintained as a formal hedge (Evans, 1985). Readily maintained as a clipped or informal hedge (Metcalf, 1985). Some pruning (Riesselman, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Tolerant of any good soil (Dirr, 1983).

pH:

Information available from the literature: Does well in calcareous soils (Dirr, 1983).

Moisture Regime Adaptability:

Drought Tolerance:

Information available from the literature: Tolerant of drought (Huddleston and Hussey, 1975).

Evaluator's Comments: Have experience only with growth under irrigation (Metcalf, 1985). Not tolerant of drought until well established (Riesselman, 1985).

Flood Tolerance:

Evaluator's Comments: Might tolerate seasonal flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 2 to 7 (Dirr, 1983). Zone 2 (Wyman, 1978). Recommended for general planting in the Brooks, Alberta area (Casement, 1984).

Evaluator's Comments: Very hardy (Evans, 1985). Appears to be very temperature hardy (Metcalf, 1985). Zone 2 hardy (Riesselman, 1985).

Light:

Information available from the literature: Full sun or shade (Dirr, 1983). Best in full sun (Huddleston and Hussey, 1975).

Evaluator's Comments: Good shade plant (Evans, 1985). Have witnessed good growth in both sun and shade sites (Metcalf, 1985).

Wind:

Information available from the literature: Withstands some wind (Huddleston and Hussey, 1975).

Evaluator's Comments: Appears to be quite windfirm (Metcalf, 1985).

Insects:

Information available from the literature: Currant aphid, imported currant worm, scales, currant bud mite (Dirr, 1983).

Evaluator's Comments: No insect problems here (Evans, 1985).

Disease:

Information available from the literature: Anthracnose, cane blight, leaf spots, rust. During wet seasons anthracnose and leaf spot can be serious problems. Male supposedly resistant to rust (Dirr, 1983).

Evaluator's Comments: No disease here (Evans, 1985).

SCIENTIFIC NAME: Ribes aureum Pursh

Common Name: Golden Currant

Transplantability:

Information available from the literature: Yes (Sutton, 1974).

Lifespan:

Information available from the literature: Regenerates by suckering; continuous (Sutton, 1974).

Evaluator's Comments: Examples show long life under abusive conditions (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds (Stark, 1966). Fruit ripens June-July. Store dried fruit with low initial moisture content. Germination is epigeal. Cold stratification if spring sown, or sow in fall (28-36 F for 60 days). Hardwood cuttings in fall (Schopmeyer, 1979). Sow 1/8-1/4" deep and mulch at rate of 40 PLS/ row foot in nursery. Fall or stratified spring sowing. Germination is epigeal. 30-90 day moist prechill for spring sowing (Wasser, 1982).

Evaluator's Comments: Softwood cuttings in July (Evans, 1985).

Maintenance/Cleanliness:

Information available from the literature: Carefree; clean (Sutton, 1974). Suckers (Kelly, 1970).

Evaluator's Comments: Pruning to maintain a more arborescent shape (Evans, 1985). Have not experienced suckering. Occasional renewal pruning may be beneficial (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Coarse to medium, moist to dry, organic matter if possible, well-drained soils (Sutton, 1974). Well-drained, fertile, loamy soils (Wasser, 1982).

Evaluator's Comments: Moist, cool soils (Evans, 1985). Does well on silt loam soils at Bozeman, Montana (Metcalf, 1985).

pH:

Information available from the literature: 6.5-7.0 (Sutton, 1974). Tolerant of weakly acid (6.0) to weakly basic soils (Wasser, 1982).

Moisture Regime Adaptability: 12-20"+ (Wasser, 1982).

Drought Tolerance:

Information available from the literature: Moderate (Sutton, 1974). No, needs frequent watering (Mathias et al, 1977).

Evaluator's Comments: In cultivation, probably best under irrigated conditions (Metcalf, 1985). Requires frequent watering after planting (Riesselman, 1985).

Flood Tolerance:

Evaluator's Comments: Natural streambank habitat suggests early season tolerance (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Cold tolerant and winter hardy (Wasser, 1982). Frost susceptible (Mathias et al, 1977). Recommended for general planting in the Brooks, Alberta area (Casement, 1984).

Evaluator's Comments: Zone 2 (Riesselman, 1985).

Light:

Information available from the literature: Sun or shade (Van Dersal, 1938). Adapted to all but dense forest shade, optimal in semi-shade (Wasser, 1982). Best in partial shade (Mathias et al, 1977).

Evaluator's Comments: Natural habitat suggests partially shaded sites best (Metcalf, 1985).

Wind:

Information available from the literature: Yes wind tolerant (Sutton, 1974).

Evaluator's Comments: Natural habitat indicates wind-tolerance (Metcalf, 1985).

Insects:

Information available from the literature: 7 insect on the species (Stark, 1966).

Disease:

Information available from the literature: 23 pathogens on the species (Stark, 1966). Bacterial disease kills canes, alternate host of white pine blister rust (Wasser, 1982).

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Used for hedges, windbreaks and landscape plantings in north and central prairie plains regions, game range restoration, revegetation and soil stabilizers (Wasser, 1982). Sutton (1974) recommendation. Wildlife utilization (Van Dersal, 1938). Often cultivated as an ornamental, prized by big game for browse (USDA, 1982). Schmidt (1980) recommendation. Kruckeberg (1982) recommendation.

Sources of Description:

Technical: Arnow (1980); Bailey (1949); Dorn (1984); Hitchcock and Cronquist (1981); Morris et al (1962).

Non-technical: Huddleston and Hussey (1975); Kelly (1970); Nelson (1977).

Availability: Moses Lake Conservation District Nursery; Native Plants, Inc.; Northplan; Old Farm Nursery, Inc.; Plants of the Wild.

Habitat Types: Upper Uinta sage, Douglas fir/white fir, Ponderosa pine, riparian, Chaparral (Sutton, 1974).

Range: Washington to Montana, south to New Mexico and California. Nevada 2,500-7,800´ (Sutton, 1974). Black Hills of South Dakota to Washington, south to New Mexico, Arizona and California (USDA, 1982). Native to much of Western United States (Wasser, 1982).

SCIENTIFIC NAME: Sedum spurium

Common Name: Sedum

Transplantability:

Lifespan:

Evaluator's Comments: Plantings are long lived, but may become open-centered with age (Metcalf, 1985).

Propagation:

Information available from the literature: Divisions, cuttings (Vanstone, 1982; Wyman, 1973). Sow indoors at medium temperatures of 70-80 F during germination, which takes 15-30 days (Reilly, 1978).

Evaluator's Comments: No experience with propagation from seed, but very easily propagated by divisions or cuttings (Metcalf, 1985).

Maintenance/Cleanliness:

Information available from the literature: No care required (Wyman, 1973).

Evaluator's Comments: Faded inflorescences can be removed or left as a snowcatch (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Sandy is best (Wyman, 1973). Well-drained (Reilly, 1978).

Evaluator's Comments: Have grown well in Bozeman on well-drained silt loam soils (Metcalf, 1985).

pH:

Moisture Regime Adaptability:

Drought Tolerance:

Evaluator's Comments: Will tolerate considerable drought if it has a cool root-run, as provided by rocks (Metcalf, 1985). Drought tolerant (Riesselman, 1985).

Flood Tolerance:

Evaluator's Comments: Likely intolerant of flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 3 (Wyman, 1973).

Evaluator's Comments: A generally hardy plant (Metcalf, 1985).

Light:

Evaluator's Comments: Best in full sun (Metcalf, 1985). Full sun to partial shade (Riesselman, 1985).

Wind:

Evaluator's Comments: Habit of plant makes it inherently windfirm (Metcalf, 1985).

Insects:

Evaluator's Comments: No problems with insects (Riesselman, 1985).

Disease:

Evaluator's Comments: No problems with disease (Riesselman, 1985).

SCIENTIFIC NAME: Sorbus aucuparia L.

Common Name: European Mountain Ash

Transplantability:

Evaluator's Comments: Common availability in nurseries suggests readily transplantability (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Lifespan probably limited only by susceptability to insects, diseases and winter injury to trunk (Metcalf, 1985).

Propagation:

Information available from the literature: Seeds require 60 to 120 days of cold, moist stratification at 38 F. Cultivars are budded or grafted onto seedling understocks. Minimum seed bearing age is 15 years with crops every year. Collect fruit immediately when bright red (August-September). If picked early, heap and decompose for 2 months. Stratify 60-120 days at 33-41 F in moist sand, moss, or soil. Seed will go into secondary dormancy if exposed to warm germination conditions when incompletely stratified or if stored dry after cold moist stratification. Germination is epigeal. Sow in fall or spring with stratification. Outplant as 1-1 stock. (Schopmeyer, 1979).

Evaluator's Comments: Seed direct in fall after removing fruit pulp. Full germination after two seasons (Evans, 1985).

Maintenance/Cleanliness:

Evaluator's Comments: Fallen pomes can be messy (Metcalf, 1985). Requires pruning of dead wood annually (Riesselman, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Well-drained loam (Dirr, 1983). Sandy loam (Stark, 1966).

Evaluator's Comments: Can grow well in clay loam (Evans, 1985). Appears to grow well in silt loams in Montana (Metcalf, 1985).

pH:

Information available from the literature: Prefers acidic soils and is often short-lived on chalky soils (Dirr, 1983).

Evaluator's Comments: May show Fe-chlorosis on limey soils (Metcalf, 1985).

