

THE  
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NATURAL RESOURCES CONSERVATION SERVICE  
WASHINGTON, D.C.

and

MONTANA AGRICULTURAL EXPERIMENT STATIONS  
MONTANA STATE UNIVERSITY  
BOZEMAN, MONTANA

and

WYOMING AGRICULTURAL EXPERIMENT STATIONS  
UNIVERSITY OF WYOMING  
LARAMIE, WYOMING

NOTICE OF RELEASE OF EKALAKA GERMPLASM BUR OAK SELECTED CLASS OF NATURAL  
GERMPLASM

The U.S. Department of Agriculture, Natural Resources Conservation Service-Bridger Plant Materials Center, Montana Agricultural Experiment Stations-Montana State University, and Wyoming Agricultural Experiment Stations-University of Wyoming, announce the Selected Class pre-varietal release of Ekalaka Germplasm bur oak *Quercus macrocarpa* Michx. for the northern Great Plains and valleys of the Intermountain West. This selection was evaluated and selected by the staff from the USDA-NRCS Plant Materials Center, Bridger, Montana.

As a Selected Class release, this selection will be referred to as Ekalaka Germplasm bur oak, NRCS accession number 9087732.

Justification for alternative release is based on a critical need for well-adapted plant materials for windbreaks, shelterbelts, riparian forest buffers, and wildlife plantings in the northern Great Plains and Intermountain West. In addition, the emergence of the emerald ash borer *Agrilus planipennis* will create an urgent demand for medium-stature deciduous trees to replace green ash *Fraxinus pennsylvanica* Marsh in numerous conservation practices. Discontinuation of Russian olive *Elaeagnus angustifolia* as a conservation species, as well as its removal and control from existing plantings and habitats, will create a need for well-adapted alternatives. A lack of tested and adapted germplasm and the potential use of nonadapted seed sources further support Selected Class release. Given this selection originates from a bulk of several northern Great Plains seed sources, it should prove well adapted to the conditions in the intended geographic area of use. Ekalaka Germplasm bur oak was selected for superior seedling survival, rate of height growth, and vigor rating, relative to other bur oak individual trees and seed

sources tested. Ekalaka Germplasm bur oak can also be used in other conservation applications such as reforestation, Xeriscaping<sup>®</sup>, and woody draw restoration.

**Collection Site/Seed Source Information:** The original Ekalaka Germplasm bur oak (accession number 9087732) seed collections were made in various locations across the Great Plains (see TABLE 1). In 1991, the Bridger PMC entered into a cooperative bur oak study initiated by the GP-13 Improved Trees Task Force and organized by W. R. Schroeder of the Prairie Farm Rehabilitation Administration (PFRA) Shelterbelt Centre at Indian Head, Saskatchewan, and Richard Cunningham of the ARS-Northern Great Plains Research Lab at Mandan, North Dakota. The goals of the study include the following:

TABLE 1. Bur oak seed source origin, Bridger PMC, Bridger, MT.

| Accession Number | Seed Source Identification | County of Origin | State |
|------------------|----------------------------|------------------|-------|
| 9076042          | 103                        | McKenzie         | ND    |
| 9076043          | 106                        | Griggs           | ND    |
| 9076044          | 111                        | Burleigh         | ND    |
| 9076045          | 112                        | Pennington       | SD    |
| 9076046          | 122                        | Bottineau        | ND    |
| 9076047          | 128                        | Oliver           | ND    |
| 9076048          | 139                        | Dunn             | ND    |
| 9076049          | 142                        | Carter           | MT    |
| 9076050          | 151                        | Emmons           | ND    |
| 9076051          | 209                        | Bottineau        | ND    |
| 9076052          | 211                        | Stark            | ND    |
| 9076053          | 218                        | Oliver           | ND    |
| 9076054          | 219                        | McKenzie         | ND    |
| 9076055          | 226                        | Burleigh         | ND    |
| 9076056          | 227                        | Burleigh         | ND    |
| 9076057          | 228                        | Sioux            | ND    |
| 9076058          | 236                        | Morton           | ND    |
| 9076059          | 237                        | Morton           | ND    |
| 9076060          | 250                        | Emmons           | ND    |
| 9076061          | Tree A                     | Carter           | MT    |
| 9076062          | ETTII                      | Carter           | MT    |
| 9076063          | Tree B                     | Carter           | MT    |
| 9076064          | 144                        | Carter           | MT    |
| 9076065          | Tree 3                     | Carter           | MT    |

1. To identify the nature and extent of genetic variation among selected sources of bur oak,
2. To provide genetically improved bur oak seed for shelterbelt plantings, and
3. To provide germplasm for selection and trait improvement research and advanced generation breeding.

In conjunction with the GP-13 goals, the MITOSIS (Montana Interagency Tree and/or Shrub Improvement Study) program seeks to improve the quality and diversity of the nursery stock produced by the Montana Conservation Seedling Nursery for windbreak and shelterbelt applications. After data was collected for the GP-13 study, selections of individual trees and families with superior traits were retained and used to establish a foundation seed orchard for the production of superior germplasm for release to cooperating agencies and the commercial nursery industry.

Wildland bur oak seed collections were made in 1991 and 1992 from individual trees demonstrating superior phenotypic characteristics. These characteristics included single, straight stems with strong apical dominance, well-formed crowns, at least 30 years of age, and the production of abundant crops of sound acorns. Acorns were shipped to study cooperators in 1992 and 1993 for propagation.

Propagation of test plants for this study began in late fall of 1991 when five Montana sources were collected and sown in the greenhouse at the PMC. These collections were not all original GP-13 test accessions, but were included in the Bridger planting in order to generate more information about the performance of Montana sources of

bur oak. On February 25, 1992, the Bridger PMC received 468 acorns representing 16 additional accessions collected from sites in Montana, North Dakota, Oklahoma, and South Dakota.

On February 3, 1993, the Bridger PMC received a second shipment of 300 acorns, representing 10 additional accessions. These accessions were from different trees in the same counties as those received in 1992. All counties represented in the second group of collections were also represented in the first group.

**Description:** Bur oak or mossycup oak is a medium- to tall-stature deciduous tree widely distributed across the US and native to limited areas in Montana and Wyoming. The bur oak has several desirable attributes including strong branches, drought tolerance, winter hardiness, and freedom from serious insect or disease problems. Acceptance of bur oak for use in windbreaks and shelterbelts has been limited due to a reputation for slow growth and a multi-stemmed habit of seed sources at the western edge of its natural range. The goal of this study was to assemble, evaluate, select, and release a population of bur oak demonstrating superior seedling survival, sustained rate of adequate height growth, superior overall plant vigor rating, as well as good overall form.

Bur oak is a hardy, drought-tolerant tree capable of growing over a wide range of soil conditions. A combination of high water use efficiency and a fast growing tap root enable this species to withstand the dry, windy conditions characteristic of the northern plains. Bur oak has a large, native range extending from Nova Scotia, west to Manitoba, south through Kansas to Texas, east to Alabama, and northeast to Virginia and New England. In Montana, it occurs only in Carter County (which is in the extreme southeastern corner of the state) in uncultivated, natural stands. Landscape specimens can be found in many Montana communities over much of the state. Most references list bur oak as hardy in USDA Winter Hardiness Zones 4 to 8, although Zone 2 is given in at least one source. Bur oak is considered only moderately shade tolerant.

Although it favors rich alluvial bottomland, bur oak can grow well on rocky hillsides, limestone soils, droughty soils, clayey sites, and other marginal locations -- given full sun conditions. This species even performed better than most others tested on coal-mine spoils of pH 5.6 in eastern Kansas. In the western United States bur oak is considered a pioneer species and is capable of invading prairie grasslands. In the eastern Great Plains it occurs primarily along stream bottoms and stream terraces in association with green ash (*Fraxinus pennsylvanica*), boxelder (*Acer negundo*), and cottonwood (*Populus sp.*). Bur oak is, however, intolerant of flooding.

On good sites, bur oak has a spreading habit with a broad crown; massive bole; and low, large branches. It is capable of reaching heights of 25 to 28 meters (82.0 to 91.9 ft.), and individual trees up to 30.5 meters (100 ft.) are common on good sites. An individual tree with a height of 51 meters (170 ft.) and a d.b.h. (diameter breast high) of 213 centimeters (84 inches) has been reported in the lower Ohio Valley. In Montana, heights of 15 meters (49.2 ft.) can be considered about the upper limits of growth.

Although bur oak is monoecious, with both male and female flowers on the same plant, cross pollination between individual trees appears to be favored. Acorns ripen in 1 year and can fall as early as August or as late as November depending on the tree and location. Acorns can usually germinate immediately without pretreatment, but may require some cold stratification when collected from sources in northern climates. The average minimum seed-bearing age of forest trees is approximately 35 years with best production typically between 75 to 150 years. Good crops usually occur every 2 to 3 years. It may be necessary to check seed-bearing trees regularly in order to assure harvesting the acorns before the wildlife do.

Serious insect and disease problems are relatively limited for bur oak in the western United States. Reported insect problems include oak webworm, oak skeletonizer, leaf miner, variable oakleaf caterpillar, oak lacebug, and June beetles. Oak lacebug can be a serious problem in shelterbelt plantings, especially during drought conditions. Fungal pathogens are also known to occur, but disease does not appear to be a major problem with this species.

In addition to its windbreak and shelterbelt applications, bur oak has several other positive attributes and uses. This species makes an impressive street tree and large landscape plant. The wood of bur oak is quite valuable and is often marketed as white oak. Bur oak acorns are a favored food for numerous wildlife species deer, turkeys, rabbits, and squirrels.

Despite its tolerance of a wide range of site conditions, bur oak has not been widely used in conservation plantings. The primary limiting factor for lack of acceptance has been its reputation for slow rate of height growth, which is approximately 4.6 to 6.1 meters (15 to 20 ft.) per 20 years. In addition, seed sources at the western edge of its natural range tend to have poor form. There appears to be much opportunity for selecting a genetically improved strain capable of sustaining greater rates of height growth and improved form.

**Method of Selection:** Ekalaka Germplasm bur oak is being released as a 'Natural-Track' germplasm, i.e., it is being increased without purposeful manipulation. This selection was based on a comparison of 24 seed sources of bur oak from the northern Great Plains. Selection was based on a combination of sustained rate of annual height growth, seedling survival, and plant vigor rating. Final selections appear in TABLE 2.

TABLE 2. Bur oak provenance study, mean performance data, final selections (bold), Bridger, Montana, 2003.

| Accession Number    | Study I.D.    | County            | State     | Original Number Planted | 2003            | 2003             | 2003         | 2003               | 2003        | 2003              |
|---------------------|---------------|-------------------|-----------|-------------------------|-----------------|------------------|--------------|--------------------|-------------|-------------------|
|                     |               |                   |           |                         | Number Selected | Percent Survival | Mean Height  | Mean Basal Caliper | Mean DBH    | Mean Vigor Rating |
|                     |               |                   |           |                         |                 | %                | cm           | mm                 | mm          | (1-9)             |
| 9076042             | 103           | McKenzie          | ND        | 12                      |                 | 66.7             | 218.5        | 48.0               | 20.6        | 4.4               |
| 9076043             | 106           | Griggs            | ND        | 16                      |                 | 87.5             | 227.1        | 53.0               | 25.2        | 4.5               |
| <b>9076044</b>      | <b>111</b>    | <b>Burleigh</b>   | <b>ND</b> | <b>15</b>               | <b>6</b>        | <b>93.3</b>      | <b>275.2</b> | <b>68.3</b>        | <b>31.2</b> | <b>3.6</b>        |
| <b>9076045</b>      | <b>112</b>    | <b>Pennington</b> | <b>SD</b> | <b>14</b>               | <b>5</b>        | <b>92.9</b>      | <b>285.7</b> | <b>67.8</b>        | <b>35.6</b> | <b>3.7</b>        |
| 9076046             | 122           | Bottineau         | ND        | 15                      |                 | 80.0             | 248.8        | 54.5               | 27.6        | 3.9               |
| 9076047             | 128           | Oliver            | ND        | 16                      |                 | 87.5             | 258.7        | 68.2               | 30.4        | 3.4               |
| 9076048             | 139           | Dunn              | ND        | 14                      |                 | 71.4             | 289.2        | 70.1               | 37.0        | 3.9               |
| 9076049             | 142           | Carter            | MT        | 16                      |                 | 68.7             | 188.5        | 54.6               | 19.6        | 4.2               |
| <b>9076050</b>      | <b>151</b>    | <b>Emmons</b>     | <b>ND</b> | <b>14</b>               | <b>7</b>        | <b>92.9</b>      | <b>279.4</b> | <b>69.0</b>        | <b>37.9</b> | <b>3.9</b>        |
| 9076051             | 209           | Bottineau         | ND        | 16                      |                 | 100.0            | 150.3        | 41.9               | 13.2        | 4.9               |
| 9076052             | 211           | Stark             | ND        | 16                      |                 | 87.5             | 229.5        | 54.8               | 24.7        | 4.1               |
| <b>9076053</b>      | <b>218</b>    | <b>Oliver</b>     | <b>ND</b> | <b>16</b>               | <b>9</b>        | <b>93.8</b>      | <b>300.6</b> | <b>76.5</b>        | <b>37.8</b> | <b>3.5</b>        |
| 9076054             | 219           | McKenzie          | ND        | 14                      |                 | 57.1             | 191.1        | 48.3               | 17.4        | 4.4               |
| <b>9076055</b>      | <b>226</b>    | <b>Burleigh</b>   | <b>ND</b> | <b>16</b>               | <b>11</b>       | <b>93.8</b>      | <b>311.6</b> | <b>75.0</b>        | <b>37.4</b> | <b>3.5</b>        |
| 9076056             | 227           | Burleigh          | ND        | 16                      |                 | 81.2             | 284.0        | 65.2               | 30.1        | 3.5               |
| <b>9076057</b>      | <b>228</b>    | <b>Sioux</b>      | <b>ND</b> | <b>16</b>               | <b>9</b>        | <b>93.8</b>      | <b>310.0</b> | <b>76.0</b>        | <b>42.7</b> | <b>3.1</b>        |
| 9076058             | 236           | Morton            | ND        | 16                      |                 | 75.0             | 223.8        | 59.6               | 24.5        | 4.3               |
| 9076059             | 237           | Morton            | ND        | 16                      |                 | 81.2             | 235.4        | 62.4               | 30.3        | 3.8               |
| 9076060             | 250           | Emmons            | ND        | 16                      |                 | 93.8             | 243.3        | 58.5               | 26.3        | 3.9               |
| <b>9076061</b>      | <b>Tree A</b> | <b>Carter</b>     | <b>MT</b> | <b>16</b>               | <b>6</b>        | <b>75.0</b>      | <b>279.6</b> | <b>71.8</b>        | <b>34.1</b> | <b>3.3</b>        |
| <b>9076062</b>      | <b>ETTII</b>  | <b>Carter</b>     | <b>MT</b> | <b>16</b>               | <b>7</b>        | <b>87.5</b>      | <b>289.6</b> | <b>66.7</b>        | <b>31.4</b> | <b>3.3</b>        |
| <b>9076063</b>      | <b>Tree B</b> | <b>Carter</b>     | <b>MT</b> | <b>16</b>               | <b>7</b>        | <b>87.5</b>      | <b>254.7</b> | <b>67.2</b>        | <b>32.4</b> | <b>3.4</b>        |
| 9076064             | 144           | Carter            | MT        | 16                      |                 | 81.2             | 218.2        | 52.0               | 22.3        | 4.5               |
| 9076065             | Tree 3        | Carter            | MT        | 16                      |                 | 81.2             | 244.4        | 68.7               | 32.0        | 3.6               |
| <b>Grand Mean:</b>  |               |                   |           |                         |                 | <b>84.1</b>      | <b>253.2</b> | <b>62.9</b>        | <b>29.6</b> | <b>3.8</b>        |
| <b>Grand Total:</b> |               |                   |           | <b>370</b>              | <b>67</b>       |                  |              |                    |             |                   |

**Testing:** Field testing was conducted at the Plant Materials Center at Bridger, Montana. The test site was located at an elevation of 1,128 m (3,700 ft.) in a 254- to 330-mm (10- to 13-in.) annual precipitation zone. Bridger falls in USDA Winter Hardiness Zone 4b, with annual minimum temperatures of -20 to -25°F (-28.9 to -31.6°C). The site was located in Major Land Resource Area (MLRA) 32, Northern Intermountain Desertic Basin. This classification consists of sites in Montana and Wyoming ranging in elevation from 1,100 to 1,800 m (3,609 to 5,905 ft.). The climate averages 125 to 225 mm (4.9 to 8.9 in.) of annual precipitation with most precipitation in the spring and fall. Precipitation is low and erratic. The average annual temperature is about 7°C (44.6°F) with an average frost-free period of 120 to 140 days.

