# Forest Health Update – North Dakota
# 2004 Great Plains Tree Pest Council

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## 2003 Reports

**State Conditions Report**

Kangas, Michael. 2003. North Dakota Forest Health Report, 2001-2002. North Dakota Forest Service [Bottineau, ND]. 26 p.

The 2001 – 2002 North Dakota Forest Health Report is a biennial summary of tree pest conditions throughout the state of North Dakota. The report can be found at: www.ndsu.nodak.edu/ndsu/lbakken/forest/sustain/sustainable_homepage.htm.

**North Central FIA Report**

Haugen, David; Brand, Gary; Rymal, Travis; Kangas, Michael. 2004. North Dakota's Forest Resources in 2002. Resourc. Bull. NC-229. St. Paul, MN. USDA Forest Service. North Central Research Station. 21 p.

An interim forest resources report has been published for North Dakota. The report focuses on forest inventory however a forest health narrative is included. The report can be found at:
www.ndsu.nodak.edu/ndsu/lbakken/forest/sustain/sustainable_homepage.htm.

**Forest Health Highlights 2003**

Available at:
www.na.fs.fed.us/spfo/fhm/fhh/fhmusamap.htm

## Forest Health "Happenings" in North Dakota

**Invasive Tree Pest Contingency Plan**

The ND Forest Service, NDDA, APHIS, USFS, and NPPDN have begun a collaborative effort to address invasive tree pests. A preliminary meeting took place on April 12th. This meeting focused on coordination of activities, resources, and planning.

**Plains States Forest Health Tour**

The North Dakota Forest Service hosted a Plains States Forest Health tour in Bismarck, North Dakota on September 10th and 11th, 2003. The purpose of this field tour was two-fold:

1) Illustrate forest health issues of the plains states that relate to FHM and FHP. Specifically the field tour included site visits to riparian forests, windbreaks, and community forests within North Dakota.
2) Develop and Identify resolutions regarding organizational hurdles among the plain states, FHP regions, and FHM regions to facilitate future program delivery and implementation.

The tour consisted of site visits to rural plantings, native forests, community forests, the NRCS Plant Materials Center, the Lincoln-Oakes Nursery, and several presentations. Participants included USFS Regional Forest Health pathologists and entomologists representing the Plains States, Rocky Mountain States, Lakes States, and the Washington Office. Other participants included North Dakota Forest Service personnel, North Dakota State University personnel, and North Dakota City foresters.

In addition to the afore-mentioned site visits and presentations, a discussion session was also integrated into the tour. This discussion session was intended to address various emerging issues in the plains states. Various topics were discussed and tour participants had an opportunity to provide input and insight.

**NASF Forest Health Committee**

Larry Kotchman, ND State Forester, is currently the chair of the NASF Forest Health Protection Committee. By working in partnership with the Forest Service, the State Plant Protection Agencies, and the USDA Animal and Plant Health Inspection Service, the Forest Health Committee helps set priorities and determine funding for forest pest suppression, control, and eradication efforts. Recently, this committee has produced an invasive species workbook to provide general guidelines following detection of an invasive species.

**Intermountain Risk Map Team**

Congress has asked Forest Health Monitoring to produce another National Risk Map. Michael Kangas, is currently the Co-Chair of the Intermountain Risk Map Team. His primary responsibility is to contact state representatives from the Intermountain region and facilitate their involvement.

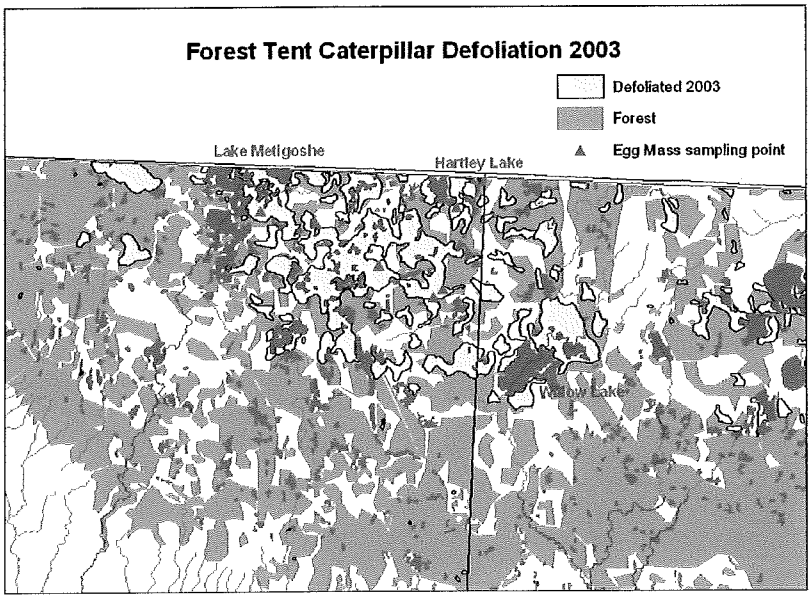
## Forest Health Surveys

**Forest Tent Caterpillar**

Defoliation by the forest tent caterpillar increased substantially in 2003 (Table 1). Based on aerial surveys, 17,800 acres were defoliated in the Turtle Mountains for 2003. The majority of this defoliation occurred from the western edge of the Wakopa Wildlife Management Area to Lake Metigoshe State Park and extended as far south as Willow Lake. Based on egg mass surveys conducted in October 2003, it appears that the FTC defoliation will remain heavy for 2004. The Turtle Mountains will be aerially surveyed again in 2004.

Table 1. Forest Tent Caterpillar Defoliation by Year

| Year | Defoliation (Acres) |
|---|---|
| 2001 | 3,045 |
| 2002 | 4,300 |
| 2003 | 17,800 |




**Aspen Trunk Rot**

Stem Decay caused by the fungus *Phellinus tremmulae* is common in mature aspen stands throughout the state. The fungus reduces structural soundness, increases the probability of top breakage, and discourages utilization of aspen for wood products. The pathological rotation of aspen that is dictated by *P. tremmulae* is not well understood in North Dakota.

Fixed radius plots were set up in the Turtle Mountain State Forest to determine the current condition of the resource and shred light on the pathological rotation age. Standard stand inventory and *P. tremulae* sporocarps were recorded within these plots. In addition, randomly selected aspen stems were felled, bisected at 2-m intervals and the extent of decay was recorded.

Based on initial surveys, the percentage of aspen with sporocarps increased with stand age. Similarly, percent volume loss increased with tree age for randomly selected trees. The percentage of decay increased substantially for trees over 45 years of age. Additional surveys will be conducted in 2004

**Hypoxlon Canker**

Hypoxylon canker caused by the fungus *Hypoxylon mammatum* is a common disease of native quaking aspen within the state. Fixed radius plots were set up in the Turtle

Mountain State Forest to determine the current condition of the resource and determine the incidence of hypoxylon canker. Based on this survey, it appears that 6.5% of aspen age 18 to 42 possess hypoxylon cankers and the fungus accounts for ~ 2% mortality (annually) within the stands surveyed. Additional surveys will be conducted in 2004 to provide a more thorough picture on hypoxylon canker.

**Ash Fomes**

Stem decay of green ash caused by the fungus *Perenniporia fraxinophila* has been observed throughout the state. This fungus has been reported in many ash woodlands and plantings including; wooded draws of the Little Missouri Grasslands, forested areas along the Missouri River, riparian forests of eastern North Dakota and field windbreaks. A pilot survey was conducted in the Upper Sheyenne River Valley to assess the incidence of this fungus.

**Gypsy Moth**

The North Dakota Forest Service, North Dakota Department of Agriculture, and APHIS conduct annual statewide gypsy moth detection trapping surveys. There were 312 gypsy moth detection traps placed in 2003. These traps were distributed throughout the state to encompass major forest types and risk of gypsy moth introductions. One gypsy moth was captured near Jamestown in 2003. This was the first positive detection since 1998. Trapping efforts will continue in the future and include new areas of potential risk as the established North American range of the moth expands.

**Sphaeropsis at Towner Nursery**

Shoot blight, caused by *Sphaeropsis sapinea*, has been a problem observed in windbreaks of the Towner State Nursery for the past decade. Towner State Nursery annually produces 200,000 ponderosa pine seedlings and there is concern that this disease could reduce the supply of pine seedlings the nursery will provide in the future. There is also the concern the fungus may be spread throughout the region by infected nursery stock if the blight is not suppressed or eliminated within the nursery. Removal of ponderosa pine tree rows is critical to the management of this disease. A survey identifying infected trees was utilized to prioritize windbreak removal.