Moisture Regime Adaptability: 10-20" annual rainfall (Howard, 1972).

Drought Tolerance:

Evaluator's Comments: Most commonly seen in irrigated situations (Metcalf, 1985). Not drought tolerant (Riesselman, 1985). In clay soil, it needs to be kept drier (Watson, 1985).

Flood Tolerance:

Evaluator's Comments: Probably intolerant to flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 3 to 6 or 7 (summer heat induces problems) (Dirr, 1983). Zone 4 to 5 (Howard, 1972). Recommended for general planting in the Brooks, Alberta area (Casement, 1984). Zone 2 (Bailey and Bailey, 1976).

Evaluator's Comments: Grows best if trunk can be in winter shade (to avoid sunscald), while crown is in sun in summer. Is hardy if these conditions are provided (Metcalf, 1985). Zone 3, Zone 2 marginal (Riesselman, 1985).

Light:

Information available from the literature: Sun or shade (Van Dersal, 1938).

Evaluator's Comments: Grows best if trunk can be in winter shade and crown is in sun in summer (Metcalf, 1985). Does well in shade (Riesselman, 1985).

Wind:

Evaluator's Comments: More apt to suffer from early snowfalls, ice storms (Metcalf, 1985). Requires some protection from wind (Riesselman, 1985).

Insects:

Information available from the literature: Aphids, pear leaf blister mite, Japanese leaf hopper, round headed borer, mountain ash sawfly, scales. Borers are serious in weakened poorly growing trees (Dirr, 1983). 16 insects on the group (Stark, 1966).

Evaluator's Comments: Blister mite is greatest problem here (Evans, 1985). Subject to all insects affecting pome fruits (Metcalf, 1985).

Disease:

Information available from the literature: Fireblight (can be devastating), crown gall, canker, leaf rusts, scab (Dirr, 1966). 12 pathogens on the genus (Stark, 1966).

Evaluator's Comments: Fireblight is greatest problem here (Evans, 1985). Fireblight and blister mites are likely to be the most serious problem (Metcalf, 1985). Fireblight is a problem in Montana (Riesselman, 1985).

SCIENTIFIC NAME: Spiraea betulifolia Pall.

Common Name: Shiny-leaf Spirea

Transplantability:

Lifespan:

Propagation:

Information available from the literature: Seed; fruit ripens mid-July to September (straw colored or light brown and follicle splits). No stratification is required. Fall sowing (Schopmeyer, 1979).

Maintenance/Cleanliness:

Soil Adaptability:

Texture:

pH:

Moisture Regime Adaptability:

Drought Tolerance:

Evaluator's Comments: S. betulifolia occurs in Douglas Fir forests and similar sites. Has moderate moisture requirements (Rumely, 1985).

Flood Tolerance:

Exposure:

Temperature:

Information available from the literature: Zone 5? (Bailey and Bailey, 1976).

Light:

Evaluator's Comments: Not a forest-interior plant. Probably moderately heliophytic and opportunistically sciophytic for short-term growth (Rumely, 1985).

Wind:

Evaluator's Comments: Does not occur on wind-exposed sites. Would assume it to be wind-intolerant if constantly exposed (Rumely, 1985).

Insects:

Disease:

ADDITIONAL INFORMATION ON THIS SPECIES:

Current Use and Value: Kruckeberg (1982) recommendation.

Sources of Description:

Technical: Dorn (1984); Hitchcock and Cronquist (1981).

Non-technical: Taylor (1978).

Availability:

Habitat Types: Subalpine Fir Climax Forest (Ross and Hunter, 1976).

Range:

SCIENTIFIC NAME: Syringa vulgaris L.

Common Name: Common Lilac

Transplantability:

Evaluator's Comments: Readily transplantable if given reasonable care during the first year or two (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Regeneration continuous from basal shoots on this species (Evans, 1985). One of the longest-lived woody shrubs grown in Montana (Metcalf, 1985).

Propagation:

Information available from the literature: Softwood cuttings under mist; semi-hardwood or mature cuttings also work; suckers; cultivars grafted (Dirr, 1983). September sowing of seed. Seed ripen in mid-October. Stratify seed at 5 C for 2 months and at 21 C for 2 1/2 months then spring sow (Vanstone, 1982).

Evaluator's Comments: Not highly successful from cuttings (Evans, 1985).

Maintenance/Cleanliness:

Information available from the literature: Old flowers need to be removed after flowering (Dirr, 1983).

Evaluator's Comments: Primarily basal suckers (Evans, 1985). Renewal pruning is desirable to maintain vigor (time-consuming, highly labor intensive) (Metcalf, 1985). Suckers freely (Pohl, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Best if supplemented with peat (Dirr, 1983). Wide tolerance (Stark, 1966).

Evaluator's Comments: Appears adapted to a wide variety of soil textures, persists for long periods (Metcalf, 1985).

pH:

Information available from the literature: Neutral (Dirr, 1983).

Moisture Regime Adaptability:

Drought Tolerance:

Evaluator's Comments: Persists about old honesteads for many years, but benefits from adequate moisture (Metcalf, 1985). Not drought tolerant (Riesselman, 1985). If well established, lilac will withstand drought (Watson, 1985).

Flood Tolerance:

Evaluator's Comments: Probably rather intolerant of flooding (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 3 to 7 (Dirr, 1983). Zone 3 (Wyman, 1978). Recommended for general planting in the Brooks, Alberta area (Casement, 1984). Zone 4 (Bailey and Bailey, 1976).

Evaluator's Comments: Very hardy and adapted to stress conditions. Less so on cultivars (Evans, 1985). Generally hardy (Metcalf, 1985). Hot temperatures and wind commonly causes severe leaf scorch (Riesselman, 1985).

Light:

Information available from the literature: Sun (Stark, 1966).

Evaluator's Comments: Growth/flowering will be superior when plant is grown in full sun (Metcalf, 1985).

Wind:

Evaluator's Comments: Unlikely to be damaged by wind, but may be by ice storms (Metcalf, 1985). Dry winds may cause leaf scorch (Riesselman, 1985).

Insects:

Information available from the literature: One insect on the genus (Stark, 1966).

Evaluator's Comments: Subject to leaf miner (Evans, 1985). Lilac leaf miner, but not serious problem (Jensen, 1985). Lilac leaf miner a problem (Metcalf, 1985).

Disease:

Information available from the literature: 28 pathogens on the species, powdery mildew (Stark, 1966).

Evaluator's Comments: Pseudomonas blight can be disfiguring. Resistance to mildew should be sought among species (Metcalf, 1985). Pseudomonas, mildew are major problems (Riesselman, 1985).

SCIENTIFIC NAME: Viburnum opulus 'Nanum'

Common Name: Dwarf Highbush Cranberry

Transplantability:

Evaluator's Comments: Probably best handled as canned stock (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Twenty years or more (Evans, 1985). May be weakened by aphid attack (Metcalf, 1985).

Propagation:

Evaluator's Comments: Softwood cuttings in July (Evans, 1985). Must be propagated vegetatively (Metcalf, 1985). Usually propagated from softwood (greenwood) cuttings (Watson, 1985).

Maintenance/Cleanliness:

Evaluator's Comments: More than usual amount of leaf cleanup (Evans, 1985). May require aphid control; otherwise few problems since it rarely fruits (Metcalf, 1985).

Soil Adaptability:

Texture:

Evaluator's Comments: Will likely do well on sandy loams to silt loams (Metcalf, 1985).

pH:

Evaluator's Comments: Neutral to slightly acid. Shows iron deficiency (Evans, 1985). Probably prefers a soil well supplied with bases (Metcalf, 1985).

Moisture Regime Adaptability:

Drought Tolerance:

Evaluator's Comments: Unlikely to tolerate severe drought; likely best with irrigation (Metcalf, 1985).

Flood Tolerance:

Information available from the literature: No (Dirr, 1983).

Exposure:

Temperature:

Information available from the literature: Zone 3 to 8 (Dirr, 1983). Zone 3 (Bailey and Bailey, 1976). Recommended for general planting in the Brooks, Alberta area (Casement, 1984).

Evaluator's Comments: May suffer from severe chinook conditions (Metcalf, 1985).

Light:

Evaluator's Comments: Partial shade (Evans, 1985). Probably best in half to full sun (Metcalf, 1985).

Wind:

Evaluator's Comments: Unlikely to be wind damaged, but may be crushed by heavy snowloads (Metcalf, 1985).

Insects:

Information available from the literature: Aphids (Dirr, 1983).

Evaluator's Comments: Aphids a problem (Evans, 1985). Aphid control essential for good presentation (Metcalf, 1985).

Disease:

Information available from the literature: Significant leaf spot in wet weather (Dirr, 1983).

Evaluator's Comments: No disease problem here (Evans, 1985). No experience with leaf spot (Metcalf, 1985).

SCIENTIFIC NAME: Vinca minor L.

Common Name: Periwinkle

Transplantability:

Evaluator's Comments: Easily transplanted by division in spring or early fall (Evans, 1985). Transplants readily (Metcalf, 1985).

Lifespan:

Evaluator's Comments: Spreads, providing a continuous supply of new plants (Evans, 1985). A long-lived persistent species (Metcalf, 1985).

Propagation:

Information available from the literature: Division (Vanstone, 1982). Division, root cuttings, stem cuttings (Dirr, 1983; Wyman, 1973).

Evaluator's Comments: Division (Evans, 1985). Easy vegetative propagation (Metcalf,1985).