The 3.0-acre planting site gradually slopes from east to west and north to south. The planting site soil is a Heldt silty clay loam. The Heldt soil series is classified as a fine, montmorillonitic, mesic, Ustetric, Camborthid, on 4 to 8 percent slopes. The upper 46 cm (18 in.) of the profile are characterized as mildly alkaline, whereas the lower 46 to 152 cm (18 to 60 in.) are strongly alkaline. These soils are formed in deep alluvium and have moderate shrink-swell potential, but high frost-action potential. Although permeability is slow, these soils are well-drained and runoff is considered medium with only a slight risk of erosion. The mean annual soil temperature is 8.9 to 10.6°C (48 to 51°F) and the frost-free period is 120 to 130 days. This soil falls in the Windbreak Group 1 suitability group; and is characterized by deep, friable, nearly level to steep, well-drained soils on stream terraces and fans. Soils in this

group are well suited to caragana (*Caragana arborescens* Lam.), honeysuckle (*Lonicera* sp.), lilac (*Syringa* sp.), chokecherry (*Prunus virginiana* L.), American plum (*Prunus americana* Marsh), skunkbush sumac (*Rhus trilobata* Nutt.), silver buffaloberry (*Shepherdia argentea* [Pursh] Nutt.), sand cherry (*Prunus pumila* var. *besseyi* [Bailey] Gleason), red-osier dogwood (*Cornus sericea* L.), and Russian olive (*Elaeagnus angustifolia* L.). Natural vegetation is mixed mid- and short grasses, forbs, shrubs, and cottonwoods along the streams. The dominant vegetation in uncultivated areas adjacent to the site includes bluebunch wheatgrass (*Pseudoroegneria spicata* [Pursh] A. Love), needle and thread (*Hesperostipa comata* Trin. & Rupr.), prairie junegrass (*Koeleria macrantha* [Ledeb.] J.A.Schultes), big sagebrush (*Artemisia tridentata* ssp. *spiciformis* [Osterhout] Kartesz & Gandhi), ponderosa pine (*Pinus ponderosa*), Rocky Mountain juniper (*Juniperus scopulorum* Sarg.), and limber pine (*Pinus flexilis* James). The planting site at Bridger was located at an elevation of 1,128 m (3,700 ft.) in a 254- to 330-mm (10- to 13-in.) annual precipitation zone.

Propagation of test plants for this study began in fall 1991 when five Montana sources were collected and sown in the PMC greenhouse. These collections were not all original GP-13 test accessions, but were included in the Bridger planting in order to generate more information about the performance of Montana sources of bur oak. On February 25, 1992, the Bridger PMC received 468 acorns representing 16 additional accessions collected from sites in Montana, North Dakota, Oklahoma, and South Dakota. The collections, shipped in zip-lock bags, were immediately stored in a 37°F walk-in cooler. From February 26 through March 2, 1992, the acorns were planted in 40-cubic-inch Deepots® in Fison's #3® potting mix, watered, and then placed in the greenhouse at 80°F days and 65°F nights under 62 percent shade. Germination and height data were recorded on July 30, 1992.

The oaks were moved outdoors in early August, under the partial shade of a green ash windbreak, for the remainder of the summer. Although generally not severe, some plants did develop symptoms of sunscald. After their leaves had abscised in October, all plants were moved into a temporary, overwintering structure. Plants were periodically watered until the propagation media had frozen. In mid-January 1993, a check of the seedlings revealed rodents had chewed most stems down to the media surface. All accessions were brought into the greenhouse and allowed to break bud. Survival data were taken in April.

On February 3, 1993, the Bridger PMC received a second shipment of 300 acorns, representing 10 additional accessions. These accessions were from different trees in the same counties as those received in 1992. All counties represented in the second group of collections were also represented in the first group. The acorns were handled and processed identically as the initial group, being removed from the cooler and planted in Fisons #4® in Deepots® on March 12, 1993. The plants were watered and placed in the headhouse to germinate. After germination was complete, data were collected on each accession. All plants were fertigated periodically with 125 ppm N-P-K. Gnatrol® at a rate of 4 teaspoons-per-gallon was used on two occasions to control fungus gnat larva.

An evaluation of all trees was conducted on March 29, 1994, and April 4, 1994, in order to record preplanting height. On June 17, 1994, a 24 accession RCB (Randomized Complete Block) design planting was installed in Field 23 at the Bridger PMC with collections from Montana, North Dakota, and South Dakota represented. Only accessions containing 12 or more surviving trees were included in the study as test plants. The RCB consisted of 8 blocks, each block consisting of three rows of 16 test positions each. This resulted in a total of 384 RCB planting locations. When available, two trees of each accession were randomized in each block resulting in the planting of 16 trees per accession (see APPENDIX 1). Trees were planted on 14-foot centers between rows and 18 feet within rows occupying an area of approximately 3.0 acres. Holes were drilled with an 8-inch auger to a depth of 24 to 30 inches. Each tree was hand planted and then irrigated with approximately 2 gallons of water. Most plants were produced in containers; however, a small number of additional plants were shipped to Bridger in early 1994 as bareroot stock. Bareroot stock has been identified on the layout and evaluation forms in case performance differences appear over time.

The entire oak study was flood irrigated four times over the course of the 1994 growing season because of exceptionally hot, dry, windy conditions. The planting continues to be maintained in a fallow condition by a combination of roto-mowing, mechanical cultivation, and spot spraying of noxious weeds. Each tree was evaluated on October 12, 1994, for survival, height, and animal damage.

On July 18, 1995, extra seedlings held in containers were used to replace dead trees and blanks within the RCB, and to establish a border row around the perimeter of the entire planting. Each replacement was given approximately 2 gallons of water at planting and then twice more over the course of the 1995 growing season. No additional irrigation was supplied to any of the 1994 planted trees. As in 1994, mechanical cultivation and spot

spraying were used to maintain the planting. On October 9, 1995, all bur oak were evaluated for survival, height, and animal damage.

Although a three-wire electric fence was installed around the perimeter of the field prior to planting in 1994, deer browsing was fairly high in 1994 and 1995. A combination of inadequate electrical grounding and poor design was the probable cause of failure. To correct this problem, Vexar<sup>®</sup> seedling protectors were placed over each tree on October 25, 1995, to deter rabbit and deer predation. A PVC (polyvinyl chloride) sleeve was first placed over each tree and then the seedling protector placed over the tube. The PVC sleeve was then pulled upward leaving the protector in place. This technique prevented branch damage and greatly reduced installation time. The seedling protectors worked well to prevent serious stem and terminal bud damage although browsing of foliage continued over time. In 2000, evidence of girdling from the protectors resulted in their removal from all trees. The fence, which had been inoperative since 1996, was removed in 2001 to facilitate cultivation operations. Final selections were made in March 2004 and all non-selected trees were removed in April. The lower limbs on all selected trees were pruned in July 2004 to facilitate cultivation and seed collection. In August and September 2004, a 6-foot high welded-wire fence was constructed around the entire seed orchard to exclude deer. In 2007, a two-wire electric fence was attached to the existing welded-wire fence at 6 inches and 3 feet above the ground. Evidence of animal predation of the 2007 crop was minimal. The planting continues to be maintained fallow by a combination of hand, mechanical, and chemical cultivation. The only herbicide used in this study has been 2 to 4 percent glyphosate solutions to control field bindweed (*Convolvulus arvensis*) and Canada thistle (*Cirsium arvense*). No other herbicides, fertilizers, or fungicides have been used to date. Since 2001, fairly high numbers of aphids have warranted the use of insecticidal soap and paraffinic oil for control. For seed collection information, see Seed Increase.

## Results and Discussion

Data has been collected annually since 1999. For mean results and other descriptive statistics, reference the Bridger Plant Materials Center 1996-2003 and 2004-2005 Technical Reports.

Final selections in 2004 were based on data from the fall 2003 evaluation. Raw data from the 2003 evaluation appears in APPENDIX 2.

Selection was based on a combination of descriptive statistics (mean height growth, percentage survival, and vigor rating at or above the overall population mean), a visual (subjective) field review of each tree within a family (seed source), and statistical analyses. In general, seed sources with mean survival, height growth, and vigor rating at or above overall population means were selected. Additionally, individual trees within a selected seed source that did not meet established mean criteria or that did not appear suitable based on the field inspection were omitted. A total of 67 trees from 9 seed sources from three states (Montana, North Dakota, and South Dakota) were selected (see TABLE 3). Selected seed sources maintained 89.9 percentage survival until 2003, whereas non-selected and all seed sources maintained 80.5 and 84.1 percentage survival, respectively. Percentage survival among selected seed sources ranged from 75.0 to 94.0 percent. Selected trees averaged 28.8 cm (11.3 inches) of height growth in 2003, with individual tree annual growth as high as 84.8 cm (33.4 inches). Mean annual height growth by seed source ranged from 7.2 cm (2.8 inches) to 37.1 cm (14.6 inches). Selected trees averaged 339.1 cm (133.5 inches) in height in 2003, whereas non-selected and all trees measured 229.6 cm (90.4 inches) and 253.2 cm (99.7 inches), respectively. Plant vigor rating of selected trees in 2003 averaged 2.9, whereas non-selected and all trees averaged 4.1 and 3.8, respectively. The basal caliper of selected trees averaged 84.1 mm (3.3 inches), whereas the basal caliper of non-selected and all trees averaged 57.0 mm (2.25 inches) and 62.9 mm (2.5 inches), respectively. The D.B.H. (diameter breast high) of selected trees averaged 45.6 mm (1.8 inches), whereas the D.B.H. of non-selected and all trees averaged 25.2 mm (1 inch) and 29.6 mm (1.2 inches), respectively.

TABLE 3. Bur oak provenance study, “selected” versus “non-selected” versus “all” mean performance data, Bridger, Montana, 2003.

| Original Number Planted   | 2003 Number | 2003 Percent Survival<br>% | 2003 Mean Height<br><i>cm</i> | 2003 Mean Basal Caliper<br><i>mm</i> | 2003 Mean D.B.H.<br><i>mm</i> | 2003 Mean Vigor Rating<br>(1-9) |
|---------------------------|-------------|----------------------------|-------------------------------|--------------------------------------|-------------------------------|---------------------------------|
| Selected Seed Sources     | 67          | 89.9                       | 339.1                         | 84.1                                 | 45.6                          | 2.9                             |
| Non-Selected Seed Sources | 244         | 80.5                       | 229.6                         | 57.0                                 | 25.2                          | 4.1                             |
| All Seed Sources          | 311         | 84.1                       | 253.2                         | 62.9                                 | 29.6                          | 3.8                             |

As previously noted, a statistical analysis of pseudo-replicates by ANOVA was conducted (see APPENDIX 3), but was not the sole basis for selection.

**Seed Increase:** A total of 67 trees selected in 2004 were retained to create an open-pollinated seed orchard. All non-selected trees were mechanically removed and sprouts sprayed with glyphosate. Seed production and data collection from the test plot actually began in 1999 when seedlings were 7 or 8 years of age. Two studies were developed to track seed production by individual tree and seed source (MT-02-0008) and to determine if seed production correlated with one or more plant growth factors (MT-02-0009). Reference the Bridger Plant Materials Center 1996-2003 Technical Report, Volume 2 – Woody Plant, Propagation, and Germination Research; and the Bridger Plant Materials Center 2003-2005 Technical Report for more information.

Annual evaluations for seed production by individual tree began in 1999 with the first evidence of flowering and fruit production. Each evaluation consisted of counting the number of seeds and caps produced by an individual tree in order to estimate total seed production. Seed weight data was also collected and summarized depending on the year.

In 1999, only one tree from Stark, North Dakota, (211-08), produced one acorn. In 2000, a total of 48 test trees representing 20 of the 24 seed sources tested produced at least one acorn. A total of 588 acorns were produced in 2000 when the trees were 8 or 9 years old. A formal evaluation of bur oak seed production was not possible in 2001 because most acorns were lost to animal predation. It was noted that of the 48 trees producing acorns in 2000, 47 trees (98 percent) produced evidence of acorns in 2001. An additional 75 trees produced acorns in 2001 for a total of 122 acorn-producing trees in 2001.

There was substantial evidence of seed predation throughout the study again in 2002.

In 2002, a total of 165 test trees representing all 24 tested seed sources produced at least one acorn. An estimated 39,060 acorns were produced in 2002. The highest number of acorns produced by an individual tree was 1,336 by Carter, Montana -Tree B II-46. The overall mean number of acorns produced per acorn-producing tree was 236.7 in 2002. In 2002 and 2003, correlation analyses were conducted to determine if plant height, basal caliper, diameter breast high, or vigor rating could be used as indices of seed production and productivity.

In 2003, a total of 188 test trees representing all 24 tested seed sources produced at least one acorn, an increase of 23 trees from the 2002 level. An estimated 9,768 acorns were produced in 2003, a substantial decrease from the 39,060 acorns produced in 2002. The highest number of acorns produced by an individual tree was 610 by Emmons, North Dakota -151-8. The overall mean number of acorns produced per acorn-producing tree was 52.0 in 2003.

In 2004, a total of 144 test trees representing 10 tested seed sources produced at least one acorn. An estimated 6,684 acorns were produced in 2004, a decrease from the 9,768 acorns produced in 2002. The highest number of acorns produced by an individual tree was 586 by Oliver, ND-218-13. The overall estimated mean number of acorns produced per acorn-producing tree was 46.4 in 2004.

As a result of severe late spring frosts in 2005 and 2006, seed production was very low each year and no seed was collected.

Data was again collected on individual tree seed production in 2007. A total of 723.3 pounds (328 kg) of bulk seed representing 201,613 seeds with a grand mean viability of 77 percent was collected from the orchard and stored in a walk-in cooler for conservation seedling production. Reference MT-07-0002 Bur Oak Seed Production and Germination by Individual Selected Tree, Bridger Plant Materials Center 2006-2007 Technical Report for detailed information.

Seed was collected for production purposes in 2008, but no production data was recorded.

Ekalaka Germplasm bur oak averages 614 seeds-per-kilogram (279 seeds-per-pound). Average date of harvest of Ekalaka Germplasm bur oak at the Plant Materials Center, Bridger, Montana, ranges from late August to early October each year with peak production in mid- to late-September.

**Ecological Considerations and Evaluation:** Bur oak is a long-lived deciduous tree native to Montana and Wyoming. At reproductive maturity it is a prolific seed producer, but is not weedy. Bur oak stands readily perpetuate themselves through seed shatter, but the seedlings are sensitive to grazing, flooding, and fire. The species is very tolerant to cold temperatures. Ekalaka Germplasm bur oak passes the NRCS Plant Materials Program, Environmental Evaluation of Plant Materials Releases (attached) for potential invasiveness.

**Anticipated Conservation Use:** Ekalaka Germplasm bur oak is intended primarily for use in windbreaks, shelterbelts, and riparian forest buffers. This selection may also be used for other conservation practices including woody draw restoration, wildlife habitat, Xeriscaping<sup>®</sup>, and reforestation projects.

**Anticipated Area of Adaptation:** Ekalaka Germplasm bur oak is a bulk of multiple seed sources originating in the northern Great Plains. Although testing of this selection has been limited to the Bridger, Montana, test site, it should perform well across broad areas of eastern Montana and Wyoming, as well as western North Dakota and western South Dakota. Based on the performance data in Bridger, Montana, and in its native range, Ekalaka Germplasm bur oak is best adapted to elevations of 2,000 to 4,000 feet, performing more favorably on lower elevation (valley) sites.