A plan has been developed to prevent damage to nursery crops by monitoring the disease, systematically removing ponderosa pine tree rows and replacing with other species, applying preventive fungicides to nursery crops, and relocating ponderosa pine nursery crops to fields with minimum exposure to the disease. Forest Health Protection Funds were used to remove three windbreaks in 2002 and three more windbreaks will be removed in 2003. The Towner State Nursery will provide funds to replant the windbreaks with species other than ponderosa pine.

# Report to the Great Plains Tree Pest Council

April 14-15, 2004
Rapid City, South Dakota

Mark Harrell and Laurie Stepanek
Nebraska Forest Service, University of Nebraska

## Pine wilt

Scotch pines in large numbers were killed again by pine wilt in 2004. The southeastern corner of the state, generally south and east of Lincoln, is still the area where mortality is the greatest, but the disease has killed trees at several locations in areas to the north and west. The growing concern about the effect of pine wilt on Scotch and Austrian pines is causing many people to look for alternative species for windbreaks and other plantings. Austrian pines are also dying, but in lower numbers. In one area where pine wilt is very common, even jack pines seem to be dying from the disease.

A test was continued to determine whether trunk-injection treatments could be effective in protecting trees from pine wilt. Three insecticide products had been tested in the lab for their effectiveness in killing pinewood nematodes. One product, abamectin, was able to kill or immobilize the nematodes when present in concentrations similar to what the nematodes would encounter in a treated tree. In April and May 2003, abamectin (Greyhound) was injected into 20 pines at Horning State Farm near Plattsmouth in eastern Nebraska. Ten trees received 4 ml of a 2% abamectin formulation (Greyhound) at 4-inch spacings around the trunk, and 10 trees received 6 ml at 4-inch spacings. The higher rate reduced mortality by 80% compared to the untreated trees. The lower rate did not reduce mortality.

Plans for pine wilt for 2004 are to (1) compare populations of pinewood nematode from Scotch and ponderosa pine hosts in areas with high and low incidence of pine wilt to determine if differences exist in morphology or genetic makeup, and (2) collect and identify pine sawyer beetles and other vectors of the pinewood nematode to determine the potential for spread of the disease.

## Cercospora blight control test

Cercospora blight is a serious problem in juniper and redcedar in central and eastern Nebraska. In 2003 a test of the copper fungicide Champ was continued for the third year to try to find an economical alternative to the fungicide Camelot. Blocks of trees were sprayed twice as recommended in five windbreaks near Lexington in central Nebraska. The trees were evaluated in the fall. No differences were found between the treated trees and untreated trees, so Champ did not control the disease.

## Oak decline

Bur oaks in eastern Nebraska over the past several years have shown symptoms that have often been diagnosed as oak wilt. The symptoms include foliage that dies completely or has large necrotic areas, branch dieback, general decline in the tree, and occasionally some streaking in the wood. The trees seem to be declining from a combination of oak wilt and changes in site conditions from human activities, and Tubakia leaf spot has often been present causing a large amount of brown foliage.

**Pest Conditions**

**Pine wilt:** Continues to kill many Scotch pines annually in southeastern Nebraska. It also appears to be killing jack pine at Horning Tree Farm--an area where disease pressure is high. Eastern white pine at Horning seems unaffected.

**Oak wilt:** Continues to be a problem in red oak and bur oak along the eastern edge of the state.

**Tubakia leaf spot:** Defoliation and twig dieback were common and widespread on bur oaks in eastern Nebraska.

**Cercospora blight of juniper:** Continues to severely defoliate and kill junipers and redcedars in windbreaks in central and eastern Nebraska.

**Sphaeropsis (Diplodia) blight:** Continues to be a serious problem on Austrian and ponderosa pines in windbreaks and landscape plantings in eastern Nebraska.

**Dutch elm disease:** Was a problem in riparian areas and cities throughout Nebraska.

**Bagworm:** Populations continue to be higher than normal on eastern redcedar and Rocky Mountain juniper in some areas in eastern Nebraska.

**European pine sawfly:** Was common again in eastern Nebraska.

**Dioryctria pine moths:** *Dioryctria ponderosae* and *D. tumicolella* in central and western Nebraska and *D. zimmermani* in eastern Nebraska continue to kill branches and entire trees in pine windbreaks, plantations, and landscape plantings.

**Ash/lilac borer:** This is consistently a problem for young ash in urban and rural plantings throughout Nebraska.

**Drought:** Many young trees have been lost.

**REPORT TO GREAT PLAINS TREE PEST COUNCIL**
**RAPID CITY, SOUTH DAKOTA**
**APRIL 2004**

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**Pinyon Ips Beetle (*Ips confusus*)** – This insect continues to cause widespread, heavy mortality of pinyon pine, in the southwestern US. In Colorado, it is particularly acute in the southern Front Range and southwest corner of the state. For the first time, special aerial surveys are being conducted by the USFS to delineate the range and severity of the infestation. These will not be completed and analyzed until after press time for this report. However certain surveys completed early are indicative of the problem (see survey in the Cortez area). The insect has killed more trees in areas where it occurred in 2002, and has spread to new areas in 2003. Along the Front Range, the insect is now affecting native pinyon stands as far north as Colorado Springs (Garden of the Gods) and Poncha Springs, and has become much more evident out onto the eastern plains in Huerfano and Las Animas Counties. In the southwestern part of the state, mortality now extends in a band from east of Durango, west to Four Corners, north to Dolores Canyon and Grand Junction. Other "internal" Colorado locations include the Montrose area and portions of the San Luis Valley near Crestone. Indications are that pinyon ips is beginning to move into the Upper Arkansas Valley from Poncha Springs to Buena Vista, but so far in this area damage is not severe. Damage to ornamental pinyon trees planted outside the native range has been minor.

Research by the USFS Forest Pest Management group has confirmed the existence of four generations per year under current Colorado conditions, with adult flights extending from April to early November.

It is now clear that two applications (April and late August/early September) of approved preventive chemicals are required to protect live trees from attack. Even with such practices, given the tremendous pressure such trees are under from sheer numbers of beetles, not all protected trees are surviving.

At least 7 informational meetings, with an average attendance of 100 landowners each, have been held by responsible forestry agencies in the affected area during 2003.

On a positive note, the heavy rains in late spring and early summer 2003 throughout much of the state, seemed to slow the progress of the ips infestation until hot temperatures resumed again in July. This lends credence to the theory that if and when

Colorado returns to normal moisture patterns, the ips infestation should subside. The question now becomes how much of the host resource will still be alive when this happens.

**Other Pine Ips Beetles (several species, including *I. pini, I. calligraphus, I. latidens* (particularly prairie locations/windbreaks), *I. knausi,* and *I. integer*)** – Hosts other than pinyon also fell victim to ips beetle attacks during 2003. Trees attacked were primarily weakened by the drought and dwarf mistletoe and included ponderosa pine and lodgepole pine. The number of trees affected by this group statewide is unknown but conservatively numbers in the tens of thousands of trees. Part of the problem in evaluating the scope of the ips problem is the similar "signature" such trees present during aerial surveys to other pine killers such as mountain pine beetle, western pine beetle, roundheaded pine beetle, drought, and dwarf mistletoe.

Also, numerous costly incidents occurred with pine nursery stock being infested by ips, some of the infestations originating out of state and being brought into the state, and others occurring from local beetles after shipments of uninfested trees arrived in the state. The regulatory inspection network cannot be expected to prevent and detect all such incidents and plant industry firms need to step up self-inspections, plan to apply preventive sprays, and do a better job of monitoring the quality of stock in general.

**Blue Spruce Ips (*I. hunteri*)** - This insect continues to cause major mortality to mature and overmature Colorado blue spruce along the Front Range. Estimates are that as many as 1000 trees have been lost in Colorado Springs, at least several hundred in the Denver Metro area (including Aurora), 200+ in Fort Collins, 100+ in Greeley, and lesser, unknown numbers in other cities and towns. Detection is very difficult, with most off-color foliage first appearing in the upper 1/3 of the crown. Early needle drop of pale green needles, as well as browner ones, is also an early clue, along with boring dust and pitch flow or pitch tubes at attack points. Emergence of the overwintering generation was noted in Fort Collins as early as 7April2004. There are at least 3 generations along the Front Range, average elevation of about 5000 feet. Most cities are now condemning any trees with signs of attack. This is a change from earlier years when attempts were made at topping trees with attacks thought to be confined to the upper crown. In almost all cases, such topped trees were later found to be colonized lower in the trunk and ended up dying, in many cases leading to infestation of nearby spruce.