Maintenance/Cleanliness:

Evaluator's Comments: Hand weeding to keep clean (Evans, 1985). Very low maintenance; may need occasional restraint if it becomes invasive (Metcalf, 1985).

Soil Adaptability:

Texture:

Information available from the literature: Well-drained (Kelly, 1980). Adapted to variable soils (Stark, 1966). All but the poorest soils (Wyman, 1973).

pH:

Moisture Regime Adaptability: Likes moist soils (Kelly, 1980).

Drought Tolerance:

Evaluator's Comments: Probably not for dryland situations (Metcalf, 1985).

Flood Tolerance:

Evaluator's Comments: Very moist but not flooded soil (Evans, 1985). Probably intolerant (Metcalf, 1985).

Exposure:

Temperature:

Information available from the literature: Zone 4 (Wyman, 1973). Zone 3 to 8, can be grown further north if protected by snow (Dirr, 1983).

Evaluator's Comments: Best where snow cover protects plants (Evans, 1985). May suffer some winter injury on open sites in severe weather (Metcalf, 1985). Requires snow cover (Pohl, 1985).

Light:

Information available from the literature: Shady spots (Kelly, 1980).

Evaluator's Comments: Does well in all but total shade (Evans, 1985). Will grow well in shade, but also survives in full sun under irrigation (Metcalf, 1985). Can perform well in full sun (Pohl, 1985).

Wind:

Evaluator's Comments: Will windburn during winter if exposed above snow (Evans, 1985). Low-growing habit makes the species inherently windfirm (Metcalf, 1985).

Insects:

Evaluator's Comments: No insect problems here (Evans, 1985).

Disease:

Information available from the literature: 14 pathogens on the species, including yellows (Stark, 1966). Blight, canker and dieback, leaf spots, and root rot; canker and dieback significant problems (Dirr, 1983).

Evaluator's Comments: No disease problems observed here (Evans, 1985).

APPENDIX F

THE AESTHETIC SCORECARD

The Aesthetic Scorecard

The following appendix presents information related to the Aesthetic Scorecard. In order of appearance are:

1) The evaluator request letter;

2) A list of evaluators who participated in the scoring process;

3) The Aesthetic Scorecard itself, including guidelines and instructions for evaluation and photo sets for 44 plant species. Species names did not appear on the original photo sets, but are provided here for the reader's convenience. Photos have been slightly trimmed to allow for proper margin spacing.

A thank you is in order, to the Office of Graduate Studies, for allowing colored pages and margin changes for this appendix. The success of the Aesthetic Scorecard relied heavily on its structure and format. Due to their understanding and willingness to compromise, the Scorecard is presented here as it was offered to the evaluator.

Evaluator Request Letter

Shelly E. Bruce
Plant and Soil Science
Leon Johnson Hall
Montana State University
Bozeman, Montana 59717

Dear Sir/Madam,

I am a graduate student at Montana State University, pursuing a research project which evaluates a number of plant species native to Montana on their ornamental potential. With the increased awareness and interest in native plants that has taken place during the past decade, there has been an increased demand for natives at the retail level. Here in Montana, certain native species have become very popular and are commonly available, often in improved forms: Green Ash (Fraxinus pennsylvanica), Quaking Aspen (Populus tremuloides), Shrubby Cinquefoil (Potentilla fruticosa) and Red Twig Dogwood (Cornus sericia). But the selection of other native species for exposure seems to be a very arbitrary and subjective process. A species one author or researcher thinks has good ornamental potential may be another's "trash tree".

The problem that I hope to resolve is this subjective method of plant selection. Through the use of two complementary ornamental scorecards, one on aesthetic qualities, the other on environmental requirements, a sound, objective basis for the selection of specific species will be presented.

I am currently assembling a panel of professional evaluators to assist me with my Aesthetic Value Scorecard. Process of evaluation would include rating 40 different plant species on 5 different aesthetic characteristics, using a numeric scale. Plants will be evaluated using a set of photographs, accompanied by a written description. The 40 plants will be sent in 1, 2 or 3 separate mailings, whichever is convenient for the evaluator. Approximate time committment would be 3 1/2 hours overall. The project will run from this December through January, 1985.

I encourage your participation in this project. Your professional assistance will greatly add to the overall integrity of the project.

Evaluator Request Letter

Shelly E. Bruce
Plant and Soil Science
Leon Johnson Hall
Montana State University
Bozeman, Montana 59717

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I encourage your participation in this project. Your professional assistance will greatly add to the overall integrity of the project.

please return the attached self-addressed, stamped page to me as soon as possible, if you are interested in further information. I will be in contact with you soon, to confirm your assistance. Thank you very much.

Sincerely,

Kelly E. Bruce

Aesthetic Scorecard Evaluators

Mr. Clayton Berg
Valley Nursery
PO Box 4845
Helena, MT 59601

Mr. Jerry Berner
PO Box 971
Polson,MT 59860

Mr. Bill Caras
Jim Caras Nursery
2727 South Third West
Missoula, MT 59801

Mr. Jerry Cashman
Cashman Nursery
252 Estes Lane
Bozeman, MT 59715

Mr. John Crowe
Idaho Dept. of Parks and Recreation
State House Mail
Boise, ID 83720

Dr. Reuben A. Dietter
57 Marilyn Drive
Missoula, MT 59801

Dr. George Evans
Plant and Soil Science Dept.
Montana State University
Bozeman, MT 59715

Mr. Joe Gutkoski
304 North 18th
Bozeman, MT 59716

Mrs. Beverly Gutman
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20. Ms. Jan Pirzio-Biroli
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27. Mrs. Shelly Engler Bruce
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Bozeman, MT 59715

Shelly E. Bruce
P&SS Dept., Leon Johnson Hall
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Bozeman, MT 59717

Dear Evaluator,

Enclosed is the set of photographs in my Aesthetic Scorecard System. The first few pages are guidelines for evaluation, following are 19 sets of photos. Ideally all of the sets should be evaluated in one sitting. I do not expect the total time for evaluation to exceed one hour. This is the first set of photographs that you will be evaluating. Thank you for sharing your professional judgement with me.

Please use the enclosed manila envelope to return the set to me as soon as possible. It will be sent on to another evaluator as soon as it is returned.

I'll be calling you in a few days to answer any questions you may have. Feel free to reach me at 406-994-4471 weekdays, or at 406-587-3400 evenings and week-ends. I will be able to accept collect calls only at the second number.

Thanks again for your cooperation!

Sincerely,

Shelly E. Bruce

Instructions and Guidelines for Evaluation

Objectively evaluate each plant according to the following criteria: form/habit, flower, fruit, leaf, and seasonal characteristics.

Ignoring the setting of the photo evaluate each species in the proper context of its ornamental value and landscaping use. Consider the following statement when scoring each species. "If this plant were being used in what I consider its ideal situation I would rate it as..."

Consider these criteria only as design qualities, do not consider maintenance requirements or other problems of that characteristic (i.e. messy fruit, etc.).

The criteria are defined below. The rating scale is from one to five with one being poor and five being excellent.

FORM/HABIT

Form entails the overall shape or outline of the plant. Habit involves the branching pattern of the plant. Together these elements evaluate the overall appearance and character of the plant.

1=Ugly, of poor quality and unimportant in defining and maintaining a certain character.
2=
3=
4=
5=Excellent, of high quality and important in defining and maintaining a certain character.

FLOWER

Consider overall effectiveness including color, fragrance and length of effective bloom period. Do not compare colors.

1=Very poor quality. No effect or adverse effect.
2=
3=
4=
5=Excellent quality. Very effective.

FRUIT

This characteristic entails such factors as color and period of effectiveness. Do not consider cleanliness or maintenance factors.

1=Very poor quality. No effect or adverse effect.
2=
3=
4=
5=Excellent quality. Very effective.

LEAF

Consider color, luster, overall appearance of foliage canopy.

1=Very poor quality.
2=
3=
4=
5=Excellent quality.

BARK

Consider color, texture and overall appearance.

1=very poor quality.
2=
3=
4=
5=Excellent quality.

SEASONAL CHARACTERISTICS

Consider the appearance of the plant throughout the four seasons: bark, fruit, flower, branching habit, fall color, winter foliage color.

1=Very poor.
2=Good qualities during one season.
3=Good qualities during two seasons.
4=Good qualities during three seasons.
5=Excellent. Redeeming qualities during all four seasons.

* An outstanding character may boost a species into a higher category.