Ekalaka Germplasm bur oak will continue to be field tested across its geographic range to assess its performance and adaptation.

**Increase and Distribution:** Generation G<sub>1</sub> (equivalent to Foundation) seed of Ekalaka Germplasm bur oak will be available from the USDA-Natural Resources Conservation Service (NRCS), Plant Materials Center in Bridger, Montana, through the Foundation Seed Stocks Program at Montana State University-Bozeman or the University of Wyoming. Foundation Class seed stock will be available in the spring of 2010. Commercial production of two generations (G<sub>2</sub> and G<sub>3</sub>) beyond G<sub>1</sub> is allowed.

**Prepared by:** Joseph D. Scianna, Research Horticulturist, USDA-NRCS, Plant Materials Center, 98 South River Road, Bridger, MT 59014; Robert Logar, State Staff Forester, USDA-NRCS, Federal Building, Room 443, 10 East Babcock Street, Bozeman, MT 59715-4704; and Darren Zentner, Biological Technician, USDA-NRCS, Plant Materials Center, 98 South River Road, Bridger, MT 59014.

**Signatures for release of:  
Ekalaka Germplasm bur oak**

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Date

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State Conservationist  
NRCS  
Bozeman, Montana

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Date

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State Conservationist  
NRCS  
Casper, Wyoming

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Date

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Director  
Montana Agricultural Experiment Station  
Montana State University  
Bozeman, Montana

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Date

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Director  
Wyoming Agricultural Experiment Station  
University of Wyoming  
Laramie, Wyoming

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Date

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Director  
Ecological Sciences Division  
NRCS  
Washington, DC

APPENDIX 1. Bur oak seed source study, RCB design and test plant location, Bridger, Montana.

|        | Block 1    |            |              | Block 2    |            |            | Block 3    |            |            | Block 4      |            |            |
|--------|------------|------------|--------------|------------|------------|------------|------------|------------|------------|--------------|------------|------------|
|        | Row 1      | Row 2      | Row 3        | Row 1      | Row 2      | Row 3      | Row 1      | Row 2      | Row 3      | Row 1        | Row 2      | Row 3      |
|        | 142-22     | 142-24     | 142-25       | 142-26     | 142-27     | 142-28     | 142-31     | 142-33     | 209-01     | 209-05       | 209-18     | 209-19     |
| 142-21 | 9076043-09 | 9076051-08 | 9076060-19   | 9076049-10 | 9076061-30 | 9076057-11 | 9076060-22 | 9076058-02 | 9076059-03 | (9076051-03) | 9076058-15 | 9076049-05 |
| 142-20 | 106-09     | 209-08     | 250-19       | 142-10-br  | T ASII-30  | 228-11     | 250-22     | 236-02     | 237-03     | (209-03)     | 236-15NT   | 142-05-br  |
|        | 9076053-16 | 9076063-10 | 9076051-06   | 9076045-10 | 9076062-27 | 9076063-13 | 9076045-02 | 9076046-13 | 9076065-10 | (9076051-21) | 9076053-18 | 9076061-24 |
| 142-17 | 218-16     | T BII-10   | 209-06       | 112-10     | ETT II-27  | T B II-13  | 112-02     | 122-13     | T #3-10    | (209-21)     | 218-18     | T ASII-24  |
|        | 9076064-16 | 9076058-25 | 9076046-10   | 9076042-05 | 9076050-02 | 9076055-05 | 9076047-05 | 9076053-04 | 9076049-12 | 9076063-03   | 9076060-13 | 9076062-12 |
| 136-03 | 13-1-16    | 236-25     | 122-10       | 103-05     | 151-02     | 226-05     | 128-05     | 218-04     | 142-12-br  | T B II-03    | 250-13     | ETT II-12  |
|        | 9076054-03 | 9076059-24 | (9076049-06) | 9076048-04 | 9076046-09 | 9076061-39 | 9076048-05 | 9076054-02 | 9076049-07 | 9076064-29   | 9076044-10 | 9076058-16 |
| 136-02 | 219-03     | 237-24     | 142-06-br    | 139-04     | 122-09     | T AS II-39 | 139-05     | 219-02     | 142-07-br  | T #1-10      | 111-10     | 236-16     |
|        | 9076050-08 | 9076054-13 | 9076042-11   | 9076059-22 | 9076051-10 | 9076056-20 | 9076054-08 | 9076055-02 | 9076042-10 | 9076045-15   | 9076049-09 | 9076062-39 |
| 136-01 | 151-08     | 219-13     | 103-11       | 237-22     | 209-10     | 227-20     | 219-08     | 226-02     | 103-10     | 112-15       | 142-09-br  | ETT II-39  |
|        | 9076052-11 | 9076047-01 | 9076045-13   | 9076065-40 | 9076047-02 | 9076043-16 | 9076044-08 | 9076056-15 | 9076052-12 | 9076065-11   | 9076048-06 | 9076050-14 |
| 130-02 | 211-11     | 128-01     | 112-13       | 1 1/4-3-22 | 128-02     | 106-16     | 111-08     | 227-15     | 211-12     | T #3-11      | 139-06     | 151-14     |
|        | 9076061-17 | 9076064-02 | 9076053-05   | 9076047-11 | 9076053-03 | 9076052-06 | 9076063-11 | 9076050-05 | 9076061-18 | 9076055-13   | 9076047-22 | 9076044-12 |
| 130-01 | T ASII-17  | 13-1-02    | 218-05       | 128-11     | 218-03     | 211-06     | T B II-11  | 151-05     | T ASII-18  | 226-13       | 128-22     | 111-12     |
|        | 9076045-07 | 9076059-28 | 9076062-24   | 9076062-08 | 9076055-08 | 9076046-15 | 9076058-09 | 9076059-15 | 9076064-18 | 9076060-03   | 9076042-09 | 9076046-12 |
| 128-23 | 112-07     | 237-28     | ETT II-24    | ETT II-08  | 226-08     | 122-15     | 236-09     | 237-15     | 13-1-18    | 250-03       | 103-09     | 122-12     |
|        | 9076058-18 | 9076055-01 | 9076057-17   | 9076059-17 | 9076064-12 | 9076058-13 | 9076052-02 | 9076057-07 | 9076063-41 | 9076063-46   | 9076058-24 | 9076057-03 |
| 128-20 | 236-18     | 226-01     | 228-17       | 237-17     | 13-1-12    | 236-13     | 211-02     | 228-07     | T B II-41  | T B II-46    | 236-24     | 228-03     |
|        | 9076043-18 | 9076048-08 | 9076062-41   | 9076051-11 | 9076060-09 | 9076053-06 | 9076050-09 | 9076043-04 | 9076056-28 | 9076059-19   | 9076045-18 | 9076057-04 |
| 128-17 | 106-18     | 139-08     | ETT II-41    | 209-11     | 250-09     | 218-06     | 151-09     | 106-04     | 227-28     | 237-19       | 112-18     | 228-04     |
|        | 9076055-18 | 9076065-45 | 9076063-07   | 9076048-10 | 9076064-30 | 9076042-03 | 9076062-11 | 9076064-14 | 9076048-01 | 9076064-13   | 9076065-01 | 9076046-08 |
| 128-09 | 226-18     | 1 1/4-3-27 | T B II-07    | 139-10     | T #1-11    | 103-03     | ETT II-11  | 13-1-14    | 139-01     | 13-1-13      | T #3-01    | 122-08     |
|        | 9076071-2  | 9076050-01 | 9076047-04   | 9076060-05 | 9076057-05 | 9076044-03 | 9076061-16 | 9076057-16 | 9076045-21 | 9076055-15   | 9076043-19 | 9076047-14 |
| 127-06 | 567-02     | 151-01     | 128-04       | 250-05     | 228-05     | 111-03     | T ASII-16  | 228-16     | 112-21     | 226-15       | 106-19     | 128-14     |
|        | 9076056-08 | 9076065-16 | 9076060-01   | 9076058-21 | 9076052-07 | 9076049-11 | 9076065-06 | 9076046-01 | 9076055-11 | 9076043-10   | 9076061-21 | 9076048-09 |
| 126-08 | 227-08     | T #3-16    | MT-250-01    | 236-21     | 211-07     | 142-11-br  | T #3-06    | 122-01     | 226-11     | 106-10       | T ASII-21  | 139-09     |
|        | 9076046-05 | 9076057-01 | 9076049-08   | 9076056-22 | 9076065-47 | 9076044-11 | 9076062-10 | 9076044-09 | 9076042-04 | 9076056-16   | 9076053-13 | 9076059-27 |
| 126-07 | 122-05     | 228-01     | 142-08-br    | 227-22     | 1 1/4-3-29 | 111-11     | ETT II-10  | 111-09     | 103-04     | 227-16       | 218-13     | 237-27     |
|        | 9076052-22 | 9076044-05 | 9076056-04   | 9076054-11 | 9076045-04 | 9076054-06 | 9076060-08 | 9076047-03 | 9076053-09 | 9076054-14   | 9076056-17 | 9076050-03 |
| 106-27 | 211-22     | 111-05     | 227-04       | 219-11     | 112-04     | 219-06     | 250-08     | 128-03     | 218-09     | 219-14       | 227-17     | 151-03     |
|        | 9076042-7  | 9076048-02 | 9076044-04   | 9076050-12 | 9076063-15 | 9076043-06 | 9076051-23 | 9076051-16 | 9076043-14 | 9076052-03   | 9076052-04 | 9076042-08 |
| 106-26 | 103-07     | 139-02     | 111-04       | 151-12     | T B II-15  | 106-06     | 209-23     | 209-16     | 106-14     | 211-03       | 211-04     | 103-08     |
| ETT-30 | EKTII-22   | EKTII-21   | EKTII-20     | EKTII-18   | EKTII-15   | TASII-33   | TASII-29   | TASII-26   | TASII-25   | TASII-15     | TASII-12   | TASII-11   |

APPENDIX 1 (continued) Bur oak seed source study, RCB design and test plant location, Bridger, Montana.