**Mountain Pine Beetle** – 2003 marked the first leveling off of statewide ponderosa and lodgepole pine mortality from this insect since the current epidemic began in the early 1990's. The total of 358,000 trees was down from 450,000 trees in 2001, but is still a serious level. In lodgepole pine, very heavy mortality continues to occur in large portions of Grand, southern Jackson, and Eagle Counties. In ponderosa pine, the most serious populations continue to expand in Chaffee, Park, and northwestern Fremont Counties (basically southwestern South Park on west into the Upper Arkansas Valley), with troublesome populations continuing in western Larimer, northeastern Park, and, to a lesser extent, in parts of Boulder, Clear Creek, Jefferson, Douglas, Elbert, El Paso, Pueblo, Custer, Saguache, and Huerfano Counties.

**Western Pine Beetle (*Dendroctonus brevicomis*)** - This relative of mountain pine beetle is not a common pest in Colorado but has increased to above-normal levels in southwestern Colorado ponderosa pine. With two generations a year and its habit of sharing host trees with mountain pine beetle and other bark beetles, the total extent of the current epidemic is difficult to delineate. Mortality primarily from this insect is thought to occur from the Pagosa Springs area west to areas west and north of Durango and probably amounts to the few 1000's of trees. Western pine beetle is yet another manifestation of the dry conditions.

**Fir Engraver (*Scolytus ventralis*)** – This beetle is to white fir what ips beetles are to pine and spruce. It is particularly noticeable killing (in concert with the drought) white firs in the Wet (Beulah to Rye) and San Juan Mountains (particularly from Durango to Ouray). An estimated 5,000-10,000 trees died during 2003.

**Balsam Bark Beetle (*Dryocoetes confusus*)** - Ditto for this beetle in subalpine fir. Usually thought to act in concert with root diseases such as Armillaria, this combination is often referred to as "subalpine fir decline". Decline is evident statewide at the lower elevational limits of subalpine fir and amounts to several hundred thousand trees.

**Elm Leaf Beetle** – After several years of being relatively inconspicuous, this common defoliator of elms occurred at high levels virtually statewide in 2003. This leaf beetle has two generations per year, sometimes a partial third, and by the end of the summer many elms were quite brown from the "skeletonizing" type injury the larvae inflict on leaves. While usually not life-threatening, elm leaf beetle in combination with the drought, can invite fatal organisms like the elm bark beetles (both the "old" one from Europe and the "new" one from China). In many towns on the eastern plains, Siberian elms make a significant portion of the urban tree cover. Aesthetic (or worse) injury to elms can be cause for concern and community-wide control efforts.

**Giant conifer aphids (*Cinara* spp.)** – Several species of these large aphids were evident during the summer in southwestern CO. They produce copious amounts of sugary excrement called "honeydew" and this material led to detection of their presence by many homeowners. These aphids are not thought to be particularly serious in their impact but probably add to the stresses from other sources.

**Animal Damage** – While the late spring-early summer rains definitely improved food conditions for wildlife in the mountains, unusually high amounts of damage from porcupines to trees continued during 2003, particularly in ponderosa pine on the eastern plains and in pinyon pine statewide. Heavy browsing of oak and aspen sprouts by elk, deer, and rabbits was observed in many areas recovering from the fires of 2002.

**Drought** – The drought manifested itself in many ways. Mostly the effects were "invisible" in the form of stress, that later became visible in the form of bark beetle, root disease, and canker fungi attacks. One graphic indicator of abnormal conditions occurred in selected aspen forests in southwestern CO which produced prolific amounts of seed in

mid-summer. (See attached photo from Middle Mountain northeast of Vallecito Reservoir, LaPlata County, 9July03). The trees in question were still alive, had small compliments of leaves, but were primarily devoting most of their energy to seed production. This is clearly "emergency" activity, in the event the trees die, they will have attempted to provide for the continuation of the species.

Dr. Ann M. Lynch, a research entomologist with the USFS in Flagstaff, AZ has been studying the impact of the drought on bark beetles. Among the many interesting things she has learned from weather analysis are:

1) The growing season in the Southwest since 1940 has increased by an average of 55 days (defined as the period from the last frost in spring to the first frost in fall). That is enough time for most bark beetle species to complete an extra generation.
2) The coldest days of winter are occurring with increasing frequency only during the "middle" of winter (i.e. December, Janauary, and February), which is precisely the time bark beetles are protected against subfreezing temperatures via self-generated "anti-freeze" chemicals including glycols. Bark beetle populations have long been regulated by early and late freezes, when the beetles are not particularly prepared. The current trend leads to greater survival of the beetles.
3) Most of the bark beetle species are not particularly adapted to attacking healthy trees and require stress as a precursor. Drought is providing landscape scale stress. The so-called "aggressive" species such as mountain pine utilize companion organisms such as bluestain fungi to help them overcome the pitch defenses of their hosts. Species such as members of the genera Ips and Scolytus cannot overcome wet, pitchy tree defenses because they do not always carry bluestain fungi. They need dried out trees.
4) Drought is extending up the mountain. Dry conditions are normally a periodic characteristic of the low elevation forests. Low snowpacks, mild temperatures, and below average precipitation in general, have made drought stress a reality all the way to timberline. As a result, we are seeing bark beetles at high elevation that are apparently outside the range of known natural variability. Balsam bark beetle in subalpine fir is perhaps the best example. [Dr. Lynch has not published this information and I am not sure how she would respond to seeing it in print. I would hope she would like to see her information used, but researchers get a little touchy about being "stolen from" prior to publication of their results.]

Yet another manifestation of the drought evident in Colorado is the considerable dieback of Gambel Oak. This is probably a combination of low moisture levels and some late frosts that occurred in May and June of 2001. (See discussion of oak borers provided earlier for the potential implications of this in terms of a borer problem in urban oaks).

Riparian vegetation is suffering statewide from low water levels. This is particularly evident in streams flowing into the east side of the San Luis Valley from the Sangre de Cristo Range. Narrowleaf cottonwoods lining these streams in the vicinity of Crestone,

to name one town, are dead. Widespread dieback and mortality of cottonwoods is also evident throughout the San Luis Valley, on the Eastern Plains, and in the southwestern corner of the state.

Junipers, perhaps the most drought-tolerant trees in Colorado, are also showing signs of drought stress. Attacks by "cedar bark beetles" in the genus *Phloeosinus* are now evident in certain areas such as Mesa Verde National Park, along the Arkansas River between Salida and Canon City, and on the eastern plains.

## NEW ISSUES

### BANDED ELM BARK BEETLE (*Scolytus schevyrewi*)

In response to an increasing number of exotic wood-infesting organisms being imported to North America (Asian Longhorned Beetle, Emerald Ash Borer, Pine Shoot Beetle, numerous ambrosia beetles, and others), the USFS Washington Office, in cooperation with USDA-APHIS, PPQ, placed in spring 2003 a number of traps baited with general wood-boring insect attractants at a number of US sites. Most sites were along the coasts at ports, but a few were located inland. Sites near large quantities of solid wood packing material, such as pallet recycling facilities, were favored. One such site in Aurora, CO immediately after its placement in March began picking up an exotic bark beetle. This was determined to be *Scolytus schevyrewi*, a species with a Eurasian distribution, particularly Russia and China. Subsequent trapping and searches found this beetle to be widespread in Colorado (throughout the eastern plains and Front Range west to Durango). As of October 2003, it also has been detected in 8 other states (Utah, Kansas, Nebraska, New Mexico, Wyoming, Idaho, Nevada, and South Dakota) and will no doubt be found in others. CSFS was directly involved in the Wyoming, Nebraska, and South Dakota discoveries and found this beetle for the first time in trees (i.e. outside traps) in New Mexico. So-called "super stores" (particularly Walmart) are suspected of inadvertently introducing this insect via pallets made of elmwood having unknown quantities of bark attached. The latter pathway of introduction has not been proven but seems likely due to the distribution of discovery sites in relation to store locations. Because of its widespread distribution and ubiquitous presence, it appears this beetle has just been overlooked and that its introduction was at least 5 years ago (but not much longer than that).