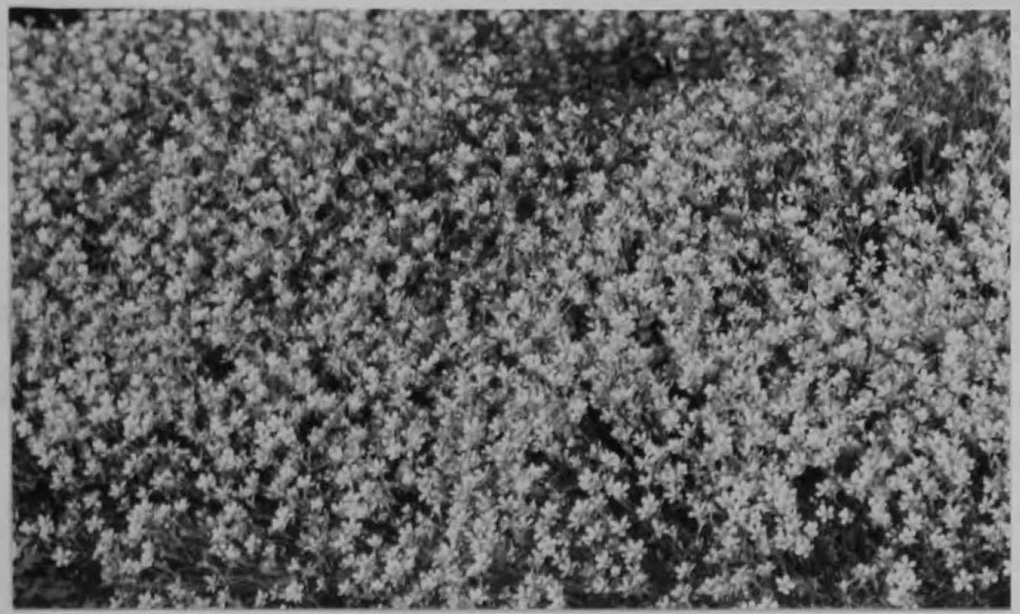
The Aesthetic Scorecard



WINTER



SUMMER



SUMMER



FALL

PHOTO SET #1 (Cerastium tomentosum)

FORM/HABIT: 6" tall mat forming ground cover. A persistent perennial.

LEAVES: Linear-lanceolate white wooly gray-green leaves, 1" in length.

FLOWERS: White, 1 cymes of 3 to 15 flowers with notched petals blooming in early to mid-summer for a period of 6 to 8 weeks.

FRUIT: A small dry capsule. Flower stalks present in summer and fall.



FALL

PHOTO SET #2 (Ajuga reptans)

FORM/HABIT: 6 to 9" tall stoloniferous groundcover.

LEAVES; Ovate, lustrous green leaves, 1 to 4" long. Persistent with winter protection.

FLOWERS: 6 to 9" spikes of violet-blue flowers in late spring or early summer for a period of 4 to 6 weeks.

FRUIT: Flower stalk present in summer and fall.



SUMMER



WINTER



SPRING



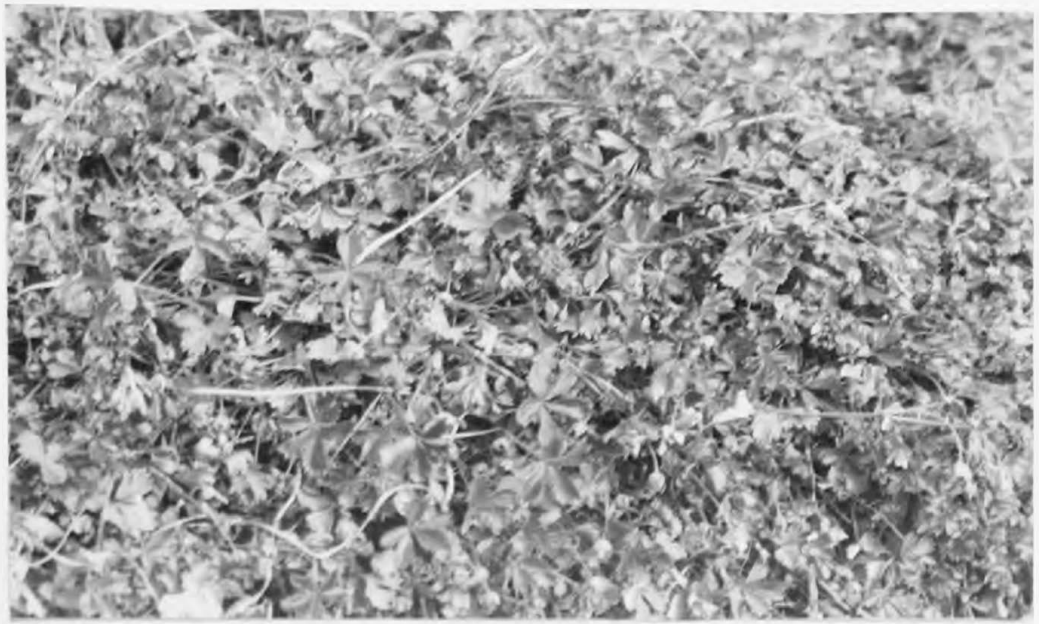
FALL



MID SUMMER



SUMMER



FALL



WINTER

PHOTO SET #3 (Potentilla tabernaimontanii)

FORM/HABIT: 1 to 2" tall, herbaceous, creeping groundcover.

LEAVES: Green palmately compound, 1/2 to 1 1/2" long, few-toothed leaves. Coming out in May. Fall color is wine-red. Dies to the ground in winter, late to green up in spring.

FLOWER: Prolific golden-yellow flowers, 1/4 to 1/2" across. Bloom from June until frost.

FRUIT: Small, dry inconspicuous achene.

PHOTO SET #4 (Vinca minor)

FORM/HABIT: Trailing semi-evergreen perennial groundcover.

LEAVES: 1 1/2 TO 2" long dark green, lustrous oblong leaves.

FLOWERS: Lilac-blue flowers, 1/2 to 3/4" across in late spring and early summer for a period of 4 to 5 weeks.

FRUIT: Dry inconspicuous follicle.



SUMMER



LATE SPRING



LATE SPRING



WINTER



EARLY SUMMER



SUMMER



WINTER

PHOTO SET #5 (Spiraea betulifolia)

FORM/HABIT: Woody, groundcover 12 to 18" tall.

LEAVES: Toothed, dull green leaves 3/4 to 1 1/4" long. Fall color is yellow-gold to wine-red. Fall color photo unavailable for the 1984 season.

FLOWERS: Flat-topped corymb of white or slightly pink flowers in early summer for a period of 4 to 5 weeks.

FRUIT: Corymb of brown follicles in summer and persistent through winter.

PHOTO SET #6 (Eriogonum umbellatum)

FORM/HABIT: Mat-forming perennial groundcover.

LEAVES: Whorled basal leaves are 1" x 1/8" dark green above, white underneath. Turning bronze-purple in Fall, persisting through Winter.

FLOWER: Cymes of creamy flowers are borne on 4" flower stalk in early Summer for a period of 4 to 6 weeks.

FRUIT: Small achene. Seed heads persistent through Winter.



FALL



EARLY SUMMER



SUMMER



LATE SUMMER



WINTER



EARLY SUMMER



SUMMER



FLOWER FRUIT
SUMMER FALL



WINTER

PHOTO SET #7 (Artemisia cana)

FORM/HABIT: Woody deciduous groundcover growing 1 1/2 to 2 1/2' tall.

LEAVES: Linear, 1" to 1 1/2" long x 1/16 to 1/8" wide, gray-green, woolly. No fall color change.

FLOWER: Small brown flower heads displayed along stem in late summer and early fall for 5 to 6 weeks.

FRUIT: Small glabrous achene present from flowering until heavy snow.

PHOTO SET #8 (Antennaria rosea)

FORM/HABIT: Mat-forming, 1" tall, white-woolly, gray-green persistent perennial.

LEAVES: Basal leaves are white-woolly, gray-green, mat-forming. No fall color change.

FLOWERS: Head of several white and light red flowers on 5 to 8" stalk in early summer for 4 to 6 weeks.

FRUIT: Tufted achene. Flower stalk persists through winter.



FALL



EARLY SUMMER



FLOWER EARLY SUMMER



WINTER



EARLY SUMMER



LATE SUMMER



WINTER

PHOTO SET #9 (Anaphalis margaritacea)

FORM/HABIT: A rhizomatous, herbaceous groundcover, 12" to 30´ tall.

LEAVES: Leaves are 5" long by 1/2 to 3/4" wide, lanceolate white-wooly, gray-green. Lower leaves soon falling. No fall color change.

FLOWER: Head of pearly white flowers, 1/3" wide, born in short, broad many flowered inflorescence throughout summer.

FRUIT: Tufted achene. Seed head present until heavy snow.

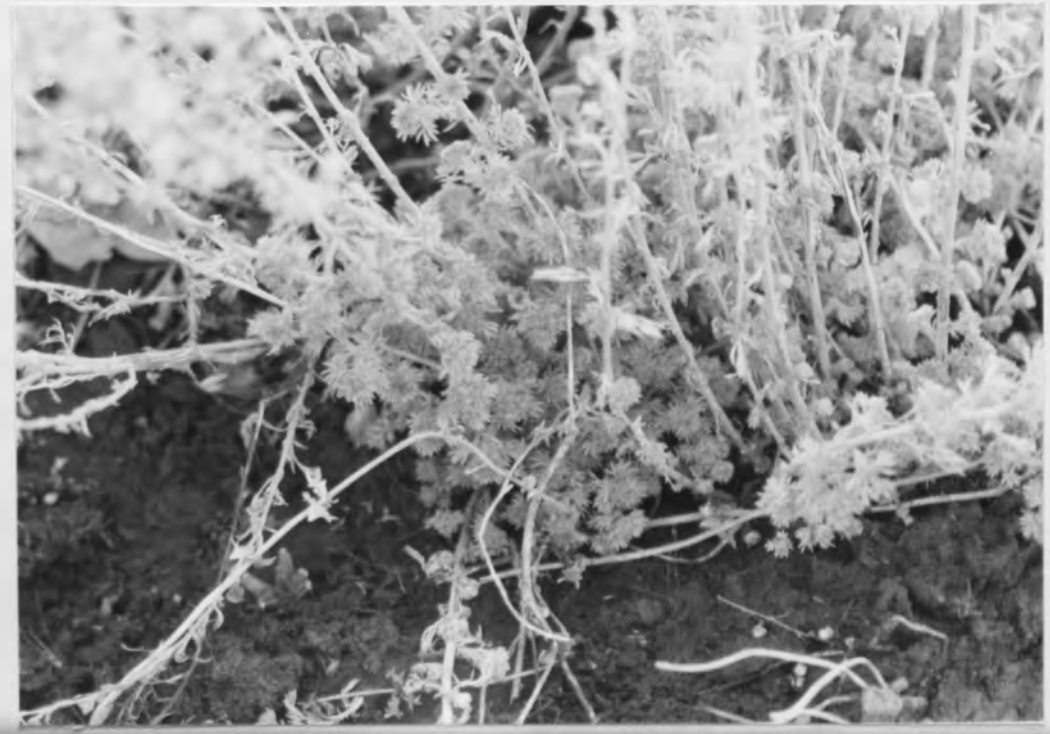
PHOTO SET #10 (Artemisia frigida)

FORM/HABIT: Herbaceous gray-green, wooly perennial groundcover. Growing 4 to 14" tall, mat-forming and sub-shrubby.