| Block 5         |                 |                 | Block 6         |                 |                 | Block 7       |               |               | Block 8       |               |               | Border        |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Row 1           | Row 2           | Row 3           | Row 1           | Row 2           | Row 3           | Row 1         | Row 2         | Row 3         | Row 1         | Row 2         | Row 3         |               |
| <b>218-01</b>   | <b>218-02</b>   | <b>218-11</b>   | <b>218-17</b>   | <b>218-23</b>   | <b>218-26</b>   | <b>218-27</b> | <b>226-03</b> | <b>226-07</b> | <b>226-09</b> | <b>226-10</b> | <b>226-14</b> | <b>226-23</b> |
| 9076048-19      | 9076066-02      | 9076042-13      | 9076053-22      | 9076063-01      | 9076044-14      | 9076065-17    | 9076055-16    | 9076056-25    | 9076060-10    | 9076051-04    | Blank         |               |
| 139-19-br       | 126-02          | 103-13-br       | 218-22          | T B II-01       | 111-14          | T #3-17       | 226-16        | 227-25        | 250-10        | 209-04        |               | <b>226-24</b> |
| 9076050-11      | 9076051-12      | 9076057-22      | 9076064-23      | 9076059-26      | 9076042-12      | 9076065-08    | 9076049-16    | 9076062-32    | Blank         | Blank         | 9076053-12    |               |
| 151-11          | 209-12          | 228-22          | T #1-04         | 237-26          | 103-12-br       | T #3-08       | 142-16-br     | ETT II-32     |               |               | 218-12        | <b>227-01</b> |
| 9076059-04      | 9076053-10      | 9076055-19      | 9076052-08      | 9076043-17      | 9076052-01      | 9076048-17    | 9076053-07    | 9076051-09    | 9076043-22    | 9076051-13    | 9076049-15    |               |
| 237-04          | 218-10          | 226-19          | 211-08          | 106-17          | 211-01          | 139-17-br     | 218-07        | 209-09        | 106-22-br     | 209-13        | 142-15-br     | <b>227-03</b> |
| 9076064-26      | 9076059-02      | 9076044-01      | 9076051-17      | 9076062-23      | 9076057-12      | 9076064-28    | 9076052-18    | 9076055-04    | 9076043-23    | 9076057-27    | 9076065-09    |               |
| T #1-07         | 237-02          | 111-01          | 209-17          | ETT II-23       | 228-12          | T #1-09       | 211-18        | 226-04        | 106-23-br     | 228-27        | T #3-09       | <b>227-05</b> |
| 9076049-02      | 9076055-12      | 9076044-13      | 9076048-15      | 9076051-02      | 9076058-20      | 9076056-12    | 9076071-03    | Blank         | 9076055-17    | 9076061-13    | 9076059-10    |               |
| 142-02-br       | 226-12          | 111-13          | 139-15-br       | 209-02          | 236-20          | 227-12        | 567-03        |               | 226-17        | T ASII-13     | 237-10        | <b>227-07</b> |
| 9076049-04      | 9076053-14      | 9076065-44      | 9076063-49      | 9076061-37      | 9076060-12      | 9076048-18    | 9076047-08    | 9076063-43    | 9076046-22    | Blank         | Blank         |               |
| 142-04-br       | 218-14          | 1 1/4-3-26      | T B II-49       | T ASII-37       | 250-12          | 139-18-br     | 128-08        | T B II-43     | 122-22-br     |               |               | <b>227-09</b> |
| 9076048-14      | 9076062-07      | 9076047-16      | 9076055-06      | 9076056-27      | 9076050-04      | 9076064-21    | 9076045-12    | 9076043-21    | 9076058-14    | 9076065-07    | 9076052-20    |               |
| 139-14-br       | ETT II-07       | 128-16          | 226-06          | 227-27          | 151-04          | T #1-02       | 112-12        | 106-21-br     | 236-14        | T #3-07       | 211-20        | <b>227-14</b> |
| 9076042-14      | 9076052-15      | 9076058-05      | 9076055-20      | 9076058-22      | 9076049-01      | 9076044-06    | 9076061-42    | 9076045-16    | Blank         | 9076060-20    | 9076056-02    |               |
| 103-14-br       | 211-15          | 236-05          | 226-20          | 236-22          | 142-01-br       | 111-06        | T ASII-42     | 112-16        |               | 250-20        | 227-02        | <b>227-18</b> |
| 9076045-06      | 9076045-14      | 9076054-01      | 9076064-11      | 9076048-16      | 9076065-39      | 9076054-12    | 9076053-21    | 9076060-14    | 9076044-15    | Blank         | 9076057-21    |               |
| 112-06          | 112-14          | 219-01          | 13-1-11         | 139-16-br       | 1 1/4-3-21      | 219-12        | 218-21        | 250-14        | 111-15        |               | 228-21        | <b>227-19</b> |
| 9076065-43      | 9076046-04      | 9076043-11      | 9076054-07      | 9076060-21      | 9076054-05      | 9076043-20    | 9076062-04    | 9076052-23    | 9076056-24    | 9076055-22    | 9076052-10    |               |
| 1 1/4-3-25      | 122-04          | 106-11          | 219-07          | 250-21          | 219-05          | 106-20-br     | ETT II-04     | 211-23        | 227-24        | 226-22        | 211-10        | <b>227-21</b> |
| 9076056-13      | 9076063-05      | 9076051-07      | 9076057-08      | 9076047-13      | 9076061-23      | 9076057-14    | 9076047-15    | 9076059-08    | Blank         | 9076053-19    | 9076062-06    |               |
| 227-13          | T B II-05       | 209-07          | 228-08          | 128-13          | T ASII-23       | 228-14        | 128-15        | 237-08        |               | 218-19        | ETT II-06     | <b>227-23</b> |
| 9076061-01      | 9076064-24      | 9076060-25      | 9076045-05      | 9076043-07      | 9076053-25      | 9076051-20    | 9076059-06    | 9076049-14    | 9076059-09    | Blank         | 9076047-21    |               |
| T ASII-01       | T #1-05         | 250-25          | 112-05          | 106-07          | 218-25          | 209-20        | 237-06        | 142-14-br     | 237-09        |               | 128-21        | <b>227-29</b> |
| 9076046-11      | 9076062-13      | 9076056-11      | 9076062-14      | 9076044-07      | 9076042-15      | 9076060-23    | 9076046-20    | 9076063-04    | 9076047-10    | 9076062-09    | 9076063-54    |               |
| 122-11          | ETT II-13       | 227-11          | ETT II-14       | 111-07          | 103-15-br       | 250-23        | 122-20-br     | T B II-04     | 128-10        | ETT II-09     | T B II-54     | <b>142-19</b> |
| 9076058-23      | 9076057-02      | 9076050-15      | 9076050-13      | 9076056-10      | 9076045-01      | 9076066-03    | 9076050-16    | 9076046-21    | 9076058-10    | Blank         | 9076049-13    |               |
| 236-23          | 228-02          | 151-15          | 151-13          | 227-10          | 112-01          | 126-03        | 151-16        | 122-21-br     | 236-10        |               | 142-13-br     | <b>237-05</b> |
| 9076043-08      | 9076054-09      | 9076047-07      | 9076059-01      | 9076046-18      | 9076065-18      | 9076057-23    | 9076044-02    | 9076058-17    | Blank         | 9076063-06    | 9076061-02    |               |
| 106-08          | 219-09          | 128-07          | 237-01          | 122-18-br       | T #3-18         | 228-23        | 111-02        | 236-17        |               | T B II-06     | T ASII-02     | <b>237-07</b> |
| 9076063-02      | 9076060-15      | 9076061-43      | 9076049-03      | 9076047-18      | 9076046-19      | 9076061-14    | 9076058-19    | Blank         | Blank         | 9076064-37    | 9076064-36    |               |
| T B II-02       | 250-15          | T ASII-43       | 142-03-br       | 128-18          | 122-19-br       | T ASII-14     | 236-19        |               |               | T #1-04       | T #1-03       | <b>237-11</b> |
| <b>TASII-10</b> | <b>TASII-09</b> | <b>TASII-08</b> | <b>TASII-06</b> | <b>TASII-05</b> | <b>TASII-04</b> | <b>250-26</b> | <b>250-18</b> | <b>250-17</b> | <b>250-06</b> | <b>237-23</b> | <b>237-16</b> | <b>237-12</b> |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test   | Accession  | Previous ID   | Plant    | Height | Comments                |
|-------|-----|----------|--------|------------|---------------|----------|--------|-------------------------|
|       |     |          | Plant  | Number     | Number        | Survival |        |                         |
|       |     |          | (t,nt) |            |               |          | (0,1)  | cm                      |
| 1     | 1   | 1        | nt     | 9076038    | 130-R97       | 1        | 165.0  | 1997                    |
| 1     | 1   | 2        | t      | 9076052-22 | 211-22        | 1        | 62.0   |                         |
| 1     | 1   | 3        | t      | 9076046-05 | 122-5         | 1        | 255.0  |                         |
| 1     | 1   | 4        | nt     | 9076056-26 | 227-26-R97    | 1        | 230.0  | 1997                    |
| 1     | 1   | 5        | nt     | 9076045    | 112-R97       | 1        | 195.0  | 1995;1997; low fork     |
| 1     | 1   | 6        | t      | 9076055-18 | 226-18        | 1        | 360.0  |                         |
| 1     | 1   | 7        | t      | 9076043-18 | 106-18        | 0        |        | dead                    |
| 1     | 1   | 8        | t      | 9076058-6  | 236-6-R96     | 1        | 162.0  | 1996                    |
| 1     | 1   | 9        | t      | 9076045-07 | 112-7         | 1        | 460.0  | leaves 11/14/03         |
| 1     | 1   | 10       | nt     | 9076043-25 | 106-25-R97    | 1        | 176.0  | 1997                    |
| 1     | 1   | 11       | t      | 9076052-11 | 211-11        | 1        | 190.0  |                         |
| 1     | 1   | 12       | t      | 9076050-08 | 151-8         | 1        | 250.0  |                         |
| 1     | 1   | 13       | t      | 9076054-03 | 219-3         | 1        | 187.0  |                         |
| 1     | 1   | 14       | t      | 9076064-16 | 13-1-16       | 1        | 290.0  |                         |
| 1     | 1   | 15       | t      | 9076053-16 | 218-16        | 1        | 270.0  |                         |
| 1     | 1   | 16       | t      | 9076043-09 | 106-9         | 1        | 215.0  |                         |
| 1     | 2   | 1        | t      | 9076048-02 | 139-2         | 1        | 330.0  |                         |
| 1     | 2   | 2        | t      | 9076044-05 | 111-5         | 0        |        | weed badger blight 2003 |
| 1     | 2   | 3        | t      | 9076057-01 | 228-1         | 1        | 370.0  |                         |
| 1     | 2   | 4        | nt     | 9076065-13 | T#3-13-R97    | 1        | 185.0  | 1997,etiolated+M52      |
| 1     | 2   | 5        | t      | 9076050-01 | 151-1         | 1        | 230.0  |                         |
| 1     | 2   | 6        | t      | 9076065-45 | 1 1/4-3-27    | 1        | 370.0  |                         |
| 1     | 2   | 7        | t      | 9076048-08 | 139-8         | 1        | 270.0  |                         |
| 1     | 2   | 8        | t      | 9076055-01 | MT-226-1      | 1        | 435.0  |                         |
| 1     | 2   | 9        | t      | 9076059-28 | 237-28        | 1        | 225.0  |                         |
| 1     | 2   | 10       | t      | 9076064-02 | 13-1-2        | 1        | 62.0   |                         |
| 1     | 2   | 11       | t      | 9076047-01 | 128-1         | 1        | 140.0  |                         |
| 1     | 2   | 12       | t      | 9076054-13 | 219-13        | 0        |        | dead                    |
| 1     | 2   | 13       | t      | 9076059-24 | 237-24        | 1        | 190.0  |                         |
| 1     | 2   | 14       | t      | 9076058-25 | 236-25        | 1        | 270.0  |                         |
| 1     | 2   | 15       | t      | 9076063-10 | Tree B II-10  | 0        |        | dead                    |
| 1     | 2   | 16       | t      | 9076051-08 | 209-8         | 1        | 175.0  |                         |
| 1     | 3   | 1        | t      | 9076044-04 | 111-4         | 1        | 180.0  |                         |
| 1     | 3   | 2        | t      | 9076056-04 | 227-4         | 1        | 240.0  | corky                   |
| 1     | 3   | 3        | t      | 9076049-08 | 142-8         | 1        | 120.0  | bareroot;corky          |
| 1     | 3   | 4        | nt     | 9076060-24 | MT-250-24-R97 | 1        | 262.0  | 1997                    |
| 1     | 3   | 5        | t      | 9076047-04 | 128-4         | 1        | 290.0  | low fork                |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test   | Accession  | Previous ID  | Plant    | Survival | Height | Comments                    |  |
|-------|-----|----------|--------|------------|--------------|----------|----------|--------|-----------------------------|--|
|       |     |          | Plant  | Number     | Number       | Survival |          | cm     |                             |  |
|       |     |          | (t,nt) |            |              |          | (0,1)    | cm     |                             |  |
| 1     | 3   | 6        | t      | 9076063-07 | Tree B II-7  | 1        | 1        | 285.0  | low fork                    |  |
| 1     | 3   | 7        | nt     | 9076043-24 | 106-24-R97   | 1        | 1        | 310.0  | 1997                        |  |
| 1     | 3   | 8        | t      | 9076057-17 | 228-17       | 1        | 1        | 237.0  |                             |  |
| 1     | 3   | 9        | t      | 9076062-24 | E.T.T.II-24  | 1        | 1        | 345.0  |                             |  |
| 1     | 3   | 10       | t      | 9076053-05 | 218-5        | 1        | 1        | 390.0  |                             |  |
| 1     | 3   | 11       | t      | 9076045-13 | 112-13       | 1        | 1        | 50.0   |                             |  |
| 1     | 3   | 12       | t      | 9076042-11 | 103-11       | 1        | 1        | 278.0  |                             |  |
| 1     | 3   | 13       | t      | 9076049-18 | 142-18-R95   | 1        | 1        | 212.0  | 1995                        |  |
| 1     | 3   | 14       | t      | 9076046-10 | 122-10       | 1        | 1        | 225.0  | low fork,corky              |  |
| 1     | 3   | 15       | t      | 9076051-06 | 209-6        | 1        | 1        | 120.0  |                             |  |
| 1     | 3   | 16       | t      | 9076060-19 | 250-19       | 1        | 1        | 165.0  | etiolated                   |  |
| 2     | 1   | 1        | t      | 9076050-12 | 151-12       | 1        | 1        | 345.0  |                             |  |
| 2     | 1   | 2        | t      | 9076054-11 | 219-11       | 1        | 1        | 87.0   |                             |  |
| 2     | 1   | 3        | t      | 9076056-22 | 227-22       | 1        | 1        | 390.0  | corky                       |  |
| 2     | 1   | 4        | t      | 9076058-21 | 236-21       | 1        | 1        | 255.0  | corky                       |  |
| 2     | 1   | 5        | t      | 9076060-05 | 250-5        | 1        | 1        | 335.0  |                             |  |
| 2     | 1   | 6        | t      | 9076048-10 | 139-10       | 1        | 1        | 270.0  | corky                       |  |
| 2     | 1   | 7        | t      | 9076051-11 | 209-11       | 1        | 1        | 287.0  |                             |  |
| 2     | 1   | 8        | t      | 9076059-17 | 237-17       | 1        | 1        | 290.0  | corky,*Vexar branch problem |  |
| 2     | 1   | 9        | t      | 9076062-08 | E.T.T.II-8   | 1        | 1        | 100.0  | poorly planted              |  |
| 2     | 1   | 10       | t      | 9076047-11 | 128-11       | 1        | 1        | 285.0  |                             |  |
| 2     | 1   | 11       | t      | 9076065-40 | 1 1/4-3-22   | 1        | 1        | 305.0  |                             |  |
| 2     | 1   | 12       | nt     | 9076063-35 | T.BII-35-R97 | 1        | 1        | 275.0  | 1997;forked low             |  |
| 2     | 1   | 13       | t      | 9076048-04 | 139-4        | 1        | 1        | 310.0  |                             |  |
| 2     | 1   | 14       | t      | 9076042-05 | 103-5        | 1        | 1        | 137.0  |                             |  |
| 2     | 1   | 15       | t      | 9076045-10 | 112-10       | 1        | 1        | 362.0  |                             |  |
| 2     | 1   | 16       | t      | 9076049-10 | 142-10       | 1        | 1        | 135.0  | barer;corky                 |  |
| 2     | 2   | 1        | t      | 9076063-15 | Tree B II-15 | 1        | 1        | 330.0  | exc. form, but low fork?    |  |
| 2     | 2   | 2        | t      | 9076045-04 | 112-4        | 1        | 1        | 325.0  | leaf retention 11/14/03     |  |
| 2     | 2   | 3        | nt     | Blank      | Blank        | 0        |          |        | dead 1998                   |  |
| 2     | 2   | 4        | t      | 9076052-07 | 211-7        | 1        | 1        | 310.0  |                             |  |
| 2     | 2   | 5        | t      | 9076057-05 | 228-5        | 1        | 1        | 320.0  |                             |  |
| 2     | 2   | 6        | nt     | 9076072-4  | 3/4-C-4-R97  | 1        | 1        | 242.0  | 1997;low fork               |  |
| 2     | 2   | 7        | t      | 9076060-09 | 250-9        | 1        | 1        | 200.0  | etiolated                   |  |
| 2     | 2   | 8        | t      | 9076064-12 | 13-1-12      | 1        | 1        | 135.0  |                             |  |
| 2     | 2   | 9        | t      | 9076055-08 | 226-8        | 1        | 1        | 290.0  |                             |  |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test<br>Plant | Accession<br>Number | Previous ID<br>Number | Plant<br>Survival | Height<br>cm | Comments          |
|-------|-----|----------|---------------|---------------------|-----------------------|-------------------|--------------|-------------------|
|       |     |          | (t,nt)        |                     |                       | (0,1)             |              |                   |
| 2     | 2   | 10       | t             | 9076053-03          | 218-3                 | 1                 | 450.0        |                   |
| 2     | 2   | 11       | t             | 9076047-02          | 128-2                 | 1                 | 60.0         |                   |
| 2     | 2   | 12       | t             | 9076051-10          | 209-10                | 1                 | 25.0         |                   |
| 2     | 2   | 13       | t             | 9076046-09          | 122-9                 | 1                 | 152.0        | etiolated         |
| 2     | 2   | 14       | t             | 9076050-02          | 151-2                 | 1                 | 420.0        | bean pole shape   |
| 2     | 2   | 15       | nt            | 9076063-39          | T.B.II-39-R97         | 1                 | 200.0        | 1997              |
| 2     | 2   | 16       | t             | 9076061-30          | Tree AS II-30         | 1                 | 320.0        |                   |
| 2     | 3   | 1        | t             | 9076043-06          | 106-6                 | 1                 | 300.0        |                   |
| 2     | 3   | 2        | nt            | 9076063-37          | T.B.II-37-R97         | 1                 | 212.0        | 1997              |
| 2     | 3   | 3        | t             | 9076044-11          | 111-11                | 1                 | 265.0        | forked low        |
| 2     | 3   | 4        | t             | 9076049-11          | 142-11                | 0                 |              | bareroot;dead     |
| 2     | 3   | 5        | t             | 9076044-03          | 111-3                 | 1                 | 330.0        |                   |
| 2     | 3   | 6        | t             | 9076042-03          | 103-3                 | 1                 | 218.0        | narrow            |
| 2     | 3   | 7        | t             | 9076053-06          | 218-6                 | 1                 | 250.0        |                   |
| 2     | 3   | 8        | t             | 9076058-13          | 236-13                | 0                 |              | dead              |
| 2     | 3   | 9        | t             | 9076046-15          | 122-15                | 1                 | 227.0        |                   |
| 2     | 3   | 10       | t             | 9076052-06          | 211-6                 | 1                 | 245.0        |                   |
| 2     | 3   | 11       | t             | 9076043-16          | 106-16                | 1                 | 25.0         | barely alive      |
| 2     | 3   | 12       | t             | 9076056-20          | 227-20                | 1                 | 190.0        |                   |
| 2     | 3   | 13       | t             | 9076061-39          | Tree AS II-39         | 1                 | 180.0        |                   |
| 2     | 3   | 14       | t             | 9076055-05          | 226-5                 | 1                 | 377.0        | narrow            |
| 2     | 3   | 15       | t             | 9076063-13          | Tree B II-13          | 0                 |              | dead              |
| 2     | 3   | 16       | t             | 9076057-11          | 228-11                | 1                 | 287.0        |                   |
| 3     | 1   | 1        | t             | 9076051-23          | 209-23                | 1                 | 68.0         | deer broke leader |
| 3     | 1   | 2        | t             | 9076060-08          | 250-8                 | 1                 | 55.0         |                   |
| 3     | 1   | 3        | t             | 9076062-10          | E.T.T.II-10           | 1                 | 270.0        | low fork          |
| 3     | 1   | 4        | t             | 9076065-06          | Tree #3-6             | 1                 | 227.0        |                   |
| 3     | 1   | 5        | t             | 9076061-16          | Tree AS II-16         | 1                 | 315.0        |                   |
| 3     | 1   | 6        | t             | 9076062-11          | E.T.T.II-11           | 1                 | 278.0        | low fork          |
| 3     | 1   | 7        | t             | 9076050-09          | 151-9                 | 1                 | 80.0         |                   |
| 3     | 1   | 8        | t             | 9076052-02          | 211-2                 | 1                 | 226.0        |                   |
| 3     | 1   | 9        | t             | 9076058-09          | 236-9                 | 1                 | 365.0        |                   |
| 3     | 1   | 10       | t             | 9076063-11          | Tree B II-11          | 1                 | 160.0        | etiolated         |
| 3     | 1   | 11       | t             | 9076044-08          | 111-8                 | 1                 | 352.0        |                   |
| 3     | 1   | 12       | t             | 9076054-08          | 219-8                 | 0                 |              | dead              |
| 3     | 1   | 13       | t             | 9076048-05          | 139-5                 | 1                 | 322.0        |                   |
| 3     | 1   | 14       | t             | 9076047-05          | 128-5                 | 1                 | 280.0        | low fork          |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test   | Accession  | Previous ID  | Plant    | Survival | Height | Comments                   |
|-------|-----|----------|--------|------------|--------------|----------|----------|--------|----------------------------|
|       |     |          | Plant  | Number     | Number       | Survival |          |        |                            |
|       |     |          | (t,nt) |            |              |          | (0,1)    | cm     |                            |
| 3     | 1   | 15       | t      | 9076045-02 | 112-2        |          | 1        | 330.0  | low fork, *87.98 w/o swell |
| 3     | 1   | 16       | t      | 9076060-22 | 250-22       |          | 1        | 302.0  |                            |
| 3     | 2   | 1        | t      | 9076051-16 | 209-16       |          | 1        | 62.0   | deer broke leader          |
| 3     | 2   | 2        | t      | 9076047-03 | 128-3        |          | 0        |        | dead                       |
| 3     | 2   | 3        | t      | 9076044-09 | 111-9        |          | 1        | 430.0  |                            |
| 3     | 2   | 4        | t      | 9076046-?  | 122-?-R96    |          | 1        | 175.0  | 1996                       |
| 3     | 2   | 5        | t      | 9076057-16 | 228-16       |          | 1        | 376.0  | *Vexar branch problem      |
| 3     | 2   | 6        | t      | 9076064-14 | 13-1-14      |          | 1        | 334.0  |                            |
| 3     | 2   | 7        | t      | 9076043-04 | 106-4        |          | 1        | 385.0  | low fork                   |
| 3     | 2   | 8        | t      | 9076057-07 | 228-7        |          | 1        | 248.0  |                            |
| 3     | 2   | 9        | t      | 9076059-15 | 237-15       |          | 1        | 248.0  |                            |
| 3     | 2   | 10       | t      | 9076050-05 | 151-5        |          | 1        | 255.0  |                            |
| 3     | 2   | 11       | t      | 9076056-15 | 227-15       |          | 1        | 250.0  |                            |
| 3     | 2   | 12       | t      | 9076055-02 | 226-2        |          | 1        | 280.0  |                            |
| 3     | 2   | 13       | t      | 9076054-02 | 219-2        |          | 1        | 175.0  | etiolated                  |
| 3     | 2   | 14       | t      | 9076053-04 | 218-4        |          | 1        | 215.0  | low forks                  |
| 3     | 2   | 15       | t      | 9076046-13 | 122-13       |          | 0        |        | dead                       |
| 3     | 2   | 16       | t      | 9076058-02 | 236-2        |          | 1        | 200.0  |                            |
| 3     | 3   | 1        | t      | 9076043-14 | 106-14       |          | 1        | 155.0  |                            |
| 3     | 3   | 2        | nt     | 9076053-20 | 218-20-R97   |          | 1        | 290.0  | 1997                       |
| 3     | 3   | 3        | t      | 9076042-04 | 103-4        |          | 1        | 220.0  |                            |
| 3     | 3   | 4        | nt     | 9076063-24 | T.BII-24-R97 |          | 1        | 124.0  | 1997                       |
| 3     | 3   | 5        | t      | 9076045-21 | 112-21       |          | 1        | 227.0  |                            |
| 3     | 3   | 6        | t      | 9076048-01 | 139-1        |          | 0        |        | dead                       |
| 3     | 3   | 7        | t      | 9076056-28 | 227-28       |          | 0        |        | dead                       |
| 3     | 3   | 8        | t      | 9076063-41 | Tree B II-41 |          | 1        | 65.0   |                            |
| 3     | 3   | 9        | t      | 9076064-18 | 13-1-18      |          | 0        |        | dead 2003                  |
| 3     | 3   | 10       | nt     | Blank      | Blank        |          | 0        |        | dead 1998                  |
| 3     | 3   | 11       | t      | 9076052-12 | 211-12       |          | 1        | 183.0  |                            |
| 3     | 3   | 12       | t      | 9076042-10 | 103-10       |          | 1        | 110.0  | heavy deer damage          |
| 3     | 3   | 13       | nt     | 9076049-29 | 142-29-R97   |          | 1        | 187.0  | bareroot;1997              |
| 3     | 3   | 14       | t      | 9076049-12 | 142-12       |          | 1        | 100.0  | bareroot                   |
| 3     | 3   | 15       | nt     | 9076049-3  | 11/2-2-3-R97 |          | 1        | 295.0  | 1997                       |
| 3     | 3   | 16       | t      | 9076059-03 | 237-3        |          | 0        |        | dead                       |
| 4     | 1   | 1        | t      | 9076052-03 | 211-3        |          | 1        | 155.0  |                            |