The "so what" with this insect is that it appears to be very aggressive (at least 3 generations a year and an impressive ability to locate and colonize stressed trees), to have a biology that makes it a likely vector of Dutch Elm Disease (i.e. it breeds in dead trees (where if the host had been killed by DED, the beetle could become contaminated with the causal fungus *Ophiostoma ulmi*) and feeds on healthy trees, to which it could transfer the fungus), and to have a host range that not only includes elms but also willows, caragana (an important windbreak shrub native to the beetle's native range), Russian olive (native to the beetle's native range), and fruit trees in the genus *Prunus* (some of which, like Nanking cherry, are native to the beetle's native range). The aggressiveness of this beetle is illustrated in its apparent displacement already underway of the Smaller

European Elm Bark Beetle (*Scolytus multistriatus*), another exotic beetle introduced into the US in 1904 and our default vector for DED in Colorado. Despite a 100-year head start, the "old" beetle is already outnumbered in rearings from elmwood by a factor of 10+ to 1. The drought is helping provide a vast resource of stressed elms, including Siberian Elm, an exotic tree which, while not a particularly desirable species, makes up a high percentage of the tree resource in many towns on the eastern plains of Colorado. Siberian elms hold the potential to breed huge numbers of the beetles which would be available to contact DED from dying American Elms and then be a threat to spread the disease to the remaining (75,000?) valuable American Elms left in our cities. The State of Colorado, as vested in the Colorado State Forest Service and numerous city forestry departments, has spent millions of $ over the last 35 years to combat and slow the spread of DED with good success. It would be a shame to see a new beetle and relaxed attention to DED detection and sanitation essentially eliminate American and other large-leaved elm species from our cities and towns.

**OAK BORER(S)**
(following fact sheet prepared for Colorado Nursery Association in fall of 2003:)

OAK BORERS IN COLORADO

INTRODUCTION: In Colorado during 2002 and particularly 2003, a large number of ornamental oaks in nurseries and outplantings have shown infestation by an unidentified metallic wood borer. Areas affected so far include the Front Range south of Longmont and southwestern CO. Current thinking is that the source of this problem could be infested nursery stock from the Midwest and/or borers emigrating from native Gambel oak stands. The following write-up summarizes what we know, what we don't know, and what makes sense in managing this situation.

IDENTITY OF THE INSECT(S) INVOLVED: Clearly the primary borer involved is in the genus *Agrilus* and could be likely *A. bilineatus*, the Two-lined Chestnut Borer. However, a few native species could also be involved in attacks on native Gambel oak (*Quercus gambelii*), particularly *A. quercicola* and *A. acutipennis* (see below). All have one or two-year life cycles, with adults appearing primarily in late spring and summer. Infested material is currently being held in rearing cages but adults are not expected for several months.

**[*A. quercicola* has been reared from infested oaks in the spring of 2004, and is confirmed as at least one of the insects involved.]**

EXTERNAL SYMPTOMS OF INFESTATION: Infestation is largely "invisible" until the crown shows symptoms of foliage thinning, foliage browning, or branch dieback. Initial attacks are usually in the upper crown and progress downward. Certain trees show areas of wet or gummy bark (mostly white oaks), and individual hosts vigorous enough to fight the infestation may show raised areas of bark above the winding larval galleries under the bark (mostly red oaks). This raised area resembles a vein under human skin.

The adult exit holes in the bark are D-shaped and are a little over 1/16 inch wide. Bumble flower beetles (*Euphoria inda*), a species of scarab sometimes seen at bacterial wetwood ooze, have also been seen at sites of borer-induced gum exudation. The presence of these brown beetles buzzing around oaks could be a borer indication.

INTERNAL SYMPTOMS/SIGNS OF INFESTATION: Upon peeling the bark, infested trees show zig-zagging larval galleries of the borer. The galleries may be from 1/32 of an inch wide to 1/8 inch wide, depending on the stage of larval development, and may completely encircle small diameter stems. The track of an individual larva can run for several inches, generally runs diagonally straight for a stretch, then turns roughly 90 degrees and diagonally runs straight, etc. As the gallery progresses, it widens slightly. There may be periodic patches of wet inner back along the path and there may be some dark staining of the wood near the gallery. The gallery can be right beneath the bark or under the outer 1 or 2 rings of wood (thus, to find larvae or tracks you may need to carve into the wood beyond just what is visible with the bark peeled). Larvae of *Agrilus* are very narrow and have flattened, segmented white bodies up to 1 inch in length. The head end of an *Agrilus* larva is as narrow as the rest of the body, unlike most flatheaded wood borer larvae that have wide thoraxes and resemble horseshoe nails in shape.

HOSTS ATTACKED: So far, most of the ornamental infestation has been found in bur oak (*Quercus macrocarpa*) but other species such as swamp white (*Q. bicolor*), northern red (*Q. rubra*), and others can harbor this insect. Considerable dieback (from drought and late frosts) also exists in our native Gambel oak (*Q. gambelii*) and flatheaded borers, including *A. quercicola*, have been found in such trees. To date we think the ornamental material is probably afflicted with *A. bilineatus* and the native oakbrush with our native *Agrilus* species. But, of course, intermixing is possible and could be a source of confusion (albeit confusion that makes little difference from an on-site management standpoint).

THE NATURE OF THE BEAST: The borer species involved in this situation are not particularly aggressive or scary. They could be called "moderately" aggressive, at best. If this is a native insect, the problem could stem from simply a large population size. Even so, it appears if we can manage stress, we can manage this situation. In the interim, considerable amounts of money could be lost, yes, but a continuation of losses is not inevitable.

WHAT CAN BE DONE?

.Infested nursery stock not fit for sale or outplanted trees beyond recovery should be destroyed, preferably by chipping, burning, or deep burial. Take pictures and document your losses for possible compensation from suppliers.

.Lightly infested trees may be treatable with external sprays to prevent further infestation and/or systemics to kill larvae under the bark.

.In the future, oak nursery stock should be inspected AT THE TIME OF RECEIPT. This may involve some peeling of bark and other forms of destructive sampling. <u>In purchase</u>

contracts it may be advisable to include the right to conduct such inspections without paying for the sampled trees.

.Properly water and otherwise maintain nursery stock and outplantings. Trees that seem particularly at risk are those held over in nurseries for an extra summer or those that have been transplanted within the last few years. Oak *Agrilus* borers are not aggressive and are only capable of attacking stressed trees. Vigorous trees should not be at risk, particularly when the large population subsides. As always, problem situations include drying of root balls, wounding of trunk bark, constricting root collar twine, undersized root balls, healing-in areas or berms that do not receive regular waterings, etc.

.Communicate about suspected sources of infested stock and let your Colorado Nursery Association and the Colorado Department of Agriculture do what they can to stop problems at their origin. Prevention is always easier than culling lost stock or replanting.

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**WHITE PINE BLISTER RUST**

This disease of 5-needled pines (i.e. "white pines") was introduced from Asia via Europe into the Northeast and Northwest U.S. in separate incidents early this century. Since the 1921 introduction of the disease at Vancouver, B.C., the disease has slowly spread southward in the western U.S. Prior to this year, the only known occurrence of WPBR in Colorado was in northern Larimer County, where it spread naturally from Wyoming in the last few decades. In 2003 an area of infection was detected by the USFS at a widely separate location at Mosca Pass east of the Sand Dunes National Monument in the San Luis Valley (SLV). It is speculated that this fungus arrived to limber pines at Mosca Pass on spores carried on south winds from known infected areas in New Mexico or perhaps from infected ornamental currants (the alternate host) planted in towns of the SLV. Also of interest and possible ecological significance is the detection at Mosca Pass of infected bristlecone pines, a new host record for Colorado.