LEAVES: Fringed gray-green woolly leaves 3/8 to 1/2" long. No fall color change.

FLOWERS: Small white flower heads displayed along stem in late summer and early fall for 6 to 8 weeks.

FRUIT: Small glabrous achene. Present from flowering until heavy snow.





SPRING



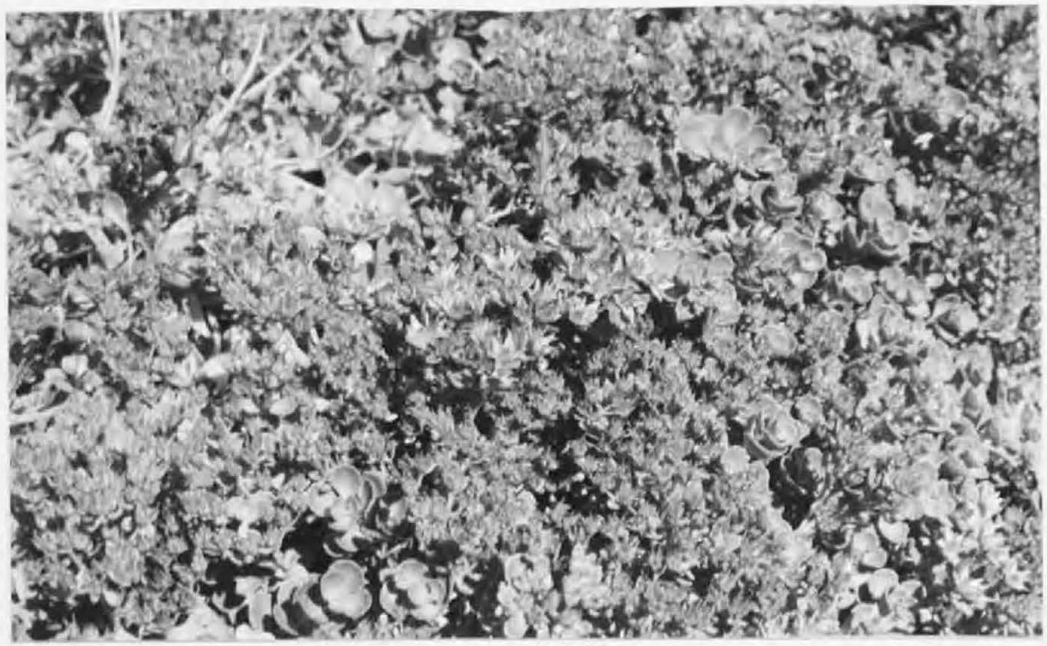
SUMMER



FLOWER FRUIT
SUMMER FALL



WINTER



SPRING



SUMMER



WINTER

PHOTO SET #11 (Sedum spurium)

FORM/HABIT: A low growing stoloniferous groundcover. Persistent through winter with protection.

LEAVES: Thick succulent green leaves with red-tinged ruffled edges 1/4 to 1/2" across. Fall and winter color is red-bronze.

FLOWER: Pink star-shaped flowers 1/4" borne in cymes on 4 to 6" stalks in early summer for 4 to 6 weeks.

FRUIT: Brown seed heads, persistent through winter.

PHOTO SET #12 (Abies grandis)

FORM/HABIT: Large evergreen tree up to 300´ tall. Branches are horizontally spreading.

LEAVES: Needles are 1 1/4 to 2 1/4" long, displayed in flat sprays. They are shining dark green above with white banks below. No winter color change.

BARK: Tight silvery-gray smooth bark with resinous blisters, becoming fissured at maturity.



SUMMER



BARK



YOUNG FORM FALL



BARK

PHOTO SET #13 (Picea engelmannii)

FORM/HABIT: A densely pyramidal evergreen tree with ascending branches. Maximum height is 100 to 120´, generally 60 to 80´ tall in cultivation. Maximum spread is 20 to 40´.

LEAVES: 1" needles are blue-green. No winter color change.

BARK: Thin and broken into large purple-brown to russet-brown scales.



MATURE FORM SUMMER

PHOTO SET #14 (Pinus sylvestris)

FORM/HABIT: A wide-spreading, open, flat-or round-topped evergreen tree. Maximum height is 60 to 80´, maximum spread is 30 to 40´.

LEAVES: Pairs of 1 to 4" long needles persisting three years, blue-green in color, often changing to yellowish-green in the winter.

BARK: Grayish or reddish brown, fissured into irregular, long scaly plates. On upper stems, bark is thin, smooth, papery and peeling, orange or orangish-brown in color.



MATURE FORM WINTER



BARK



BARK



YOUNG FORM SPRING



MATURE FORM WINTER



YOUNG FORM SPRING



BARK

PHOTO SET #15 (Abies concolor)

FORM/HABIT: A large evergreen tree, conical in form and branching to the ground. Rather stiff or rigid in appearance. Maximum height is 30 to 50', maximum spread is 15 to 30'.

LEAVES: Flattened needles are 2 to 3" long. They curve upwards and outwards. New growth is a light rich green or bluish green, maturing to a blue or gray green with pale blue stomatal bands underneath. No winter color change.

BARK: Tight silvery-gray smooth bark with resinous blisters, becoming fissured at maturity.

PHOTO SET #16 (Pinus contorta v. latifolia)

FORM/HABIT: Large evergreen tree reaching a mature height of 110´. Somewhat columnar or broadly pyramidal in form.

LEAVES: 2 to 3 " long needles are green-yellow in color. No winter color change.

BARK: Reddish-brown, deeply fissured and scaly, branchlets are orange to brown.



FORM WINTER
MATURE



FORM FALL
YOUNG



BARK



FORM SUMMER
MATURE



FORM WINTER
YOUNG



BARK

PHOTO SET #17 (Abies lasiocarpa)

FORM/HABIT: Large evergreen tree up to 100´ in height. Spire-like form.

LEAVES: Needles are 1 1/4 to 2 1/4" long, erect, bluish-green and waxy. No winter color change.

BARK: Tight silvery-gray smooth bark with resinous blisters becoming fissured at maturity.

PHOTO SET #18 (Picea pungens)

FORM/HABIT: A large evergreen tree, pyramidal in form with stiff horizontal branches, reaching 100´ in height with 20 to 30´ spread.

LEAVES: 3/4 to 1" long rigid, spiny-tipped, bluish-green needles. No winter color change.

BARK: Ashy brown thin and scaly.



FORM WINTER
MATURE



FORM FALL
YOUNG



BARK



FORM SUMMER
MATURE



BARK



WINTER

PHOTO SET #19 (Picea glauca v. densata)

FORM/HABIT: Large evergreen tree growing up to 70´ tall. Pyramidal in form, somewhat open in maturity. Branches are ascending.

LEAVES: 1/3 to 3/4" long bluish green needles. No winter color change.

BARK: Grayish-brown thin, flaky and scaly.



SPRING

PHOTO SET #1 (Clematis ligusticifolia)

FORM/HABIT: A deciduous climbing vine.

LEAVES: Pinnately compound leaves with 5 to 7 leaflets, each ovate, 1 to 2" long. Dark green in summer, yellow to brown in fall.

FLOWER: 2 to 3" white flowers in late Spring through August.

FRUIT: White tufted achenes in late Summer into Winter.



WINTER



EARLY SUMMER



SUMMER



SUMMER



SUMMER



SUMMER



FALL



WINTER

PHOTO SET #2 (Humulus lupulus)

FORM/HABIT: A rough-stemmed twining deciduous perennial vine. Grows 15 to 20´ tall each season.

LEAVES: 3 to 5 to 7 lobed, serrate, ovate leaves. Dark green and rough above. Lighter and not rough beneath. Fall color is yellow to brown.

FLOWER: Green male flowers borne in panicled tassel-like racemes. Female flowers are two together under large persistent bracts which at maturity form a cone-like body.

FRUIT: An achene in an enlarged cone-like, tan calyx.



SUMMER

PHOTO SET #3 (Parthenocissus quinquefolia)

FORM/HABIT: Deciduous vine climbing by tendrils with adhesive like tips.

LEAVES: Leaves are palmately compound, 1 3/5 to 4" long, 1/2 to 2 1/2" wide, lustrous dark green above. Young growth is bright waxy bronze to red. Fall color is purple red to crimson. Colors early in the fall.

FLOWER: Inconspicuous greenish white flowers in June - July. Not pictured.