| 4     | 1   | 2        | t      | 9076054-14 | 219-14       |          | 1        | 326.0  |                            |
| 4     | 1   | 3        | t      | 9076056-16 | 227-16       |          | 1        | 450.0  | low fork                   |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test<br>Plant<br>(t,nt) | Accession<br>Number | Previous ID<br>Number | Plant<br>Survival<br>(0,1) | Height<br>cm | Comments              |
|-------|-----|----------|-------------------------|---------------------|-----------------------|----------------------------|--------------|-----------------------|
| 4     | 1   | 4        | t                       | 9076043-10          | 106-10                | 0                          |              | dead 2003             |
| 4     | 1   | 5        | t                       | 9076055-15          | 226-15                | 1                          | 425.0        | *Vexar branch problem |
| 4     | 1   | 6        | t                       | 9076064-13          | 13-1-13               | 1                          | 385.0        |                       |
| 4     | 1   | 7        | t                       | 9076059-19          | 237-19                | 1                          | 352.0        | low fork              |
| 4     | 1   | 8        | t                       | 9076063-46          | Tree B II-46          | 1                          | 377.0        |                       |
| 4     | 1   | 9        | t                       | 9076060-03          | 250-3                 | 1                          | 252.0        |                       |
| 4     | 1   | 10       | t                       | 9076055-13          | 226-13                | 1                          | 440.0        | corky                 |
| 4     | 1   | 11       | t                       | 9076065-11          | Tree #3-11            | 1                          | 210.0        |                       |
| 4     | 1   | 12       | t                       | 9076045-15          | 112-15                | 1                          | 290.0        |                       |
| 4     | 1   | 13       | t                       | 9076064-29          | Tree #1-10            | 1                          | 130.0        |                       |
| 4     | 1   | 14       | t                       | 9076063-03          | Tree B II-3           | 1                          | 305.0        | small dead leaves??   |
| 4     | 1   | 15       | t                       | 9076051-21          | 209-21-R95            | 1                          | 148.0        | 1995                  |
| 4     | 1   | 16       | t                       | 9076051-03          | 209-3-R95             | 1                          | 185.0        | 1995                  |
| 4     | 2   | 1        | t                       | 9076052-04          | 211-4                 | 0                          |              | dead                  |
| 4     | 2   | 2        | t                       | 9076056-17          | 227-17                | 0                          |              | dead                  |
| 4     | 2   | 3        | t                       | 9076053-13          | 218-13                | 1                          | 350.0        |                       |
| 4     | 2   | 4        | t                       | 9076061-21          | Tree AS II-21         | 1                          | 380.0        | high fork             |
| 4     | 2   | 5        | t                       | 9076043-19          | 106-19                | 1                          | 33.0         |                       |
| 4     | 2   | 6        | t                       | 9076065-01          | Tree #3-1             | 1                          | 196.0        |                       |
| 4     | 2   | 7        | t                       | 9076045-18          | 112-18                | 0                          |              | dead                  |
| 4     | 2   | 8        | t                       | 9076058-24          | 236-24                | 1                          | 47.0         | barely alive          |
| 4     | 2   | 9        | t                       | 9076042-09          | 103-09                | 1                          | 335.0        |                       |
| 4     | 2   | 10       | t                       | 9076047-22          | 128-22                | 1                          | 300.0        |                       |
| 4     | 2   | 11       | t                       | 9076048-06          | 139-6                 | 1                          | 220.0        |                       |
| 4     | 2   | 12       | nt                      | 9076065-24          | 1/4-3-24-R97          | 1                          | 300.0        | 1996;1997             |
| 4     | 2   | 13       | t                       | 9076044-10          | 111-10                | 1                          | 376.0        |                       |
| 4     | 2   | 14       | t                       | 9076060-13          | 250-13                | 1                          | 225.0        |                       |
| 4     | 2   | 15       | t                       | 9076053-18          | 218-18                | 1                          | 190.0        |                       |
| 4     | 2   | 16       | nt                      | 9076058-15          | 236-15NT-R95          | 1                          | 245.0        | 1995;nontest;         |
| 4     | 3   | 1        | t                       | 9076042-08          | 103-8                 | 1                          | 302.0        |                       |
| 4     | 3   | 2        | t                       | 9076050-03          | 151-3                 | 1                          | 285.0        | low fork              |
| 4     | 3   | 3        | t                       | 9076059-27          | 237-27                | 1                          | 105.0        |                       |
| 4     | 3   | 4        | t                       | 9076048-09          | 139-9                 | 1                          | 407.0        | low fork              |
| 4     | 3   | 5        | t                       | 9076047-14          | 128-14                | 1                          | 303.0        | low fork              |
| 4     | 3   | 6        | t                       | 9076046-08          | 122-8                 | 1                          | 268.0        |                       |
| 4     | 3   | 7        | t                       | 9076057-04          | 228-4                 | 1                          | 302.0        |                       |
| 4     | 3   | 8        | t                       | 9076057-03          | 228-3                 | 1                          | 175.0        | low fork              |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test   | Accession  | Previous ID   | Plant    | Survival | Height | Comments       |        |
|-------|-----|----------|--------|------------|---------------|----------|----------|--------|----------------|--------|
|       |     |          | Plant  | Number     | Number        | Survival |          |        |                | Height |
|       |     |          | (t,nt) |            |               |          | (0,1)    | cm     |                |        |
| 4     | 3   | 9        | t      | 9076046-12 | 122-12        | 1        | 260.0    |        |                |        |
| 4     | 3   | 10       | t      | 9076044-12 | 111-12        | 1        | 100.0    |        |                |        |
| 4     | 3   | 11       | t      | 9076050-14 | 151-14        | 1        | 425.0    |        |                |        |
| 4     | 3   | 12       | t      | 9076062-39 | E.T.T.II-39   | 1        | 287.0    |        |                |        |
| 4     | 3   | 13       | t      | 9076058-16 | 236-16        | 1        | 55.0     |        |                |        |
| 4     | 3   | 14       | t      | 9076062-12 | E.T.T.II-12   | 1        | 280.0    |        |                |        |
| 4     | 3   | 15       | t      | 9076061-24 | Tree AS II-24 | 1        | 280.0    |        | low fork       |        |
| 4     | 3   | 16       | t      | 9076049-05 | 142-5         | 1        | 224.0    |        | bareroot       |        |
| 5     | 1   | 1        | t      | 9076063-02 | Tree B II-2   | 1        | 296.0    |        | low fork       |        |
| 5     | 1   | 2        | t      | 9076043-08 | 106-8         | 1        | 276.0    |        |                |        |
| 5     | 1   | 3        | t      | 9076058-23 | 236-23        | 1        | 262.0    |        | low fork       |        |
| 5     | 1   | 4        | nt     | 9076060-11 | 250-11-R97    | 1        | 170.0    |        | 1997           |        |
| 5     | 1   | 5        | t      | 9076061-14 | Tree AS II-14 | 1        | 240.0    |        |                |        |
| 5     | 1   | 6        | t      | 9076056-13 | 227-13        | 1        | 390.0    |        | low fork       |        |
| 5     | 1   | 7        | t      | 9076065-43 | 1 1/4-3-25    | 1        | 95.0     |        |                |        |
| 5     | 1   | 8        | t      | 9076045-06 | 112-6         | 1        | 400.0    |        | low fork       |        |
| 5     | 1   | 9        | nt     | Blank      | Blank         | 0        |          |        | 1995, dead     |        |
| 5     | 1   | 10       | t      | 9076048-14 | 139-14        | 1        | 177.0    |        | bareroot       |        |
| 5     | 1   | 11       | t      | 9076049-04 | 142-04        | 1        | 220.0    |        | bareroot       |        |
| 5     | 1   | 12       | nt     | Blank      | Blank         | 1        | 37.0     |        | bareroot;alive |        |
| 5     | 1   | 13       | t      | 9076064-26 | Tree #1-7     | 1        | 360.0    |        |                |        |
| 5     | 1   | 14       | t      | 9076059-04 | 237-4         | 1        | 360.0    |        |                |        |
| 5     | 1   | 15       | t      | 9076050-11 | 151-11        | 1        | 249.0    |        |                |        |
| 5     | 1   | 16       | nt     | 9076066-01 | 126-1-R95     | 1        | 277.0    |        | 1995           |        |
| 5     | 2   | 1        | t      | 9076060-15 | 250-15        | 1        | 348.0    |        |                |        |
| 5     | 2   | 2        | t      | 9076054-09 | 219-9         | 1        | 280.0    |        | low fork       |        |
| 5     | 2   | 3        | t      | 9076057-02 | 228-2         | 1        | 258.0    |        |                |        |
| 5     | 2   | 4        | t      | 9076062-13 | E.T.T.II-13   | 1        | 390.0    |        |                |        |
| 5     | 2   | 5        | t      | 9076064-24 | Tree #1-5     | 1        | 326.0    |        |                |        |
| 5     | 2   | 6        | t      | 9076063-05 | Tree B II-5   | 1        | 227.0    |        |                |        |
| 5     | 2   | 7        | t      | 9076046-04 | 122-4         | 1        | 287.0    |        |                |        |
| 5     | 2   | 8        | t      | 9076045-14 | 112-14        | 1        | 199.0    |        |                |        |
| 5     | 2   | 9        | t      | 9076052-15 | 211-15        | 1        | 235.0    |        |                |        |
| 5     | 2   | 10       | t      | 9076062-07 | E.T.T.II-7    | 1        | 307.0    |        | low fork       |        |
| 5     | 2   | 11       | t      | 9076053-14 | 218-14        | 1        | 310.0    |        | low fork       |        |
| 5     | 2   | 12       | t      | 9076055-12 | 226-12        | 1        | 290.0    |        |                |        |
| 5     | 2   | 13       | nt     | Blank      | Blank         | 0        |          |        | dead           |        |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test   | Accession  | Previous ID   | Plant    | Height | Comments                |
|-------|-----|----------|--------|------------|---------------|----------|--------|-------------------------|
|       |     |          | Plant  | Number     | Number        | Survival |        |                         |
|       |     |          | (t,nt) |            |               |          | (0,1)  | cm                      |
| 5     | 2   | 14       | t      | 9076053-10 | 218-10        | 1        | 300.0  |                         |
| 5     | 2   | 15       | t      | 9076051-12 | 209-12        | 1        | 145.0  | etiolated               |
| 5     | 2   | 16       | nt     | 9076066-02 | 126-2-R95     | 1        | 80.0   | 1995                    |
| 5     | 3   | 1        | t      | 9076061-43 | Tree AS II-43 | 1        | 325.0  | low fork                |
| 5     | 3   | 2        | t      | 9076047-07 | 128-7         | 1        | 397.0  |                         |
| 5     | 3   | 3        | t      | 9076050-15 | 151-15        | 1        | 328.0  |                         |
| 5     | 3   | 4        | t      | 9076056-11 | 227-11        | 1        | 271.0  |                         |
| 5     | 3   | 5        | t      | 9076060-25 | 250-25        | 1        | 342.0  |                         |
| 5     | 3   | 6        | t      | 9076051-07 | 209-7         | 1        | 132.0  |                         |
| 5     | 3   | 7        | t      | 9076043-11 | 106-11        | 1        | 220.0  |                         |
| 5     | 3   | 8        | nt     | Blank      | Blank         | 0        |        | dead                    |
| 5     | 3   | 9        | t      | 9076058-05 | 236-5         | 0        |        | dead                    |
| 5     | 3   | 10       | t      | 9076047-16 | 128-16        | 1        | 351.0  | low fork                |
| 5     | 3   | 11       | t      | 9076065-44 | 1 1/4-3-26    | 1        | 202.0  |                         |
| 5     | 3   | 12       | t      | 9076044-13 | 111-13        | 1        | 370.0  |                         |
| 5     | 3   | 13       | t      | 9076044-01 | 111-1         | 1        | 52.0   |                         |
| 5     | 3   | 14       | t      | 9076055-19 | 226-19        | 1        | 85.0   |                         |
| 5     | 3   | 15       | nt     | Blank      | Blank         | 0        |        | dead 1998               |
| 5     | 3   | 16       | nt     | 9076067-01 | 127-1-R95     | 1        | 230.0  | 1995                    |
| 6     | 1   | 1        | t      | 9076049-03 | 142-3         | 1        | 228.0  | barer;dk bark, v. corky |
| 6     | 1   | 2        | t      | 9076059-01 | 237-1         | 1        | 237.0  | low fork                |
| 6     | 1   | 3        | t      | 9076050-13 | 151-13        | 1        | 370.0  |                         |
| 6     | 1   | 4        | t      | 9076062-14 | E.T.T.II-14   | 1        | 310.0  | v. corky                |
| 6     | 1   | 5        | t      | 9076045-05 | 112-5         | 1        | 226.0  |                         |
| 6     | 1   | 6        | t      | 9076057-08 | 228-8         | 1        | 412.0  | exceptionally nice      |
| 6     | 1   | 7        | t      | 9076054-07 | 219-7         | 1        | 299.0  |                         |
| 6     | 1   | 8        | t      | Blank      | Blank         | 0        |        | dead 1998               |
| 6     | 1   | 9        | t      | 9076055-20 | 226-20        | 1        | 302.0  |                         |
| 6     | 1   | 10       | t      | 9076055-06 | 226-6         | 1        | 290.0  |                         |
| 6     | 1   | 11       | t      | 9076063-49 | Tree B II-49  | 1        | 349.0  | low fork                |
| 6     | 1   | 12       | t      | 9076048-15 | 139-15        | 1        | 280.0  | bareroot                |
| 6     | 1   | 13       | t      | 9076051-17 | 209-17        | 1        | 130.0  | rub, *dead leader       |
| 6     | 1   | 14       | t      | 9076052-08 | 211-8         | 1        | 260.0  |                         |
| 6     | 1   | 15       | t      | 9076064-23 | Tree #1-4     | 1        | 137.0  |                         |
| 6     | 1   | 16       | t      | 9076053-22 | 218-22        | 1        | 222.0  | low fork                |
| 6     | 2   | 1        | t      | 9076047-18 | 128-18        | 1        | 275.0  |                         |
| 6     | 2   | 2        | t      | 9076046-18 | 122-18        | 1        | 309.0  | bareroot;dk, corky bark |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test<br>Plant<br>(t,nt) | Accession<br>Number | Previous ID<br>Number | Plant<br>Survival<br>(0,1) | Height<br>cm | Comments                    |
|-------|-----|----------|-------------------------|---------------------|-----------------------|----------------------------|--------------|-----------------------------|
| 6     | 2   | 3        | t                       | 9076056-10          | 227-10                | 1                          | 269.0        |                             |
| 6     | 2   | 4        | t                       | 9076044-07          | 111-7                 | 1                          | 352.0        | low forks                   |
| 6     | 2   | 5        | t                       | 9076043-07          | 106-7                 | 1                          | 355.0        |                             |
| 6     | 2   | 6        | t                       | 9076047-13          | 128-13                | 1                          | 138.0        | low fork                    |
| 6     | 2   | 7        | t                       | 9076060-21          | 250-21                | 1                          | 306.0        | low fork                    |
| 6     | 2   | 8        | t                       | 9076048-16          | 139-16                | 1                          | 306.0        | bareroot;corky, low fork    |
| 6     | 2   | 9        | t                       | 9076058-22          | 236-22                | 1                          | 307.0        |                             |
| 6     | 2   | 10       | t                       | 9076056-27          | 227-27                | 1                          | 212.0        |                             |
| 6     | 2   | 11       | t                       | 9076061-37          | Tree AS II-37         | 1                          | 313.0        |                             |
| 6     | 2   | 12       | t                       | 9076051-02          | 209-2                 | 1                          | 276.0        | corky                       |
| 6     | 2   | 13       | t                       | 9076062-23          | E.T.T.II-23           | 1                          | 423.0        |                             |
| 6     | 2   | 14       | t                       | 9076043-17          | 106-17                | 1                          | 248.0        |                             |
| 6     | 2   | 15       | t                       | 9076059-26          | 237-26                | 1                          | 225.0        |                             |
| 6     | 2   | 16       | t                       | 9076063-01          | Tree B II-1           | 1                          | 227.0        |                             |
| 6     | 3   | 1        | t                       | 9076046-19          | 122-19                | 1                          | 277.0        |                             |
| 6     | 3   | 2        | t                       | 9076065-18          | Tree #3-18            | 1                          | 229.0        | low fork                    |
| 6     | 3   | 3        | t                       | 9076045-01          | 112-1                 | 1                          | 337.0        |                             |
| 6     | 3   | 4        | t                       | 9076042-15          | 103-15                | 1                          | 148.0        | bareroot;low fork,etiolated |
| 6     | 3   | 5        | t                       | 9076053-25          | 218-25                | 1                          | 362.0        |                             |
| 6     | 3   | 6        | t                       | 9076061-23          | Tree AS II-23         | 1                          | 297.0        | low forks                   |
| 6     | 3   | 7        | t                       | 9076054-05          | 219-5                 | 1                          |              | v. small                    |
| 6     | 3   | 8        | t                       | 9076065-39          | 1 1/4-3-21            | 1                          | 303.0        |                             |
| 6     | 3   | 9        | t                       | 9076049-01          | 142-1                 | 0                          |              | bareroot; dead              |
| 6     | 3   | 10       | t                       | 9076050-04          | 151-4                 | 1                          | 345.0        | high fork                   |
| 6     | 3   | 11       | t                       | 9076060-12          | 250-12                | 1                          | 141.0        | etiolated                   |
| 6     | 3   | 12       | t                       | 9076058-20          | 236-20                | 0                          |              | dead                        |
| 6     | 3   | 13       | t                       | 9076057-12          | 228-12                | 1                          | 382.0        |                             |
| 6     | 3   | 14       | t                       | 9076052-01          | 211-01                | 1                          | 378.0        | 3-4 caps                    |
| 6     | 3   | 15       | nt                      | Blank               | Blank                 | 0                          |              | 1995;nontest;dead           |
| 6     | 3   | 16       | t                       | 9076044-14          | 111-14                | 1                          | 273.0        |                             |
| 7     | 1   | 1        | nt                      | Blank               | Blank                 | 0                          |              | dead                        |
| 7     | 1   | 2        | t                       | 9076057-23          | 228-23                | 1                          | 324.0        | low fork                    |
| 7     | 1   | 3        | nt                      | Blank               | Blank                 | 0                          |              | 1995                        |
| 7     | 1   | 4        | t                       | 9076060-23          | 250-23                | 1                          | 269.0        |                             |
| 7     | 1   | 5        | t                       | 9076051-20          | 209-20                | 1                          | 177.0        | low fork                    |
| 7     | 1   | 6        | t                       | 9076057-14          | 228-14                | 1                          | 406.0        |                             |
| 7     | 1   | 7        | t                       | 9076043-20          | 106-20                | 1                          | 405.0        | bareroot                    |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test   | Accession  | Previous ID   | Plant    | Survival | Height | Comments                    |  |
|-------|-----|----------|--------|------------|---------------|----------|----------|--------|-----------------------------|--|
|       |     |          | Plant  | Number     | Number        | Survival |          | cm     |                             |  |
|       |     |          | (t,nt) |            |               |          | (0,1)    |        |                             |  |
| 7     | 1   | 8        | t      | 9076054-12 | 219-12        | 1        | 150.0    |        | *dead leader                |  |
| 7     | 1   | 9        | t      | 9076044-06 | 111-6         | 1        | 285.0    |        |                             |  |
| 7     | 1   | 10       | t      | 9076064-21 | Tree #1-2     | 1        | 176.0    |        | low fork, etiolated         |  |
| 7     | 1   | 11       | nt     | 9076066-06 | 126-6         | 1        | 262.0    |        | 1995,*vexar problem         |  |
| 7     | 1   | 12       | t      | 9076056-12 | 227-12        | 1        | 345.0    |        |                             |  |
| 7     | 1   | 13       | t      | 9076064-28 | Tree #1-9     | 1        | 92.0     |        | low fork, short             |  |
| 7     | 1   | 14       | nt     | Blank      | Blank         | 0        |          |        | 1996; dead                  |  |
| 7     | 1   | 15       | t      | 9076065-08 | Tree #3-8     | 1        | 400.0    |        |                             |  |
| 7     | 1   | 16       | t      | 9076065-17 | Tree #3-17    | 1        | 260.0    |        | few                         |  |
| 7     | 2   | 1        | nt     | Blank      | Blank         | 0        |          |        | dead                        |  |
| 7     | 2   | 2        | t      | 9076044-02 | 111-2         | 1        | 350.0    |        | *vexar                      |  |
| 7     | 2   | 3        | t      | 9076050-16 | 151-16        | 1        | 50.0     |        |                             |  |
| 7     | 2   | 4        | t      | 9076046-20 | 122-20        | 1        | 239.0    |        | bareroot                    |  |
| 7     | 2   | 5        | t      | 9076059-06 | 237-6         | 1        | 151.0    |        | *dead leader                |  |
| 7     | 2   | 6        | t      | 9076047-15 | 120-15        | 1        | 332.0    |        | low fork                    |  |
| 7     | 2   | 7        | t      | 9076062-04 | E.T.T.II-42   | 1        | 172.0    |        |                             |  |
| 7     | 2   | 8        | t      | 9076053-21 | 218-21        | 1        | 294.0    |        | high fork                   |  |
| 7     | 2   | 9        | t      | 9076061-42 | Tree AS II-42 | 1        | 162.0    |        | etiolated                   |  |
| 7     | 2   | 10       | t      | 9076045-12 | 112-12        | 1        | 473.0    |        |                             |  |
| 7     | 2   | 11       | t      | 9076047-08 | 128-8         | 1        | 251.0    |        |                             |  |
| 7     | 2   | 12       | nt     | Blank      | Blank         | 0        |          |        | 1995                        |  |
| 7     | 2   | 13       | t      | 9076052-18 | 211-18        | 1        | 345.0    |        | dark, corky                 |  |
| 7     | 2   | 14       | t      | 9076053-07 | 218-7         | 1        | 362.0    |        |                             |  |
| 7     | 2   | 15       | t      | 9076049-16 | 142-16        | 1        | 180.0    |        | bareroot; lo fork,etiolated |  |
| 7     | 2   | 16       | t      | 9076055-16 | 226-16        | 1        | 177.0    |        | etiolated                   |  |
| 7     | 3   | 1        | nt     | 9076067-04 | 127-4         | 1        | 216.0    |        | 1995; low fork              |  |
| 7     | 3   | 2        | t      | 9076058-17 | 236-17        | 1        | 302.0    |        | narrow,*vexar problem       |  |
| 7     | 3   | 3        | t      | 9076046-21 | 122-21        | 1        | 311.0    |        | bareroot                    |  |
| 7     | 3   | 4        | t      | 9076063-04 | Tree B II-4   | 1        | 215.0    |        |                             |  |
| 7     | 3   | 5        | t      | 9076049-14 | 142-14        | 1        | 234.0    |        | very corky                  |  |
| 7     | 3   | 6        | t      | 9076059-08 | 237-8         | 1        | 306.0    |        |                             |  |
| 7     | 3   | 7        | t      | 9076052-23 | 211-23        | 1        | 91.0     |        | low fork                    |  |
| 7     | 3   | 8        | t      | 9076060-14 | 250-14        | 1        | 270.0    |        | *vexar problem              |  |
| 7     | 3   | 9        | t      | 9076045-16 | 112-16        | 1        | 35.0     |        |                             |  |
| 7     | 3   | 10       | t      | 9076043-21 | 106-21        | 1        | 222.0    |        | bareroot                    |  |
| 7     | 3   | 11       | t      | 9076063-43 | Tree B II-43  | 1        | 202.0    |        |                             |  |
| 7     | 3   | 12       | nt     | 9076067-02 | 127-2         | 1        | 230.0    |        | 1995                        |  |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