# Report to the Great Plains Tree Pest Council
# April 14-15, 2004; Rapid City, SD

**LAKEWOOD SERVICE CENTER, FOREST HEALTH MANAGEMENT**
USDA FOREST SERVICE, ROCKY MOUNTAIN REGION (R-2)

**Lakewood Service Area:** Northern Colorado, Kansas, and southeastern Wyoming

## Lakewood Service Center Staff:

| | | | |
|---|---|---|---|
| Service Center Leader | Jeff Witcosky | jwitcosky@fs.fed.us | (303) 236-9541 |
| Entomologist | Bob Cain | rjcain@fs.fed.us | (303) 236-9552 |
| Plant Pathologist | Kelly Sullivan | kfsullivan@fs.fed.us | (303) 236-8006 |
| Computer Specialist | Bernard Benton | bbenton@fs.fed.us | (303) 236-8002 |
| SCEP Entomologist | Sheryl Costello | | |
| Biological Technician | Brian Howell | behowell@fs.fed.us | (303) 236-1020 |
| Term Biological Technician | Vacant | | (303) 236-8008 |
| Student Technician | Meg Halford | mhalford@fs.fed.us | (303) 236-8008 |

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## Regional Office Staff:

| | | | |
|---|---|---|---|
| Director of Renewable Resources | Marisue Hilliard | mhilliard@fs.fed.us | (303) 275-5014 |
| Forest Health Management Group Leader | Frank Cross | fjcross@fs.fed.us | (303) 275-5061 |
| Forest Health Monitoring Coordinator | Jeri Lyn Harris | jharris@fs.fed.us | (303) 236-3760 |
| Aerial Survey Specialist | Erik Johnson | ejohnson02@fs.fed.us | (303) 236-8001 |

**Function:** We provide technical assistance on forest pest problems and forest health issues to federal land management agencies. We cooperate with state and other federal agencies to provide assistance on state and private lands.

**Websites:** R-2, Forest Health Management: www.fs.fed.us/r2/fhm
This site, created by Jim Worrall, Plant Pathologist at our Gunnison Service Center, includes a bulletin board, reports, staff listings, links, and much more. Our internet address site will change soon to: www.fs.fed.us/r2/resources/fhm

National Office, Forest Health Protection: www.fs.fed.us/foresthealth
This site provides national program descriptions, forest insect and disease leaflets on line, publications, the national mortality risk map, and much more.

## Staff Changes:

- Sheryl Costello has accepted our Student Career Experience Program (SCEP) Entomologist position in Region 2. She will start working with Forest Health Management in October 2004.

- Brian Howell filled the vacant Biological Technician position in March 2004.

## Some Items of Significance for the Great Plains

### (1) White Pine Blister Rust

The White Pine Forest Health group prepared and released a brochure entitled "White Pine Blister Rust. What you can do to slow the spread". The brochure is intended to increase awareness regarding identification of the fungus on host plants and procedures to limit its spread into the central Rocky Mountains and the Great Plains.

Isolated outbreaks of white pine blister rust in limber pine were discovered in the Wet Mountains (Custer County) and the Sangre de Cristo Mountains (Huerfano and Alamosa Counties) areas of Colorado in 2003. White pine blister rust was discovered for the first time on a single Rocky Mountain bristlecone pine in the Sangre de Cristo Mountains. Kelly Sullivan received funding to survey these areas in greater detail in 2004.

### (2) Scoyltus schevyrewi – Banded Elm Bark Beetle (proposed common name)

S. schevyrewi was recorded for the first time in the United States in 2003. The beetle is native to Asia and eastern Russia. The banded elm bark beetle has been recovered from American, English, rock, and Siberian elms in the U.S.

In the Denver area, the S. schevyrewi is active as early as March or April and remains active until late October or early November. The beetle completes a generation in less than eight weeks during the summer months.

The banded elm bark beetle appears to be somewhat more aggressive than another common exotic elm bark beetle, S. multistriatus (European elm bark beetle). In the Denver area, the banded elm bark beetle appears much more abundant than the smaller European elm bark beetle in traps baited with the multistriatus lure.

A study completed in 2003 indicates that the chemical, methyl butenol, is nearly as effective as the multistriatus lure at trapping S. schevyrewi. The benefit of using methyl butenol is that it attracts S. schevyrewi almost exclusively. Use of the multistriatus lure results in the capture of S. multistriatus and S. schevyrewi, so samples must be sorted under a dissecting scope for identification purposes.

Specimens of S. schevyrewi were sent to Dr. Tom Harrington, Iowa State University, for analysis of fungal associates of the beetle. Dr. Harrington did not recover any serious plant pathogens from the beetles and did not find any Ophiostoma spp., including the Dutch elm disease pathogen. Whether S. schevyrewi is able to serve as a vector of Dutch elm disease remains to be evaluated.

### (3) Agrilus quercicola – A Woodborer of Gambel Oak

Several reports of borers (Agrilus spp.) in nursery stock and street and yard trees resulted in some additional concerns regarding exotics in 2003. However, recent emergence of beetles from some of the infested material suggests that the damage was being caused by the native oak woodborer, A. quercicola. Additional infested material is being held to determine if species other than A. quercicola are present and contributing to the observed damage.

A. quercicola infests gambel oak, Quercus gambelii. The severe drought has contributed to the decline of gambel oak stands and may explain the increase in abundance of this woodborer.

## Recent Publications

**Worrall, J.J., Sullivan, K.F., Harrington, T.C., and Steimel, J.P. 2004.** Incidence, host relations and population structure of Armillaria ostoyae isolates in Colorado campgrounds. Forest Ecology and Management 192 – 206.

**Blodgett, J.T., and Sullivan, K.F. 2004.** First report of white pine blister rust on Rocky Mountain bristlecone pine. Plant Disease 88: 311.

## Recent Biological Evaluations

**Cain, R.J., Sullivan, K.F., and Jorgensen, C.L.** 2003. Biological evaluation of mountain pine beetle activity on the Arapaho National Recreation Area (ANRA) and of dwarf mistletoe on ANRA recreation sites. Arapaho-Roosevelt National Forests, Colorado. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-03-01. 34 p.

**Jorgensen, C.L.** 2003. Biological evaluation of spruce beetle and mountain pine beetle for the Hahns Peak/Bears Ears and Parks Ranger Districts, Medicine Bow-Routt National Forests, 2003. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-03-05A. 17 p.

**Cain, R.J., and Jorgensen, C.L.** 2003. Biological evaluation of mountain pine beetle activity on the Green Ridge area of Parks Ranger District, Medicine Bow-Routt National Forests, 2003. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-03-05B. 29 p.

**Sullivan, K.F.** 2003. Biological evaluation of insect and disease conditions in Teal Lake Campground. Parks Ranger District, Medicine Bow-Routt National Forests. USDA Forest Service, Rocky Mountain Region, Biological Evaluation R2-03-06. 28 p.

## Recent Service Trip Reports

| | |
|---|---|
| **LSC-03-01** | Forest insect problems at the Monument Fire Center (Pike and San Isabel NFs) |
| **LSC-03-02** | White pine blister rust survey of Canyon Lakes Ranger District (Arapaho-Roosevelt NF) |
| **LSC-03-03** | Service Trip Report to the Dillon Reservoir Campgrounds and the Frisco Nordic Center Project Area (White River NF) |
| **LSC-03-04** | Spruce beetle management recommendations for Silver Lake Campground, 2003. Medicine Bow-Routt NFs) |
| **LSC-03-05** | Decay of living conifers in spruce-fir forests of the central Rocky Mountains. |
| **LSC-03-06** | Insect and disease monitoring reports for the Medicine Bow and Routt National Forests, 2002. |
| **LSC-03-07** | White pine blister rust information sheet. |

# Report to the Great Plains Tree Pest Council
## Meeting in Rapid City, SD; April 14-15, 2004

## Rapid City Service Center, Forest Health Management
## USDA Forest Service, Rocky Mountain Region (R-2)


**Service Center Staff:**

| | |
|---|---|
| Kurt Allen | Leader/Entomologist |
| Jim Blodgett | Plant Pathologist |
| Denise Hardesty | Biological Technician |
| Dan Long | Forest Health Technician |
| Bill Schaupp | Entomologist |

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**Service Area:** All of South Dakota, except northwest corner; All of Nebraska; Northern Wyoming east of the Continental Divide.

## Summary of Rapid City Service Center: 2003 – 2004

### Personnel
Denise Hardesty has been hired as a term Biological Technician. Starting in 1995, she has worked every year as a seasonal employee at the Rapid City Service Center.

### The Mountains
Coniferophagous tree-killing bark beetles continued to dominate the activities of the Rapid City Service Center staff in 2003. Epidemic populations of mountain pine, spruce, Douglas-fir, and western balsam bark beetles once again increased dramatically, spreading within our service area in Wyoming. Pine engraver and mountain pine beetle populations behaved similarly in the Black Hills. The effects of wildfire and associated insect activity continued to generate interest in wood borers, pine engravers, and red turpentine beetles.