FRUIT: 1/4" bluish black, bloomy berry in September - October.



SUMMER



FALL



WINTER



SUMMER



SUMMER



LATE SUMMER

PHOTO SET #4 (Lonicera sempervirens)

FORM/HABIT: Twining, evergreen vine.

LEAVES: Ovate, 1 1/5 to 3" long, 3/4 to 2" wide, dark bluish-green leaves. 1 or 2 pairs below the inflorescence connate. New foliage is purplish-tinged, maturing to bluish green, then yellowing in Fall and Winter.

FLOWERS: Flowers are trumpet-shaped, 2", orange with yellow-orange throats, borne in spikes. Bloom from early Summer until frost.

FRUIT: Fruit is a bright red, 1/4", berry ripening in September and persisting through November. Rare in Montana. Not pictured.



WINTER



SPRING



BARK



WINTER

PHOTO SET #5 (Acer ginnala)

FORM/HABIT: A single or multi-stemmed large deciduous shrub or small tree. Maximum height is 15 to 18', spread may exceed this. Canopy is rounded in outline.

LEAVES: 1 1/2 to 3" long, 3 lobed, doubly serrate leaves. Dark green, lustrous above and light green beneath. Fall leaf color is yellow to orange to deep red.

BARK: Stem is glabrous gray. Older brances are grayish-brown.

FLOWER: Yellowish-white flowers are borne in small (1 to 1 1/2") panicles. Bloom in late Spring - early Summer.

FRUIT: 3/4 to 1" long, double samaras (schizocarps) are persistent into late Fall. They are pink to red to brown in color.



SUMMER



SUMMER



FALL



FALL



SUMMER



LATE SUMMER



FALL



WINTER

PHOTO SET #6 (Alnus incana)

FORM/HABIT: A single or multi-stemmed deciduous tree, reaching a height of 40 to 60´, and spreading 15 to 20´.

LEAVES: 2 to 4" long, ovate, doubly serrate leaves. Dull green above, grayish beneath. Fall color is yellow-green to brown.

BARK: Thin white-gray bark with horizontal lenticels.

FLOWER: Small strobiles, and catkins in early Spring before the leaves.

FRUIT: Small cone-like strobiles in Fall and Winter.



WINTER



BARK

PHOTO SET #7 (Betula occidentalis)

FORM/HABIT: A multi-stemmed small, shrubby deciduous tree, with slender, pendulous branches. 15 to 30´ tall, 15 to 20´ wide.

LEAVES: 1 to 2" ovate, serrate, shiny green leaves. Fall color is gold-brown.

BARK: Close reddish-brown bark with prominent lenticels.

FLOWER: Green catkins in Spring.

FRUIT: Brown cone-like catkins with nutlet in late summer and fall.

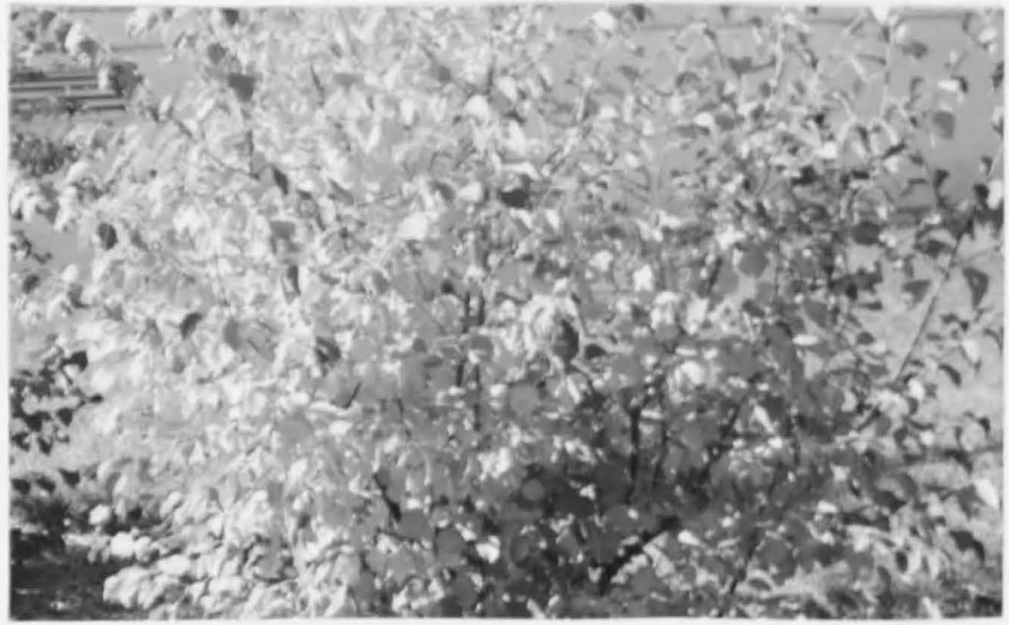




FRUIT



FALL



FALL



WINTER



BARK



SPRING



LATE SUMMER



WINTER

PHOTO SET #9 (Larix occidentalis)

FORM/HABIT: A large deciduous conifer, pyramidal in form, up to 200´ tall (less in cultivation).

LEAVES: Thin, light green needles, 1 to 2" long, in many-needled clusters on short side shoots, spirally arranged on branches. Fall color is yellow to gold.

BARK: Mature bark is grayish-brown, thick, furrowed into large plates or flaking into reddish-brown scales.

FLOWER: Do not rate.

FRUIT: Do not rate.



SUMMER



SPRING



FALL

PHOTO SET #8 (Sorbus aucuparia)

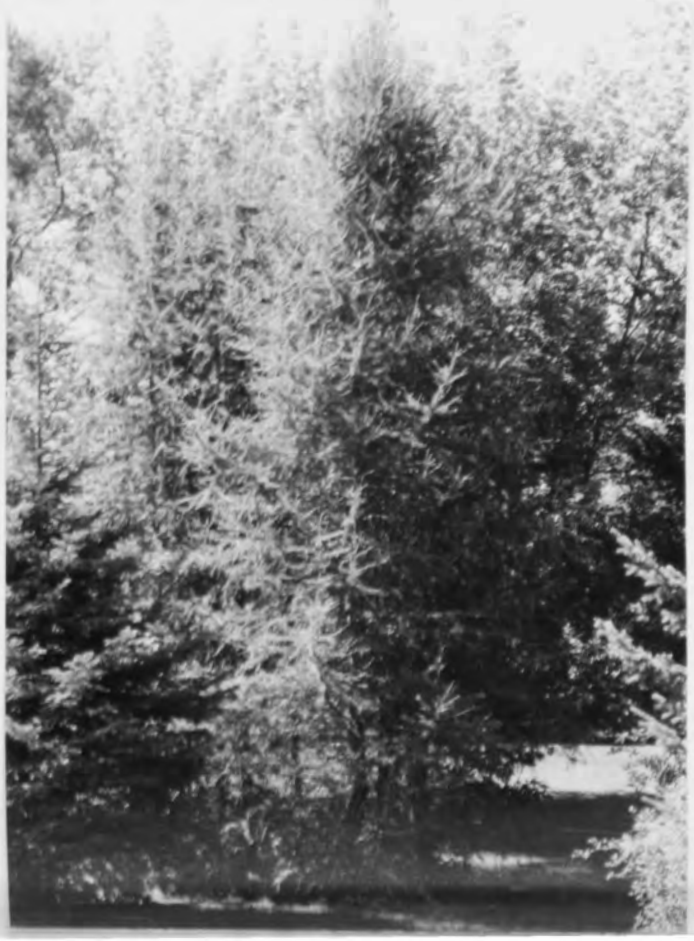
FORM/HABIT: A deciduous tree reaching 20 to 40´ in height with a spread 2/3´s its height. Form is erect and oval in youth, and gracefully open, spherical at maturity.

LEAVES: Pinnately compound. Leaflets are 3/4 to 2 1/2" long, dull dark green. Fall color ranges from green to yellow to reddish. Very late to color in fall. Late to lose leaves.

BARK: Mature bark is grayish-brown, and slightly roughened. Younger bark is brown to copper, smooth and shiny.

FLOWER: White 2/5" flowers borne in 3 to 5" flat-topped corymbs in late spring.

FRUIT: 1/4" berry-like pome, orange to red in color. Present in late August to October.