| Block | Row | Position | Test   | Accession  | Previous ID   | Plant    | Survival | Height                  | Comments |  |
|-------|-----|----------|--------|------------|---------------|----------|----------|-------------------------|----------|--|
|       |     |          | Plant  | Number     | Number        | Survival |          | Height                  |          |  |
|       |     |          | (t,nt) |            |               |          | (0,1)    | cm                      |          |  |
| 7     | 3   | 13       | t      | 9076055-04 | 226-4         | 1        | 373.0    | high fork               |          |  |
| 7     | 3   | 14       | t      | 9076051-09 | 209-9         | 1        | 295.0    |                         |          |  |
| 7     | 3   | 15       | t      | 9076062-32 | E.T.T.II-32   | 1        | 187.0    | low fork, etiolated     |          |  |
| 7     | 3   | 16       | t      | 9076056-25 | 227-25        | 1        | 108.0    |                         |          |  |
| 8     | 1   | 1        | nt     | 9076057-15 | 228-15NT      | 1        | 190.0    | 1995;nontest            |          |  |
| 8     | 1   | 2        | nt     | 9076057-06 | 228-6NT       | 1        | 226.0    | 1995;nontest            |          |  |
| 8     | 1   | 3        | t      | 9076058-10 | 236-10        | 1        | 320.0    |                         |          |  |
| 8     | 1   | 4        | nt     | 9076047-12 | 128-12-R97    | 1        | 165.0    | 1997                    |          |  |
| 8     | 1   | 5        | t      | 9076059-09 | 237-9         | 1        | 141.0    | low fork                |          |  |
| 8     | 1   | 6        | nt     | 9076066-05 | 126-5         | 1        | 324.0    | 1995                    |          |  |
| 8     | 1   | 7        | t      | 9076056-24 | 227-24        | 1        | 331.0    |                         |          |  |
| 8     | 1   | 8        | t      | 9076044-15 | 111-15        | 1        | 138.0    |                         |          |  |
| 8     | 1   | 9        | nt     | 9076067-07 | 127-7         | 1        | 251.0    | 1995                    |          |  |
| 8     | 1   | 10       | t      | 9076058-14 | 236-14        | 1        | 140.0    | ornamntl;multi.leaders  |          |  |
| 8     | 1   | 11       | nt     | Blank      | Blank         | 1        | 63.0     | bareroot; alive         |          |  |
| 8     | 1   | 12       | t      | 9076055-17 | 226-17        | 1        | 270.0    | high fork               |          |  |
| 8     | 1   | 13       | t      | 9076043-23 | 106-23        | 1        | 182.0    | bareroot                |          |  |
| 8     | 1   | 14       | t      | 9076043-22 | 106-22        | 1        | 159.0    | bareroot                |          |  |
| 8     | 1   | 15       | nt     | Blank      | Blank         | 0        |          | 1995, dead              |          |  |
| 8     | 1   | 16       | t      | 9076060-10 | 250-10        | 1        | 139.0    | deer killed leader      |          |  |
| 8     | 2   | 1        | t      | 9076064-37 | 13-1-37       | 1        | 270.0    | high fork               |          |  |
| 8     | 2   | 2        | t      | 9076063-06 | Tree B II-6   | 1        | 280.0    | low fork*vexar          |          |  |
| 8     | 2   | 3        | nt     | 9076057-29 | 228-29NT      | 1        | 356.0    | 1995;nontest            |          |  |
| 8     | 2   | 4        | t      | 9076062-09 | E.T.T.II-9    | 1        | 260.0    |                         |          |  |
| 8     | 2   | 5        | nt     | 9076057-24 | 228-24NT      | 1        | 312.0    | 1995;nontest;low fork   |          |  |
| 8     | 2   | 6        | t      | 9076053-19 | 218-19        | 1        | 362.0    |                         |          |  |
| 8     | 2   | 7        | t      | 9076055-22 | 226-22        | 1        | 280.0    |                         |          |  |
| 8     | 2   | 8        | nt     | 9076057-20 | 228-20NT      | 1        | 326.0    | 1995;nontest            |          |  |
| 8     | 2   | 9        | t      | 9076060-20 | 250-20        | 1        | 300.0    |                         |          |  |
| 8     | 2   | 10       | t      | 9076065-07 | Tree #3-7     | 1        | 193.0    | leaf retention 11/17/03 |          |  |
| 8     | 2   | 11       | nt     | 9076057-19 | 228-19NT      | 1        | 301.0    | 1995;nontest            |          |  |
| 8     | 2   | 12       | t      | 9076061-13 | Tree AS II-13 | 1        | 300.0    | *vexar problem          |          |  |
| 8     | 2   | 13       | t      | 9076057-27 | 228-27        | 1        | 295.0    |                         |          |  |
| 8     | 2   | 14       | t      | 9076051-13 | 209-13        | 1        | 135.0    |                         |          |  |
| 8     | 2   | 15       | nt     | 9076057-18 | 228-18NT      | 1        | 176.0    | 1995;nontest            |          |  |
| 8     | 2   | 16       | t      | 9076051-04 | 209-4         | 1        | 44.0     |                         |          |  |
| 8     | 3   | 1        | t      | 9076064-36 | 13-1-36       | 1        | 139.0    |                         |          |  |