### Blister Rusts
White pine blister rust occurs at varying infection levels in several whitebark and limber pine stands in Wyoming. Mortality associated with this disease appears to be intensifying in Wyoming. White pine blister rust has been found in a stand of limber pine in Custer State Park of South Dakota.

The Commandra blister rust and white pine blister rust permanent plots were re-measurements in 2003.

### *Sphaeropsis* in the Hills
Sphaeropsis canker disease (*Diplodia*) is a continuing problem in the Black Hills. A recent area of hailstorms damage was found along Highway 385 west of Wind Cave, and Sphaeropsis shoot blight was identified on branches, needles, and cones. We plan to revisit the site and establish semi-permanent plot to monitor forest health conditions. Wounds caused by hail have been associated with *Sphaeropsis* mortality, and mortality due to this disease can be enhanced by drought.

### The Great Plains
Aerial overview detection survey – A record 43.2 million acres was flown in 2003 over the five states comprising the USDA Forest Service Rocky Mountain Region by a combined workforce of 10

federal and state employees working from 4 aircraft. Responding to a request from the Bureau of Indian Affairs (BIA), an aerial survey of tribal nation and BIA-administered lands was conducted in Nebraska and South Dakota by Erik Johnson (R-2, FHM's Aerial Survey Program Manager) and Bill Schaupp. Much of this effort focused on riparian forests, but also covered shelterbelts, wooded draws, and plateau ridges. The Nebraska and Samuel P. McKelvie National Forests in Nebraska and state and private lands in Nebraska and South Dakota were also flown. The total area covered by this Great Plains survey was 6.5 million acres. A weeklong follow-up ground checking trip revealed just how difficult it is to survey hardwoods. For example, in northeastern South Dakota, what was coded as impacts from defoliators turned out to be caused by herbicide drift. While there is no substitute for on-site examination, the overview detection survey provided a valuable overview. Such a survey had not been done before over most of the area covered in the Plains. We detected significant impacts including the prevalence of Dutch elm disease; an unidentified fungus coded as defoliation on bur oak; various abiotic effects such as fire, wind and hail; Sphaeropsis canker disease (*Diplodia*); and aggressive tree-killing by what is likely several *Ips* species in the natural and planted pine forests of the Nebraska and South Dakota plains. The Nebraska National Forest survey report has been written, and a report covering the remainder of the survey area will be finalized soon. A preliminary report to the BIA included the following table:

| Reservation | Survey Dates | Primary Impacts Detected |
|---|---|---|
| Wind River | 7/10-15/2002<br>7/15-18/2003 | Douglas-fir beetle kill, limber pine decline incl. mountain pine beetle kill, white pine blister rust |
| Pine Ridge | 6/27/2003 | pine engraver beetle, fire, Sphaeropsis canker disease |
| Rosebud | 6/27/2003 | pine engraver beetle, fire |
| Omaha | 7/01/2003 | Dutch elm disease, oak leaf fungus |
| Winnebago | 7/01/2003 | Dutch elm disease, oak leaf fungus |
| Santee Sioux | 7/01/2003 | Dutch elm disease, oak leaf fungus, dead red cedar |
| Standing Rock | 6/28/2003 | (old) dead hardwoods |
| Cheyenne River | 6/28/2003 | (old) dead hardwoods, cottonwood discoloration and defoliation |
| Sisseton | 6/30/2003 | herbicide drift onto box elder |
| Crow Creek | 6/28/2003 | (old) dead hardwoods, dead red cedar |
| Lower Brule | 6/28/2003 | (old) dead hardwoods, dead red cedar, cottonwood dieback |
| Yankton | 7/01/2003 | oak leaf fungus, Dutch elm disease |

**Service Trip Reports:**

RCSC-7-03 - Mountain pine beetle sanitation at the private/public lands interface, Black Hills National Forest

RCSC-8-03 - Bark beetle epidemics on Carter Mountain, Shoshone National Forest

RCSC-9-03 - Progress report on aerial forest pest detection surveys, Great Plains Region, Bureau of Indian Affairs

RCSC-10-03 - Spruce beetle on Bald Mountain, Bighorn National Forest

RCSC-11-03 - Mountain pine beetle concerns in the Coulsen EA, Black Hills National Forest

RCSC-12-03 - Insect and disease detection at Wind Cave National Park

RCSC-1-04 - Mountain pine beetle in the West Mystic Insect and Fuels Project Area, Black Hills National Forest

RCSC-2-04 - Spruce beetle activity on portions of the Bighorn National Forest

RCSC-3-04 - Fort Meade survey, Bureau of Land Management, Belle Fourche

RCSC-4-04 - Aspen at Mt. Rushmore National Monument
RCSC-5-04 - Tree killing bark beetle activity on the Wind River Ranger District, Shoshone National Forest
RCSC-6-04 - Insect and disease activity in the Deerfield Area, Black Hills National Forest
RCSC-7-04 - Aerial Survey in 2003 of the Nebraska and Samuel P. McKelvie National Forests
RCSC-08-04 - Damaged trees on Highway 385 west of Wind Cave, Black Hills

**Evaluations:**

Allen, K. K. and D. F. Long. 2003. Evaluation of the Douglas-fir beetle on the Shoshone National Forest, Wyoming. *USDA Forest Service, Rocky Mountain Region, Renewable Resources, Biological Evaluation* R2-04-01, 10pg.

Allen, K. K. 2003. Evaluation of MPB activity on the Black Hills National Forest. *USDA Forest Service, Rocky Mountain Region, Renewable Resources, Biological Evaluation* R2-04-02, 17 pgs.

Schaupp, W. C. Jr. 2003. Evaluation of the Spruce, Mountain Pine, and Douglas-Fir Beetle Populations on Carter Mountain, Shoshone National Forest, Wyoming. *USDA Forest Service, Rocky Mountain Region, Renewable Resources, Biological Evaluation* R2-03-09, 24 pgs.

**Publications:**

McMillin, J. D. and K .K Allen. 2003. Effects of Douglas-fir beetle (Coleoptera: Scolytidae) infestations on forest overstory and understory conditions in western Wyoming. Western North American Naturalist 63(4): 498-506.

McMillin, J. D., Allen, K. K., Long, D. F., Harris, J., and Negron, J. F. 2003. Effects of western balsam bark beetle on spruce-fir forests of north-central Wyoming. Western Journal of Applied Forestry 18(4):259-266.

Bonello, P., and Blodgett, J. T. 2004. *Pinus nigra-Sphaeropsis sapinea* as a model pathosystem to investigate local and systemic effects of fungal infection of pines. Physiological and Molecular Plant Pathology (in press).

Blodgett, J. T., and Sullivan, K. F. 2004. First report of white pine blister rust on Rocky Mountain bristlecone pine. Plant Dis. 88:311.

Blodgett, J. T., Bonello, P., and Stanosz, G. R. 2003. An effective medium for isolating *Sphaeropsis sapinea* from asymptomatic pines. Forest Pathology 33:395-404.

Blodgett, J. T., and Bonello, P. 2003. The aggressiveness of *Sphaeropsis sapinea* on Austrian pine varies with isolate group and site of infection. Forest Pathology 33:15-19.

## Planned Work at Rapid City Service Center for 2004

Insects and Diseases:

- Evaluation and monitoring of direct and indirect effects of hail damage to ponderosa pine stands on the Black Hills National Forest
- Disease, damage, and insect survey of limber and whitebark pines in the Shoshone National Forest

Insects:

- Gypsy moth detection trapping in recreation sites of national forest and parks in South Dakota and Wyoming

- Bark beetle brood and line/transect sampling: spruce beetle, *Ips*, mountain pine beetle, Douglas-fir beetle, and western balsam bark beetle in the Black Hills, Bighorn, and Shoshone National Forests
- Interaction between fire-damaged ponderosa pine and insects
- Risk-rating of uneven aged ponderosa pine stands in the Black Hills
- Impacts of Douglas-fir beetle on forest conditions in the Bighorn National Forest
- Using MCH to prevent Douglas-fir and spruce beetle attacks
- Ips infestations following jack pine budworm defoliation on the Bessey Ranger District, Nebraska National Forest

Diseases:

- White pine blister rust and 5-needle pine interactions in Wyoming
- Interaction between fire-damaged and *Armillaria* in ponderosa pine forests of the Black Hills
- *Armillaria* distributions and species survey of Wyoming
- Sphaeropsis canker disease (*Diplodia*) survey in the Black Hills, including an examination of *Sphaeropsis* as a latent pathogen of ponderosa pine

Aerial Detection Surveys:

- Black Hills, Bighorn Mountains, and perhaps some of the Shoshone National Forest
- Plains and riparian forests in Nebraska
    - Nebraska National Forest
    - State and private lands in the southeast

South Dakota Division of Resource Conservation and Forestry
Report to the Great Plains Tree Pest Council
April 14, 2004

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## Personnel update

Adrian Juttner, the Division's forest health specialist, left the Division in the summer of 2002. I have taken over the duties of the position again. I previously served as the Division's interim forest pest specialist between Richard Dorset's and Henry Burkwhat's employment and again between Henry's and Adrian's. At this time the Division and the University have signed an agreement to have me take over the duties in exchange of a reduced teaching load. I will have an office in Rapid City as well as Brookings. The Division is also developing a diagnostic laboratory at the Rapid City office.