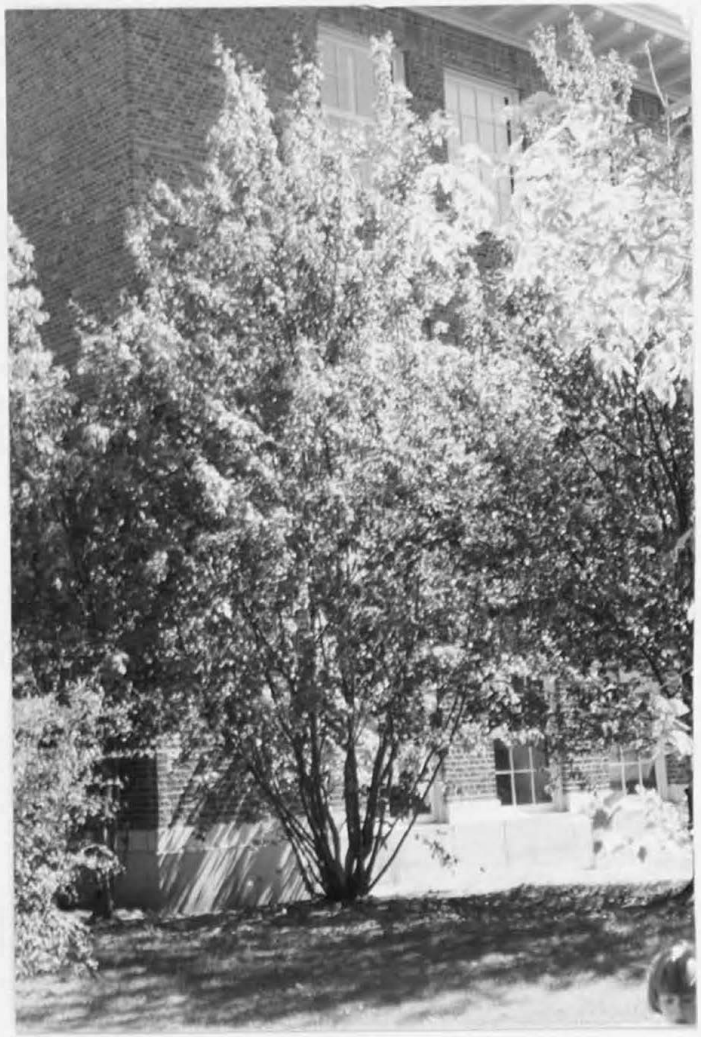
FALL



BARK



WINTER



SUMMER



BARK



WINTER

PHOTO SET #10 (Acer glabrum)

FORM/HABIT: A small deciduous tree or large shrub, rounded in form. Maximum height is 20 to 30', spread is 15'.

LEAVES: 3 to 5 lobed or parted leaves. Green above, pale green below. Fall color is yellow.

BARK: Smooth brownish-gray bark in youth, fissured in maturity. Stems are smooth red.

FLOWER: Precocious greenish-yellow flowers in early spring. Do not rate.

FRUIT: Green to yellow and red, to tan, double samara in summer persisting through the winter.



SUMMER



FALL



SUMMER



FALL



PHOTO SET #11 (Populus tremuloides)

FORM/HABIT: A deciduous tree reaching 40 to 50´ tall, with a spread of 20 to 30´. Pyramidal and narrow when young, rounded and narrow when mature.

LEAVES: Ovate leaves, 1 1/2 to 3" long and wide. Lustrous dark green above, lighter beneath. Slender flattened petiole. Fall color is yellow-gold.

BARK: Smooth greenish-white to cream. In maturity bark is furrowed, dark brown or gray, and rough.

FLOWERS: Pendulous catkins in early spring before the leaves.

FRUIT: Dehiscent capsule with tufted seeds in Spring.



SPRING



BARK



WINTER

PHOTO SET #12 (Larix sibirica)

FORM/HABIT: A deciduous conifer reaching 70 to 75´ in height and 25 to 30´ in width. Pyramidal with horizontal, drooping branches in youth, irregular and open in maturity.

LEAVES: Slender, 2" long needles, in many-needled clusters on short side shoots. Bright green in Spring, becoming deeper green through the Summer and turning yellow to gold in Fall.

BARK: Young bark is thin, scaly gray. Mature bark is thick, deeply fissured grayish brown.

FLOWER: Do not rate.

FRUIT: Do not rate.



FALL



SUMMER



BARK



WINTER



SUMMER



SPRING



WINTER

PHOTO SET #13 (Berberis aquifolium)

FORM/HABIT: An upright, heavy stemmed broadleaf evergreen shrub, often stoloniferous. 3 to 6´ tall by 3 to 5´ wide. Form may be low and broad, dense and rounded, taller and more upright, or irregular and open.

LEAVES: 1 1/2 to 2 1/2" long, stiff, leathery, lustrous dark green leaves, with sinuately spiny-dentate margins. New leaves are reddish-bronze when unfolding. Fall and winter color is purplish-bronze.

FLOWER: Bright yellow flowers borne in fascicled, erect terminal racemes in spring.

FRUIT: Blue-black bloomy, 1/3" berries borne in clusters. Fruit may persist from August/September to December.



FALL

PHOTO SET #14 (Cercocarpus ledifolius)

FORM/HABIT: A large broadleaf evergreen shrub. Maximum height is 8 to 15´, maximum spread 15´. Form is rounded, irregular, and open.

LEAVES: Leathery leaves, 3/4 to 1" long, with curling edges. Dark green above, hairy-white beneath. Yellowing in Fall.

FLOWER: Small yellow to reddish flowers in early Summer.

FRUIT: 2" long tufted achene from August through Winter.



SPRING



SUMMER



FALL



WINTER



SUMMER



FALL



WINTER



FALL

PHOTO SET #15 (Viburnum trilobum `Compacta´)

FORM/HABIT: A dense, upright, much branched deciduous shrub. 18 to 24" in height and 1 1/2 times that in spread. Some specimens may reach 3 to 4´.

LEAVES: Ovate, 3-lobed, glossy dark green leaves, 2 to 4" long. Fall color is yellow to orange to red.

FLOWER: Flowering only in maturity and then infrequently. White flowers borne in flat-topped cymes in 2 rings. Outer ring of flowers are white sterile and conspicuous, inner flowers are fetile and inconspicuous. Blooms in late Spring.

FRUIT: Fruiting only in maturity and then infrequently. 1/4" berry-like drupe, bright red ripening in September, often drying and persisting through Winter.



SPRING

PHOTO SET #16 (Purshia tridentata)

FORM/HABIT: A deciduous shrub 2 to 4´ tall, 3 to 4´ wide, rounded and irregular in form.

LEAVES: 1/4 to 1" long three-lobed wedge shaped leaves. Gray-green in summer, yellow to green to brown in Fall.

FLOWERS: Small 1/2" yellow flowers in Spring.

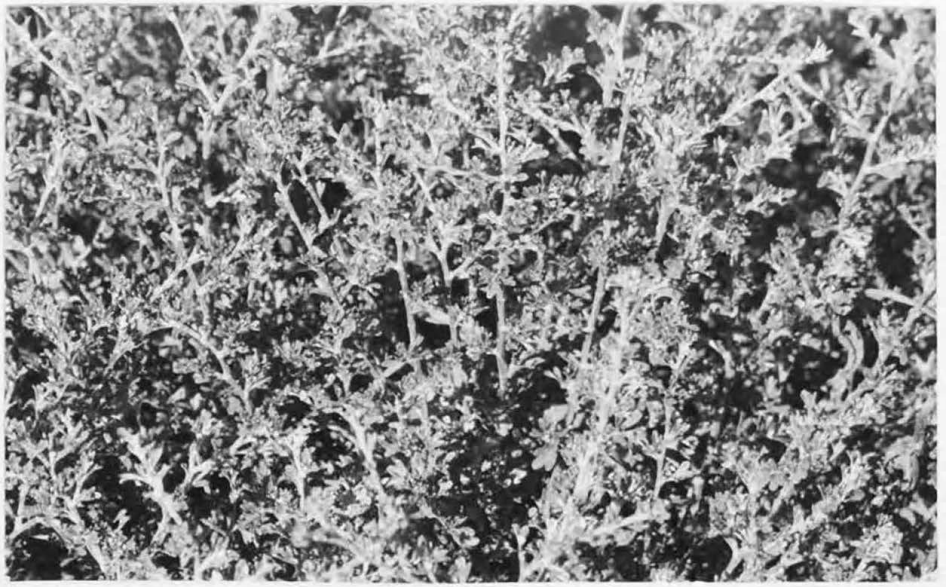
FRUIT: Inconspicuous achene in late Summer. Not pictured.



SPRING



SUMMER



SUMMER



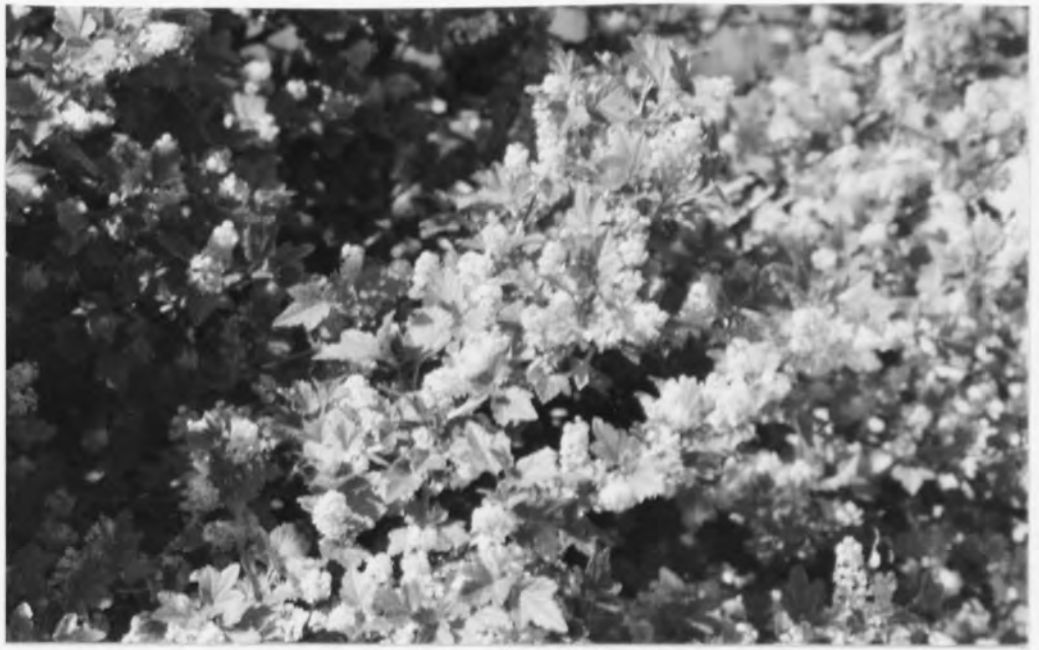
FALL



WINTER



SPRING



SPRING



SUMMER



WINTER

PHOTO SET #17 (Ribes alpinum)

FORM/HABIT: A densely twiggy, rounded deciduous shrub. Male plants predominant in nursery trade. 3 to 6' tall and as wide or wider.