APPENDIX 2. Bur oak evaluation data, Bridger, Montana, 2003.

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| Block | Row | Position | Test<br>Plant<br>(t,nt) | Accession<br>Number | Previous ID<br>Number | Plant<br>Survival<br>(0,1) | Height<br>cm | Comments                |
|-------|-----|----------|-------------------------|---------------------|-----------------------|----------------------------|--------------|-------------------------|
| 8     | 3   | 2        | t                       | 9076061-02          | Tree AS II-2          | 1                          | 243.0        |                         |
| 8     | 3   | 3        | t                       | 9076049-13          | 142-13                | 1                          | 251.0        | bareroot                |
| 8     | 3   | 4        | t                       | 9076063-54          | Tree B II-54          | 1                          | 248.0        |                         |
| 8     | 3   | 5        | t                       | 9076047-21          | 128-21                | 1                          | 220.0        |                         |
| 8     | 3   | 6        | t                       | 9076062-06          | E.T.T.II-6            | 1                          | 445.0        | low fork                |
| 8     | 3   | 7        | t                       | 9076052-10          | 211-10                | 1                          | 209.0        |                         |
| 8     | 3   | 8        | t                       | 9076057-21          | 228-21                | 1                          | 258.0        | low fork                |
| 8     | 3   | 9        | t                       | 9076056-02          | 227-2                 | 1                          | 246.0        |                         |
| 8     | 3   | 10       | t                       | 9076052-20          | 211-20                | 1                          | 324.0        | dk,corky bark; low fork |
| 8     | 3   | 11       | nt                      | 9076057-28          | 228-28NT              | 1                          | 258.0        | 1995;nontest            |
| 8     | 3   | 12       | t                       | 9076059-10          | 237-10                | 1                          | 230.0        |                         |
| 8     | 3   | 13       | t                       | 9076065-09          | Tree #3-9             | 1                          | 187.0        | deer                    |
| 8     | 3   | 14       | t                       | 9076049-15          | 142-15                | 1                          | 170.0        | bareroot                |
| 8     | 3   | 15       | t                       | 9076053-12          | 218-12                | 1                          | 182.0        |                         |
| 8     | 3   | 16       | nt                      | 9076057-26          | 228-26NT              | 1                          | 140.0        | 1995;nontest            |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

The ANOVA Procedure

Class Level Information

| Class     | Levels | Values                                                                  |
|-----------|--------|-------------------------------------------------------------------------|
| Accession | 24     | 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 |

Data for Analysis of **Percentage Survival**

|                             |     |
|-----------------------------|-----|
| Number of Observations Read | 196 |
| Number of Observations Used | 186 |

Data for Analysis of Height Vigor  
Seed\_Num Seed\_Percent Caliper DBH

|                             |     |
|-----------------------------|-----|
| Number of Observations Read | 196 |
| Number of Observations Used | 182 |

NOTE: Variables in each group are consistent with respect to the presence or absence of missing values.

The ANOVA Procedure

Dependent Variable: Survival **Percentage Survival**

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 23  | 1.87514401     | 0.08152800  | 1.27    | 0.1933 |
| Error           | 162 | 10.37351190    | 0.06403402  |         |        |
| Corrected Total | 185 | 12.24865591    |             |         |        |

|          |           |          |               |
|----------|-----------|----------|---------------|
| R-Square | Coeff Var | Root MSE | Survival Mean |
| 0.153090 | 30.26829  | 0.253049 | 0.836022      |

| Source    | DF | Anova SS   | Mean Square | F Value | Pr > F |
|-----------|----|------------|-------------|---------|--------|
| Accession | 23 | 1.87514401 | 0.08152800  | 1.27    | 0.1933 |

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APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

The ANOVA Procedure

Student-Newman-Keuls Test for **Percentage Survival**

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha 0.05  
 Error Degrees of Freedom 162  
 Error Mean Square 0.064034  
 Harmonic Mean of Cell Sizes 7.709369

NOTE: Cell sizes are not equal.

|                 |           |           |           |           |           |           |           |           |
|-----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Number of Means | 2         | 3         | 4         | 5         | 6         | 7         | 8         | 9         |
| Critical Range  | 0.2545163 | 0.3048832 | 0.3345804 | 0.3555682 | 0.3717289 | 0.3848258 | 0.3958091 | 0.4052492 |

|                 |           |           |           |          |           |           |          |           |
|-----------------|-----------|-----------|-----------|----------|-----------|-----------|----------|-----------|
| Number of Means | 10        | 11        | 12        | 13       | 14        | 15        | 16       | 17        |
| Critical Range  | 0.4135145 | 0.4208568 | 0.4274556 | 0.433443 | 0.4389193 | 0.4439622 | 0.448633 | 0.4529812 |

|                 |           |           |           |          |           |           |           |
|-----------------|-----------|-----------|-----------|----------|-----------|-----------|-----------|
| Number of Means | 18        | 19        | 20        | 21       | 22        | 23        | 24        |
| Critical Range  | 0.4570471 | 0.4608639 | 0.4644594 | 0.467857 | 0.4710766 | 0.4741355 | 0.4770483 |

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| A            | 1.0000 | 8 | 51        |
| A            |        |   |           |
| A            | 0.9375 | 8 | 60        |
| A            |        |   |           |
| A            | 0.9375 | 8 | 53        |
| A            |        |   |           |
| A            | 0.9375 | 8 | 55        |
| A            |        |   |           |
| A            | 0.9375 | 8 | 57        |
| A            |        |   |           |
| A            | 0.9286 | 7 | 50        |
| A            |        |   |           |
| A            | 0.9286 | 7 | 45        |
| A            |        |   |           |
| A            | 0.8750 | 8 | 62        |
| A            |        |   |           |
| A            | 0.8750 | 8 | 52        |
| A            |        |   |           |
| A            | 0.8750 | 8 | 44        |
| A            |        |   |           |
| A            | 0.8750 | 8 | 43        |
| A            |        |   |           |
| A            | 0.8750 | 8 | 47        |
| A            |        |   |           |
| A            | 0.8750 | 8 | 63        |
| A            |        |   |           |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

The ANOVA Procedure

Student-Newman-Keuls Test for **Percentage Survival**

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| A            | 0.8125 | 8 | 64        |
| A            |        |   |           |
| A            | 0.8125 | 8 | 56        |
| A            |        |   |           |
| A            | 0.8125 | 8 | 65        |
| A            |        |   |           |
| A            | 0.8125 | 8 | 59        |
| A            |        |   |           |
| A            | 0.7500 | 8 | 58        |
| A            |        |   |           |
| A            | 0.7500 | 8 | 46        |
| A            |        |   |           |
| A            | 0.7500 | 8 | 61        |
| A            |        |   |           |
| A            | 0.7143 | 7 | 48        |
| A            |        |   |           |
| A            | 0.6875 | 8 | 49        |
| A            |        |   |           |
| A            | 0.6667 | 6 | 42        |
| A            |        |   |           |
| A            | 0.5714 | 7 | 54        |

The ANOVA Procedure

Dependent Variable: Height **Height**

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 23  | 280386.702     | 12190.726   | 2.39    | 0.0009 |
| Error           | 158 | 804645.100     | 5092.691    |         |        |
| Corrected Total | 181 | 1085031.802    |             |         |        |

| R-Square | Coeff Var | Root MSE | Height Mean |
|----------|-----------|----------|-------------|
| 0.258413 | 28.55779  | 71.36309 | 249.8901    |

| Source    | DF | Anova SS    | Mean Square | F Value | Pr > F |
|-----------|----|-------------|-------------|---------|--------|
| Accession | 23 | 280386.7019 | 12190.7262  | 2.39    | 0.0009 |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

The ANOVA Procedure

Dependent Variable: Vigor **Vigor Rating**

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 23  | 40.8539148     | 1.7762572   | 2.29    | 0.0015 |
| Error           | 158 | 122.3383929    | 0.7742936   |         |        |
| Corrected Total | 181 | 163.1923077    |             |         |        |

| R-Square | Coeff Var | Root MSE | Vigor Mean |
|----------|-----------|----------|------------|
| 0.250342 | 22.87843  | 0.879940 | 3.846154   |

| Source    | DF | Anova SS    | Mean Square | F Value | Pr > F |
|-----------|----|-------------|-------------|---------|--------|
| Accession | 23 | 40.85391484 | 1.77625717  | 2.29    | 0.0015 |

The ANOVA Procedure

Dependent Variable: Seed\_Num **Seed Number**

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 23  | 96780.2139     | 4207.8354   | 0.95    | 0.5359 |
| Error           | 158 | 701609.2807    | 4440.5651   |         |        |
| Corrected Total | 181 | 798389.4945    |             |         |        |

| R-Square | Coeff Var | Root MSE | Seed_Num Mean |
|----------|-----------|----------|---------------|
| 0.121219 | 209.2123  | 66.63756 | 31.85165      |

| Source    | DF | Anova SS    | Mean Square | F Value | Pr > F |
|-----------|----|-------------|-------------|---------|--------|
| Accession | 23 | 96780.21385 | 4207.83538  | 0.95    | 0.5359 |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

Dependent Variable: Seed\_Percent **Seed Percentage**

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 23  | 2.70728022     | 0.11770784  | 0.69    | 0.8472 |
| Error           | 158 | 26.81607143    | 0.16972197  |         |        |
| Corrected Total | 181 | 29.52335165    |             |         |        |

| R-Square | Coeff Var | Root MSE | Seed_Percent Mean |
|----------|-----------|----------|-------------------|
| 0.091700 | 73.15037  | 0.411973 | 0.563187          |

| Source    | DF | Anova SS   | Mean Square | F Value | Pr > F |
|-----------|----|------------|-------------|---------|--------|
| Accession | 23 | 2.70728022 | 0.11770784  | 0.69    | 0.8472 |

The ANOVA Procedure

Dependent Variable: Caliper **Basal Caliper**

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 23  | 16790.75413    | 730.03279   | 2.19    | 0.0025 |
| Error           | 158 | 52615.30034    | 333.00823   |         |        |
| Corrected Total | 181 | 69406.05447    |             |         |        |

| R-Square | Coeff Var | Root MSE | Caliper Mean |
|----------|-----------|----------|--------------|
| 0.241921 | 29.18827  | 18.24851 | 62.52003     |

| Source    | DF | Anova SS    | Mean Square | F Value | Pr > F |
|-----------|----|-------------|-------------|---------|--------|
| Accession | 23 | 16790.75413 | 730.03279   | 2.19    | 0.0025 |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

The ANOVA Procedure

Dependent Variable: DBH **Diameter Breast High**

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 23  | 9200.46764     | 400.02033   | 2.34    | 0.0011 |
| Error           | 158 | 27000.48790    | 170.88916   |         |        |
| Corrected Total | 181 | 36200.95554    |             |         |        |

| R-Square | Coeff Var | Root MSE | DBH Mean |
|----------|-----------|----------|----------|
| 0.254150 | 45.01914  | 13.07246 | 29.03755 |

| Source    | DF | Anova SS    | Mean Square | F Value | Pr > F |
|-----------|----|-------------|-------------|---------|--------|
| Accession | 23 | 9200.467638 | 400.020332  | 2.34    | 0.0011 |

The ANOVA Procedure

Student-Newman-Keuls Test for **Height**

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

|                             |          |
|-----------------------------|----------|
| Alpha                       | 0.05     |
| Error Degrees of Freedom    | 158      |
| Error Mean Square           | 5092.691 |
| Harmonic Mean of Cell Sizes | 7.486075 |

NOTE: Cell sizes are not equal.

|                 |           |          |          |           |           |          |           |           |
|-----------------|-----------|----------|----------|-----------|-----------|----------|-----------|-----------|
| Number of Means | 2         | 3        | 4        | 5         | 6         | 7        | 8         | 9         |
| Critical Range  | 72.853258 | 87.27417 | 95.77797 | 101.78828 | 106.41653 | 110.1675 | 113.31329 | 116.01715 |

|                 |           |           |           |           |           |           |           |           |
|-----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Number of Means | 10        | 11        | 12        | 13        | 14        | 15        | 16        | 17        |
| Critical Range  | 118.38461 | 120.48776 | 122.37796 | 124.09308 | 125.66182 | 127.10643 | 128.44449 | 129.69015 |

|                 |           |          |           |           |           |           |           |
|-----------------|-----------|----------|-----------|-----------|-----------|-----------|-----------|
| Number of Means | 18        | 19       | 20        | 21        | 22        | 23        | 24        |
| Critical Range  | 130.85495 | 131.9484 | 132.97846 | 133.95184 | 134.87426 | 135.75061 | 136.58513 |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| A            | 309.63 | 8 | 55        |
| A            |        |   |           |
| A            | 306.75 | 8 | 57        |
| A            |        |   |           |
| A            | 295.25 | 8 | 53        |
| A            |        |   |           |
| A            | 289.50 | 8 | 56        |
| A            |        |   |           |
| A            | 286.00 | 7 | 45        |
| A            |        |   |           |
| A            | 282.58 | 6 | 48        |
| A            |        |   |           |
| A            | 281.19 | 8 | 62        |
| A            |        |   |           |
| B A          | 273.71 | 7 | 61        |
| B A          |        |   |           |
| B A          | 263.00 | 7 | 50        |
| B A          |        |   |           |
| B A          | 261.31 | 8 | 63        |
| B A          |        |   |           |
| B A          | 260.69 | 8 | 44        |
| B A          |        |   |           |
| B A          | 257.63 | 8 | 47        |
| B A          |        |   |           |
| B A          | 254.94 | 8 | 65        |
| B A          |        |   |           |

The ANOVA Procedure

Student-Newman-Keuls Test for **Height**

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| B A          | 247.38 | 8 | 59        |
| B A          |        |   |           |
| B A          | 246.21 | 7 | 46        |
| B A          |        |   |           |
| B A          | 238.38 | 8 | 60        |
| B A          |        |   |           |
| B A          | 238.19 | 8 | 58        |
| B A          |        |   |           |
| B A          | 225.19 | 8 | 52        |
| B A          |        |   |           |
| B A          | 217.40 | 5 | 42        |
| B A          |        |   |           |
| B A          | 215.13 | 8 | 64        |
| B A          |        |   |           |
| B A          | 214.25 | 8 | 43        |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

|   |   |        |   |    |
|---|---|--------|---|----|
| B | A |        |   |    |
| B | A | 194.21 | 7 | 54 |
| B | A |        |   |    |
| B | A | 186.31 | 8 | 49 |
| B |   |        |   |    |
| B |   | 150.25 | 8 | 51 |

The ANOVA Procedure

Student-Newman-Keuls Test for **Vigor Rating**

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha 0.05  
 Error Degrees of Freedom 158  
 Error Mean Square 0.774294  
 Harmonic Mean of Cell Sizes 7.486075

NOTE: Cell sizes are not equal.