## Current trends

Service foresters, along with the forest health specialist, provided more than 350 assists to private landowners during 2003. The forest health specialist, along with service foresters, provided another 780 assists to cooperative extension educators and conservation district personnel. The level of assistance was very high for some assists, particularly bark beetle infestations in the Black Hills, where extensive sampling was required to delineate infested pockets of trees. In other cases, services consisted of a disease or insect problem diagnosis and control recommendation for landowners.

The most common tree species inspected during technical assistance visits by service foresters from the South Dakota Division of Resource Conservation and Forestry was ponderosa pine (*Pinus ponderosa*)(19 percent). The remaining top five were green ash (*Fraxinus pennyslvanica*) (12 percent), Colorado blue spruce (*Picea pungens*) (9 percent), eastern redcedar (*Juniperus virginiana*) and Rocky Mountain juniper (*J. scopulorum*) (8 percent) and American elm (*Ulmus americana*) (7 percent). Other common species include Black Hills spruce (*Picea glauca* var *densata*), honeylocust (*Gleditsia triacanthanos* var *inermis*), silver maple (*Acer saccharinum*), and cottonwood (*Populus deltoides*).

The most common insect and mite problems are reflective of this species list. Problems associated with conifers generate the most calls with mountain pine beetle (9%) sphaeropsis (Dipolida) blight (*Sphaeropsis sapinea*) (9%), pine engraver beetle (*Ips pini*) (5%). Zimmerman pine moth (*Dioryctria* spp), spruce needleminer (*Endothenia*

*albolineana*), and rhizospaera needlecast (*Rhizosphaera kalkhoffii*) were also frequently identified as stressors. Broadleaf tree problems were generally borers, such as ash borer (*Podosesia syringae*) or bronze birch borer (*Agrilus anxius*). Defoliators, such as cankerworms (*Alsophila pometaria* and *Paleacrita vernata*) and tent caterpillars (*Malacosoma* spp), were also frequent reasons for a call. The most common disease question was related to Dutch elm disease (*Ophiostoma ulmi*) followed by apple scab (*Venturia inaequalis*).

The drought, continuing on for the third year in many regions of the state, has become a serious inciting stress factor, particularly in the northwest portion of the state. There has been an increase in tree mortality, particularly blue spruce, either directly or indirectly related to drought. This environmental stress may be associated with an increase in reports of borers such as ash bark beetles (*Hylesinus spp*), cottonwood borer (*Plectrodera scalator*) and Zimmerman pine moth.

Many problems were not associated with any insect or disease-causing pathogen. Improper planting, whether it be seedlings or whips planted in a shelterbelt or a 2-inch caliper shade tree planting in a residential landscape, is responsible for more reported tree mortality than any other stress. Trees planted so that the root collar or bud union is buried often decline and die within a year or two following placement. Another planting related problem is the longevity of fabric in shelterbelts. Fabrics are not breaking down as quickly as expected, resulting in the girdling of trees ten to twelve years after planting. Conservation districts are encouraging tree planters to make 'X's rather than slits for planting to allow for stem expansion. Misapplication of pesticides, particularly picloram, has resulted in the death and decline of pines and spruce in a number of locations across the state. Two misapplications alone appear to be associated with the loss of more than 200 mature conifers.

## Current issues

**Emerald ash borer (community tree inventories in South Dakota)**

The emerald ash borer (*Agrilus planipennis*) is a recent threat to ash trees in North America. The initial infestation occurred in southeastern Michigan and has now spread to some other areas of the state and country (and Ontario) via infested firewood and nursery stock. The Division is currently conducting a community forest inventory of street trees in selected towns and cities throughout the state. The communities to be inventoried have been selected based upon location and population size. When the inventory is completed we will have a valid representation of the entire state's street tree population. Data to be collected includes tree species, size, and condition. The objective of this survey is to provide the Division with a snapshot of tree diversity and health in our communities. Eight communities have been completed so far – and while not representative of the state - the data indicates a high reliance on green ash as a street tree. Approximately 29 percent of our street trees are this species, making the state highly vulnerable to the emerald ash borer.

On a related note, during two recent trips to northeastern China (primarily the Liaoning and Shadong providences) I was not able to find widespread infestations of emerald ash borer in Manchurian ash (*F. mandshurica*). It appears to colonize stressed

ash in its native environment and whether the Manchurian ash planted in this country will be as susceptible as our native species remains to be determined.

**Oak decline**

Bur oaks (*Quercus macrocarpa*) have been dying in several locations along the Big Sioux and Minnesota Rivers. The trees appear healthy one year then undergo a color change to the leaves the following year from green to pale green to brown within the season and by the third year much of the tree has died. While trees expressing these symptoms usually appear in pockets of five or more trees, it is common to find a symptomatic tree adjacent to a non-symptomatic tree. None of the sites have experienced any site disturbances, including flooding within the past 10 years and increment cores show that affected trees maintained normal diameter growth until the year twig dieback occurs. No two-lined chestnut borers (*Agrilus bilineatus*), pit scales (*Asterolecanium* spp) or other potentially threatening insects have been found on the trees. Armillaria (*Armillaria* spp) does not appear evident and tests for oak wilt (*Ceratocystis fagacearum*) have all been negative. Further investigation will continue this spring.

**Pinewood nematode**

The pinewood nematode (*Bursaphelenchus xylophilus*) is being identified as a serious problem in South Dakota. It was first noted in 1981 in an Austrian pine growing near the Gavins Point Dam in Yankton County and found shortly thereafter in ponderosa pines near St Martin Academy in Rapid City. In 1987 it was found in a Scotch pine (*Pinus sylvestris*) growing near Lake Andes. About a decade later it was found in Scotch pines growing in Bennett County. In all these instances the nematode was detected in a single tree or only a few trees. The problem appears to becoming more serious with widespread infestations identified near Martin in 2001 along with trees near Winner and Hermosa. The nematode has also been collected in Meade County where it was considered to be a contributing factor in the death of fire-damaged ponderosa pines. During the 2002 and 2003 growing season a number of conservation districts and service foresters collected samples from pines exhibiting symptoms that are associated with pinewood nematode infections. The following counties had samples logged into the lab: Bennett, Brown, Custer, Douglas, Fall River, Minneahaha, Moody, Pennington, and Todd. Only two counties had samples showing pinewood nematode infestation, Bennett and Fall River. It appears that the pinewood nematode problem is fairly localized and concentrated in the southwestern part of the state. However, there are also a number of sites across the state where Scotch pines are in serious decline. Either an unknown problem has developed in the state or these trees have pinewood nematode infestations but the tests have not been able to isolate the organism. The lack of evidence of pinewood nematodes in these trees may be due to the sampling method. Further testing will performed on suspected trees during the summer of 2004 by the forest health specialist.

**Pine engraver beetle**

The pine engraver beetle (*Ips pini*) is a common bark beetle in the Black Hills. In most years its role is as an opportunist colonizing damaged and weakened pines. The pine engraver beetle population has dramatically expanded in recent years due to the increase

in suitable host materials. The recent ice storms and fires have resulted in thousands of weakened trees, providing almost ideal conditions for beetle development. The population has expanded to the point where this insect is now successfully attacking apparently healthy trees. This increased population, and movement into healthy trees, means that the beetle can become a serious problem in the forests adjacent to sawmills. Beetles can be transported to the mills in infested logs and later emerge to move into nearby trees.

One method of reducing this problem is to install traps and a pheromone lure to capture the beetles in the immediate area. This management strategy referred to as mass trapping calls for the placement of funnel traps throughout and ringing the mill yard. A lure containing a pheromone specific to pine engraver beetles is placed in Lindgren funnel traps.