LEAVES: Ovate, 3 to 5-lobed, 1 to 2" long, bright green leaves. Fall color is green to greenish-yellow. Early to leaf out in Spring. Very late to turn in Fall.

FLOWER: Male flowers are greenish-yellow, borne in 1 to 2" long racemes of 20 to 30 flowers in early Spring.

FRUIT: 1/4 to 1/3" scarlet berry. Rarely seen in cultivation. Not pictured.



FALL

PHOTO SET #18 (Rhus trilobata)

FORM/HABIT: A deciduous shrub, 2 to 8´ tall, 6 to 10´ wide, with an open, rounded form.

LEAVES: Small three-lobed leaves, 1 to 1 1/2" long, green in Summer, yellow to orange to red in Fall.

FLOWER: Yellow, precocious flowers in short dense clusters in Spring.

FRUIT: Red crimson drupe persistent through the Winter.



WINTER



LATE SUMMER



SUMMER



SPRING



FALL



FALL



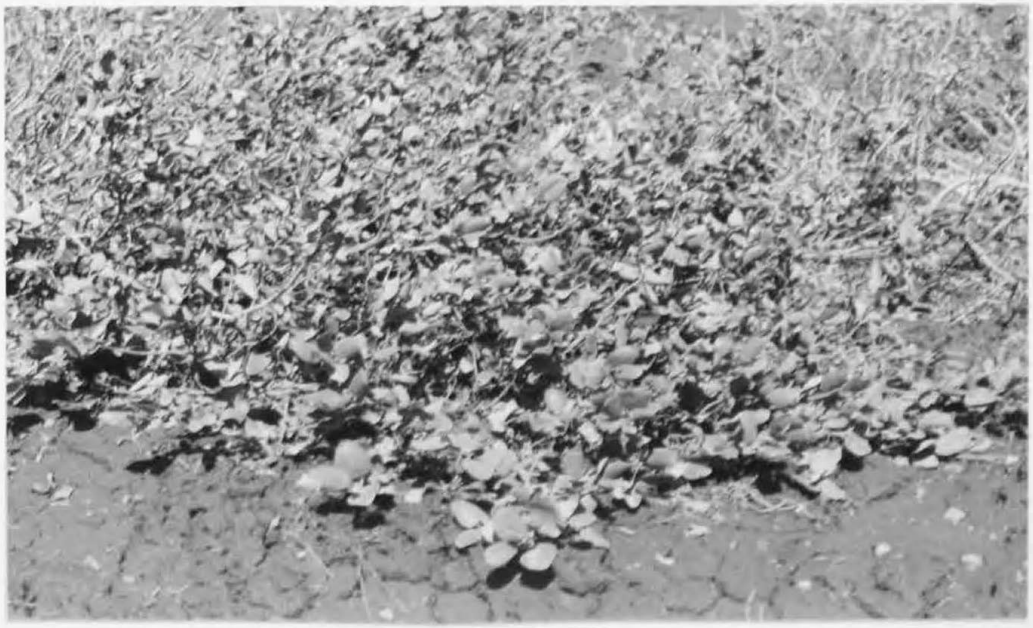
SUMMER



SPRING



FALL



WINTER

PHOTO SET #19 (Ceanothus velutinus)

FORM/HABIT: A broadleaf evergreen shrub having a spread of 10', height reaching 1 to 3', rounded in form.

LEAVES: Ovate leaves, shiny, and resinous. Dark green above, white underneath. No Fall or Winter color change.

FLOWER: White flowers borne in 2 to 4" heads in early Summer.

FRUIT: Inconspicuous capsule.

PHOTO SET #20 (Syringa vulgaris)

FORM/HABIT: An upright irregularly rounded deciduous shrub. 8 to 15´ tall with a 6 to 12´ spread.

LEAVES: 2 to 5" long ovate leaves. Dark green to bluish green in summer, staying green late into the fall, green to gold to brown in fall.

FLOWER: Flowers are lavender and borne in 4 to 8" long panicles, usually in pairs, in mid-Spring.

FRUIT: Brown capsules borne in panicles, persisting through Winter.



SPRING



SUMMER



WINTER



FRUIT



FALL



SUMMER



LATE SUMMER



FALL

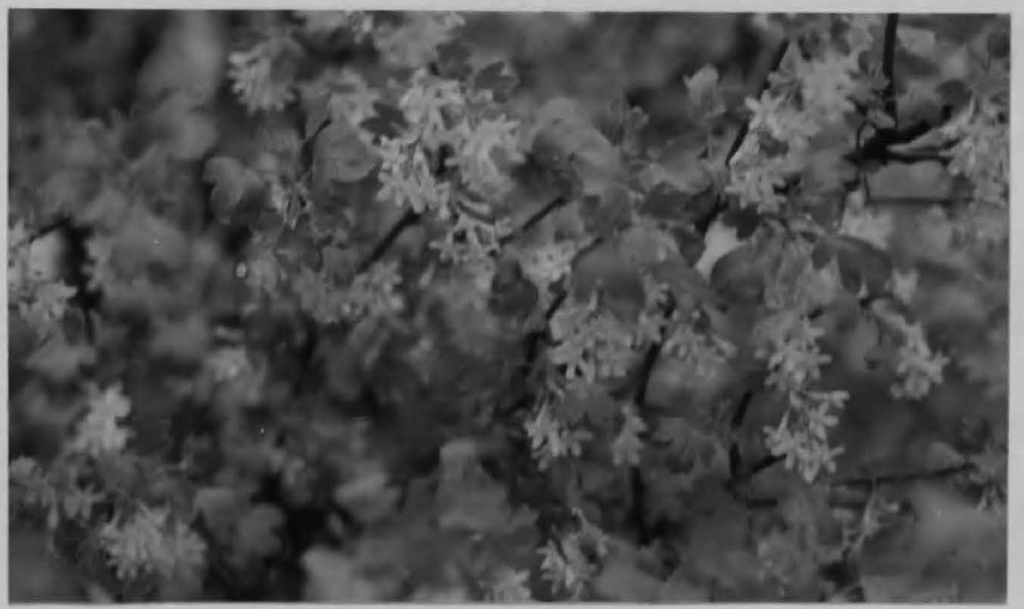


PHOTO SET #21 (Ribes aureum)

FORM/HABIT: A rounded deciduous, stoloniferous shrub. 3 to 6´ tall, 4´ spread.

LEAVES: 3 to 5 lobed obovate leaves. Green in Summer, orange to red in Fall.

FLOWER: Yellow flowers, 1" long, blooming in Spring.

FRUIT: A yellow, orange, red to black berry in late Summer, 1/2" across.



SPRING



WINTER

PHOTO SET #22 (Philadelphus x virginalis)

FORM/HABIT: An upright deciduous shrub, 5 to 9´ tall, 4 to 8´ spread.

LEAVES: Leaves are ovate, 1 1/2 to 4" long, green. Fall color is green to brown.

FLOWERS: White, 1 to 1 2/3" across, flowers borne in 5 to 7 flowered racemes in late Spring.

FRUIT: Four parted capsule persisting through Winter.



SUMMER



WINTER



SPRING



SUMMER



FALL



SPRING



SPRING



FALL

PHOTO SET #23 (Philadelphus lewisii)

FORM/HABIT: A mid-sized deciduous shrub with upright branches. 4 to 6´ tall, and spread.

LEAVES: Paired oval, dark green leaves. Fall color is yellow to brown.

FLOWERS: Many small clusters of white, 1 1/2 to 2" flowers in late Spring/early Summer.

FRUIT: A four parted capsule persisting from late Summer through Winter.



SUMMER



SUMMER



WINTER

PHOTO SET #24 (Juniperus communis)

FORM/HABIT: A much-branched sprawling evergreen shrub. Maximum height is 5 to 10´, maximum spread is 8 to 12´.

LEAVES: Awl-shaped needles are green with broad white bands on upper surface. Needles have a purplish bronze tint in Winter.

FLOWER: Do not score.

FRUIT: Bluish-black or black berry-like cone with a glaucous bloom, 1/4" across, maturing in late Summer and persisting through Winter. This species is dioecious, thus the fruit appears only on famale plants.



SUMMER



WINTER



FRUIT



SUMMER



WINTER



FRUIT

PHOTO SET #25 (Juniperus chinensis 'Pfitzeriana')

FORM/HABIT: A spreading evergreen shrub with branching angles of 30 degrees; and often appearing horizontally layered. Maximum height is 5', maximum spread is 20'.

LEAVES: Scale-like and awl-shaped, 1/4" long, needles. Young shoots are slightly pendulous. No seasonal color change.

FLOWER: Do not score.

FRUIT: Bluish-white bloomy berry-like cone, 1/4" across, maturing in late summer and persisting through the winter. This species is dioecious, thus the fruit appears only on female plants.

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