Number of Means 2 3 4 5 6 7 8 9  
 Critical Range 0.898314 1.0761305 1.1809862 1.2550961 1.3121645 1.3584158 1.3972048 1.4305446

Number of Means 10 11 12 13 14 15 16 17  
 Critical Range 1.4597364 1.4856692 1.5089762 1.5301245 1.5494677 1.5672804 1.5837794 1.5991389

Number of Means 18 19 20 21 22 23 24  
 Critical Range 1.6135014 1.6269841 1.6396852 1.6516875 1.6630614 1.6738672 1.6841572

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| A            | 4.9375 | 8 | 51        |
| A            |        |   |           |
| B A          | 4.5625 | 8 | 43        |
| B A          |        |   |           |
| B A          | 4.5000 | 8 | 64        |
| B A          |        |   |           |
| B A          | 4.4000 | 5 | 42        |
| B A          |        |   |           |
| B A          | 4.2857 | 7 | 54        |
| B A          |        |   |           |
| B A          | 4.2500 | 8 | 52        |
| B A          |        |   |           |
| B A          | 4.1429 | 7 | 50        |
| B A          |        |   |           |
| B A          | 4.1250 | 8 | 49        |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

|   |   |        |   |    |
|---|---|--------|---|----|
| B | A |        |   |    |
| B | A | 4.0625 | 8 | 58 |
| B | A |        |   |    |
| B | A | 4.0000 | 6 | 48 |
| B | A |        |   |    |
| B | A | 3.9375 | 8 | 60 |
| B | A |        |   |    |
| B | A | 3.9286 | 7 | 46 |
| B | A |        |   |    |
| B | A | 3.7857 | 7 | 45 |
| B | A |        |   |    |

Student-Newman-Keuls Test for **Vigor Rating**

Means with the same letter are not significantly different.

| SNK Grouping | Mean | N      | Accession |
|--------------|------|--------|-----------|
| B            | A    | 3.7500 | 8 44      |
| B            | A    |        |           |
| B            | A    | 3.6250 | 8 59      |
| B            | A    |        |           |
| B            | A    | 3.5625 | 8 65      |
| B            | A    |        |           |
| B            | A    | 3.4375 | 8 47      |
| B            | A    |        |           |
| B            | A    | 3.4375 | 8 53      |
| B            | A    |        |           |
| B            | A    | 3.4375 | 8 55      |
| B            | A    |        |           |
| B            | A    | 3.3750 | 8 63      |
| B            | A    |        |           |
| B            | A    | 3.3125 | 8 62      |
| B            | A    |        |           |
| B            | A    | 3.3125 | 8 56      |
| B            |      |        |           |
| B            |      | 3.2143 | 7 61      |
| B            |      |        |           |
| B            |      | 3.1875 | 8 57      |

Student-Newman-Keuls Test for **Seed Number**

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

|                             |          |
|-----------------------------|----------|
| Alpha                       | 0.05     |
| Error Degrees of Freedom    | 158      |
| Error Mean Square           | 4440.565 |
| Harmonic Mean of Cell Sizes | 7.486075 |

NOTE: Cell sizes are not equal.

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

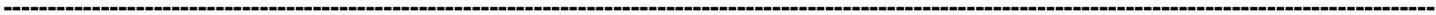
Number of Means    2    3    4    5    6    7    8    9  
 Critical Range 68.029058 81.495045 89.43574 95.048061 99.369831 102.87243 105.80991 108.33472

Number of Means    10    11    12    13    14    15    16    17  
 Critical Range 110.54541 112.50929 114.27433 115.87588 117.34074 118.68969 119.93915 121.10232

Number of Means    18    19    20    21    22    23    24  
 Critical Range 122.18999 123.21103 124.17288 125.08181 125.94315 126.76147 127.54073

Means with the same letter are not significantly different.

| SNK Grouping | Mean  | N | Accession |
|--------------|-------|---|-----------|
| A            | 88.75 | 8 | 63        |
| A            |       |   |           |
| A            | 80.71 | 7 | 61        |
| A            |       |   |           |
| A            | 64.50 | 8 | 62        |
| A            |       |   |           |
| A            | 62.86 | 7 | 50        |
| A            |       |   |           |
| A            | 49.00 | 8 | 65        |
| A            |       |   |           |
| A            | 44.13 | 8 | 58        |
| A            |       |   |           |
| A            | 39.81 | 8 | 52        |
| A            |       |   |           |
| A            | 39.06 | 8 | 53        |
| A            |       |   |           |
| A            | 34.38 | 8 | 44        |
| A            |       |   |           |
| A            | 33.36 | 7 | 54        |
| A            |       |   |           |
| A            | 27.71 | 7 | 46        |
| A            |       |   |           |
| A            | 27.56 | 8 | 43        |
| A            |       |   |           |
| A            | 26.14 | 7 | 45        |
| A            |       |   |           |



APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

Student-Newman-Keuls Test for **Seed Number**

Means with the same letter are not significantly different.

| SNK Grouping | Mean  | N | Accession |
|--------------|-------|---|-----------|
| A            | 23.50 | 8 | 57        |
| A            |       |   |           |
| A            | 23.00 | 8 | 59        |
| A            |       |   |           |
| A            | 21.42 | 6 | 48        |
| A            |       |   |           |
| A            | 19.30 | 5 | 42        |
| A            |       |   |           |
| A            | 18.13 | 8 | 56        |
| A            |       |   |           |
| A            | 12.06 | 8 | 47        |
| A            |       |   |           |
| A            | 8.25  | 8 | 49        |
| A            |       |   |           |
| A            | 7.88  | 8 | 51        |
| A            |       |   |           |
| A            | 6.75  | 8 | 64        |
| A            |       |   |           |
| A            | 4.75  | 8 | 60        |
| A            |       |   |           |
| A            | 3.06  | 8 | 55        |

Student-Newman-Keuls Test for **Seed Percentage**

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha 0.05  
 Error Degrees of Freedom 158  
 Error Mean Square 0.169722  
 Harmonic Mean of Cell Sizes 7.486075

NOTE: Cell sizes are not equal.

|                 |           |           |           |           |           |          |           |           |
|-----------------|-----------|-----------|-----------|-----------|-----------|----------|-----------|-----------|
| Number of Means | 2         | 3         | 4         | 5         | 6         | 7        | 8         | 9         |
| Critical Range  | 0.4205759 | 0.5038266 | 0.5529184 | 0.5876154 | 0.6143339 | 0.635988 | 0.6541484 | 0.6697575 |

|                 |           |           |           |           |           |          |           |           |
|-----------------|-----------|-----------|-----------|-----------|-----------|----------|-----------|-----------|
| Number of Means | 10        | 11        | 12        | 13        | 14        | 15       | 16        | 17        |
| Critical Range  | 0.6834246 | 0.6955659 | 0.7064779 | 0.7163792 | 0.7254354 | 0.733775 | 0.7414995 | 0.7486906 |

|                 |           |           |           |          |          |           |           |
|-----------------|-----------|-----------|-----------|----------|----------|-----------|-----------|
| Number of Means | 18        | 19        | 20        | 21       | 22       | 23        | 24        |
| Critical Range  | 0.7554149 | 0.7617273 | 0.7676737 | 0.773293 | 0.778618 | 0.7836772 | 0.7884948 |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| A            | 0.7500 | 6 | 48        |
| A            |        |   |           |
| A            | 0.7500 | 8 | 53        |
| A            |        |   |           |
| A            | 0.6875 | 8 | 44        |
| A            |        |   |           |
| A            | 0.6875 | 8 | 65        |
| A            |        |   |           |
| A            | 0.6875 | 8 | 56        |
| A            |        |   |           |
| A            | 0.6875 | 8 | 57        |
| A            |        |   |           |
| A            | 0.6429 | 7 | 61        |
| A            |        |   |           |
| A            | 0.6250 | 8 | 58        |
| A            |        |   |           |
| A            | 0.6250 | 8 | 62        |
| A            |        |   |           |
| A            | 0.6250 | 8 | 47        |
| A            |        |   |           |
| A            | 0.6250 | 8 | 49        |
| A            |        |   |           |
| A            | 0.6000 | 5 | 42        |
| A            |        |   |           |
| A            | 0.5714 | 7 | 45        |
| A            |        |   |           |

Student-Newman-Keuls Test for **Seed Percentage**

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| A            | 0.5625 | 8 | 43        |
| A            |        |   |           |
| A            | 0.5625 | 8 | 55        |
| A            |        |   |           |
| A            | 0.5000 | 7 | 46        |
| A            |        |   |           |
| A            | 0.5000 | 7 | 50        |
| A            |        |   |           |
| A            | 0.5000 | 8 | 63        |
| A            |        |   |           |
| A            | 0.4375 | 8 | 52        |
| A            |        |   |           |
| A            | 0.4375 | 8 | 64        |
| A            |        |   |           |
| A            | 0.4375 | 8 | 59        |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

|   |        |   |    |
|---|--------|---|----|
| A |        |   |    |
| A | 0.3750 | 8 | 60 |
| A |        |   |    |
| A | 0.3571 | 7 | 54 |
| A |        |   |    |
| A | 0.3125 | 8 | 51 |

Student-Newman-Keuls Test for **Basal Caliper**

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

|                             |          |
|-----------------------------|----------|
| Alpha                       | 0.05     |
| Error Degrees of Freedom    | 158      |
| Error Mean Square           | 333.0082 |
| Harmonic Mean of Cell Sizes | 7.486075 |

NOTE: Cell sizes are not equal.

|                 |          |           |          |           |           |          |           |           |
|-----------------|----------|-----------|----------|-----------|-----------|----------|-----------|-----------|
| Number of Means | 2        | 3         | 4        | 5         | 6         | 7        | 8         | 9         |
| Critical Range  | 18.62957 | 22.317193 | 24.49173 | 26.028649 | 27.212154 | 28.17133 | 28.975751 | 29.667164 |

|                 |           |           |           |           |           |           |           |           |
|-----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Number of Means | 10        | 11        | 12        | 13        | 14        | 15        | 16        | 17        |
| Critical Range  | 30.272556 | 30.810359 | 31.293709 | 31.732289 | 32.133437 | 32.502843 | 32.845004 | 33.163537 |

|                 |          |        |           |           |           |           |           |
|-----------------|----------|--------|-----------|-----------|-----------|-----------|-----------|
| Number of Means | 18       | 19     | 20        | 21        | 22        | 23        | 24        |
| Critical Range  | 33.46139 | 33.741 | 34.004401 | 34.253309 | 34.489184 | 34.713279 | 34.926677 |

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| A            | 76.898 | 8 | 57        |
| A            |        |   |           |
| B A          | 76.371 | 8 | 53        |
| B A          |        |   |           |
| B A          | 74.289 | 8 | 55        |
| B A          |        |   |           |
| B A          | 72.081 | 8 | 65        |
| B A          |        |   |           |
| B A          | 69.662 | 7 | 61        |
| B A          |        |   |           |
| B A          | 68.565 | 8 | 63        |
| B A          |        |   |           |
| B A          | 68.531 | 8 | 56        |
| B A          |        |   |           |
| B A          | 68.468 | 8 | 47        |
| B A          |        |   |           |
| B A          | 68.393 | 6 | 48        |
| B A          |        |   |           |
| B A          | 66.944 | 8 | 59        |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

|   |   |        |   |    |
|---|---|--------|---|----|
| B | A |        |   |    |
| B | A | 66.228 | 8 | 62 |
| B | A |        |   |    |
| B | A | 66.110 | 7 | 45 |
| B | A |        |   |    |
| B | A | 65.079 | 7 | 50 |
| B | A |        |   |    |

Student-Newman-Keuls Test for **Basal Caliper**

Means with the same letter are not significantly different.

| SNK Grouping | Mean | N      | Accession |
|--------------|------|--------|-----------|
| B            | A    | 64.891 | 8 44      |
| B            | A    |        |           |
| B            | A    | 63.357 | 8 58      |
| B            | A    |        |           |
| B            | A    | 57.361 | 8 60      |
| B            | A    |        |           |
| B            | A    | 54.771 | 8 49      |
| B            | A    |        |           |
| B            | A    | 53.622 | 8 52      |
| B            | A    |        |           |
| B            | A    | 53.510 | 7 46      |
| B            | A    |        |           |
| B            | A    | 50.909 | 7 54      |
| B            | A    |        |           |
| B            | A    | 50.435 | 8 43      |
| B            | A    |        |           |
| B            | A    | 49.418 | 8 64      |
| B            | A    |        |           |
| B            | A    | 47.630 | 5 42      |
| B            |      |        |           |
| B            |      | 41.928 | 8 51      |

Student-Newman-Keuls Test for **Diameter Breast High**

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

|                             |          |
|-----------------------------|----------|
| Alpha                       | 0.05     |
| Error Degrees of Freedom    | 158      |
| Error Mean Square           | 170.8892 |
| Harmonic Mean of Cell Sizes | 7.486075 |

NOTE: Cell sizes are not equal.

|                 |           |           |           |           |           |           |           |           |
|-----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Number of Means | 2         | 3         | 4         | 5         | 6         | 7         | 8         | 9         |
| Critical Range  | 13.345431 | 15.987087 | 17.544833 | 18.645816 | 19.493629 | 20.180742 | 20.756995 | 21.252294 |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

Number of Means    10    11    12    13    14    15    16    17  
 Critical Range    21.685971    22.07123    22.417481    22.731661    23.019027    23.283653    23.528763    23.756947

Number of Means    18    19    20    21    22    23    24  
 Critical Range    23.970316    24.170617    24.359306    24.537613    24.706583    24.867116    25.019985

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| A            | 41.006 | 8 | 57        |
| A            |        |   |           |
| B A          | 36.994 | 8 | 55        |
| B A          |        |   |           |
| B A          | 36.875 | 8 | 53        |
| B A          |        |   |           |
| B A          | 36.373 | 6 | 48        |
| B A          |        |   |           |
| B A          | 35.758 | 7 | 45        |
| B A          |        |   |           |
| B A          | 35.196 | 8 | 65        |
| B A          |        |   |           |
| B A          | 35.177 | 7 | 50        |
| B A          |        |   |           |
| B A          | 33.906 | 8 | 59        |
| B A          |        |   |           |
| B A          | 33.250 | 8 | 63        |
| B A          |        |   |           |
| B A          | 33.155 | 7 | 61        |
| B A          |        |   |           |
| B A          | 31.325 | 8 | 56        |
| B A          |        |   |           |
| B A          | 30.868 | 8 | 62        |
| B A          |        |   |           |
| B A          | 30.428 | 8 | 47        |
| B A          |        |   |           |

Student-Newman-Keuls Test for **Diameter Breast High**

Means with the same letter are not significantly different.

| SNK Grouping | Mean   | N | Accession |
|--------------|--------|---|-----------|
| B A          | 28.836 | 8 | 44        |
| B A          |        |   |           |
| B A          | 27.069 | 8 | 58        |
| B A          |        |   |           |
| B A          | 26.720 | 7 | 46        |
| B A          |        |   |           |
| B A          | 24.855 | 8 | 60        |

APPENDIX 3 – Bur oak provenance study, Analysis of Variance (ANOVA).

|   |   |        |   |    |
|---|---|--------|---|----|
| B | A |        |   |    |
| B | A | 23.836 | 8 | 52 |
| B | A |        |   |    |
| B | A | 23.189 | 8 | 43 |
| B | A |        |   |    |
| B | A | 20.629 | 8 | 64 |
| B | A |        |   |    |
| B | A | 20.174 | 5 | 42 |
| B | A |        |   |    |
| B | A | 19.259 | 8 | 49 |
| B | A |        |   |    |
| B | A | 17.709 | 7 | 54 |
| B |   |        |   |    |
| B |   | 13.244 | 8 | 51 |