The Division conducted a mass-trapping program of two mills, Pope & Talbot and Rushmore Forest Products, to reduce the potential for pine engraver beetles emerging from infested logs and infesting trees outside of the mills. The trapping program was very successful with more than 200,000 beetles captured in traps placed around each mill. Another successful mass trapping program was conducted at the Belle Fourche Country Club. The club had removed many infested trees during the last winter but had not disposed of the slash. The slash makes an excellent breeding ground for the engraver beetles that then can spread to infest nearby healthy trees. The Division conducted a mass trapping on the course to reduce the spread of the insects from the slash to the trees. The program resulted in the trapping of more than 30,000 beetles throughout the season.

## Current research

The use of Cambistat as a means of improving birch defense against the bronze birch borer. The project is a cooperative venture with Rainbow Tree Care.

**North Dakota - Woody Plant Disease Research - Jim Walla, NDSU Plant Pathology**

**Report for Great Plains Tree Pest Council meeting, Rapid City, SD, April 14-15, 2004**

**1.Chokecherry X-disease (Primary current research)** (cooperators include Dai, Knudson):

Situation: Chokecherry is our most important native shrub used for conservation plantings. X-disease is the limiting factor in the use of chokecherry in the northern Great Plains; no controls are available. Disease tolerance/resistance would be the best control. Regional chokecherry seed source provenance plantings established in 1983 by the USDA Plant Materials Center in ND and SD are being examined for tolerance to X-disease; more than 20 promising plants have been identified in the ND planting. Research to confirm the existence of tolerance in those select plants is underway, and we are searching for more select plants. Genetic engineering is also being explored to develop disease resistant lines that could provide a superior disease management option.

RESULTS:

**- Development and characterization of select clones (ca. 75% of my time in 2003):**

1) About 40% of the eventual planned materials were graft-inoculated and planted into a field trial in 2003. Another 10-20% of the field trial materials will be inoculated and planted at that site in 2004.

2) All of the 32 chokecherry clones in tissue culture declined over summer and early fall, and two were lost before changes in procedures were implemented to rejuvenate the clones. This problem eliminated the possibility of having all materials ready for the planned two field trials and one greenhouse trial by 2004. The clones were rejuvenated, and plants are moving in large numbers through the process, so it appears that materials for all trials could be in place for 2005.

**- Characterization of disease development and selection of additional tolerance:**

1) Another rating was made of all plants in the North Dakota chokecherry germplasm planting. A severe hail storm in 2001 caused major damage to the materials in this planting. Most plants that had been seriously affected by X-disease were dead in 2003, finished off by the hail. Most of the plants that had appeared to be tolerant to X-disease in 2000 were still alive in 2003, although few were now rated as vigorous. Thus, apparent tolerance to X-disease may result in greater survival and better growth of the plants in the presence of X-disease infection, and in their ability to survive other stresses such as the hail storm.

2) A second rating was made of all plants in the South Dakota chokecherry germplasm planting. Survival of all plants and of possibly tolerant plants was substantially lower in 2003 than in 2000. Survival of the 2828 plants in the original planting dropped from 41% in 2000 to 25% in 2003. Clones with at least 50% survival dropped from 30% of the 151 clones in 2000 to 12% in 2003. The percentage of plants without symptoms (rating of 5) and with symptoms but in very good condition (rating of 4) was about 16% and 27% of the living plants, respectively, in both 2000 and 2003. Thus, it appears that few of those rated as select (4s and 5s) may have an advantage in survival compared to non-select plants. However, there were 23 clones in 2003 with greater than 66% of the living plants that were select, compared to 22 clones in 2000. Select plants comprised 100% of the surviving plants in five clones in 2003 compared to two clones in 2000. These comparisons indicate that there may be an advantage in favor of the possibly tolerant plants.

**- Aggressiveness of X-disease phytoplasma isolates:** Ten isolates have been inoculated into seedlings to assess their aggressiveness. Only two of 60 inoculated plants have shown X-disease symptoms after two growing seasons. That may be because few plants became infected or because it takes longer for the isolates to affect plant development. More inoculations will be made in 2004.

**- Genetic engineering for X-disease resistance**: Started research with Dr. Dai, NDSU Plant Sciences, in 2002 to insert the PAP-Y gene to develop disease resistant chokecherry clones. In 2003, a chokecherry transformation protocol was developed and tested. Improved methods of chokecherry propagation in tissue culture were developed. Some of our susceptible chokecherry clone controls were successfully transformed using GUS and kanamycin-resistance genes, so the protocol works. Methods to insert the PAP-Y gene into a plasmid were developed, and insertion was successful.

**2. Ash yellows of green ash** (cooperators include Dai):

Situation: Green ash is the most important tree species in ND. AshY phytoplasmas are prevalent across the Great Plains and adjacent Rocky Mountains. Because of the serious potential threat of this disease to our forestry resources, research is underway to characterize current or potential impact and options for disease management. Characterization of germplasm tolerance is the primary focus for development as a disease management option.

**RESULTS:**

1) The aggressiveness of 8 ash yellows (AshY) phytoplasmal isolates from ND and 3 standard strains was compared on green ash seedlings. Aggressiveness was assessed for three growing seasons by seedling size measurements and disease severity ratings. Aggressiveness varied significantly among isolates within years. Some isolates shifted in relative aggressiveness among years. Disease severity ratings appeared to be an appropriate measure of aggressiveness, but did not account for all types of damage among various isolates. The aggressiveness among ND isolates ranged from severe stunting to no effect. That range was much wider than that among the strains used as standards. Highly aggressive and moderately aggressive isolates were identified for use in evaluating AshY tolerance of ash.
2) 19 ash cultivars that are recommended for use in the Northern Plains are being propagated to evaluate their relative AshY tolerance. Rootstocks of a moderately and a highly tolerant green ash cultivar are needed for evaluation of AshY tolerance of the 19 cultivars. These rootstocks will be identified from among the 19 cultivars. For this, the cultivars must be grown on their own roots. Grafting of the cultivars onto seedling rootstock was highly successful, and produced materials available for rooting. Rooting of softwood cuttings and hardwood cuttings essentially failed. Propagation of ash cultivars on nurse roots again yielded good graft success, and rooting of the scions started in the second growing season. Using this method will take another two years before adequate materials are available for rootstock tolerance evaluations.

**3. Lophodermium resistance in pines**

Situation: A Lophodermium needle blight, caused by an undescribed *Lophodermium* species, has caused serious defoliation of ponderosa pine in northeast ND. Apparent resistance was observed, indicating the possibility of selecting resistant seed sources. In 1986, 100 seed source provenances of a regional ponderosa pine trial were planted to identify seed sources resistant to this disease. The pines were inoculated in 1999 using needles with fruiting bodies or symptoms of the *Lophodermium* species to identify sources of resistance. A fast-moving fire swept through the planting in 2000 and killed the needles and branches in the lower canopy.

- **Activites and Results:** The planting was re-inoculated in 2002 and 2003. In 2003, symptomatic needles with *Lophodermium* hysterothecia typical of the species were observed throughout the planting. Evaluations for resistance will be made if the disease develops to a damaging level.

**4. Other**

- **Linden mortality.** Several lindens were seen in the spring of 2003 in Bismarck and Fargo that had very small leaves or green buds that were not opening. Many of the affected trees were similar in diameter and form, indicating that they may be the same cultivar. There were usually lindens of a similar size nearby that appeared healthy. Those lindens are a little-leaf linden cultivar, but the cultivar is not known. Most of the affected trees are 5-6 inches dbh and 20-25 feet tall, with indications of very good growth over the last several years. The 2002 growth was much reduced from previous years. The unopened buds that appeared healthy in early June began to discolor by mid-June. Also, the phloem and xylem of most affected trees appeared healthy, but the cambium layer began to discolor on the lower trunk of some trees by mid-June. The outer xylem was dry in the lower stems, but wet below the graft union. Excavations indicated that both large and fine roots were alive, but the roots of affected trees had little or no food reserves, as indicated by lack of starch stained with iodine.

The working hypothesis for the problem is cold injury to the lower trunk in the winter of 2001-02. The possible specific cause was a five-day warm spell in April 2002 with temperatures above 70 F followed by temperatures below 20 F. That drop possibly damaged the cambium that became active during the warm days. The trees survived in 2002 on food reserves stored in the tree and transported up through the xylem. Now that the food reserves are depleted, they may not have the energy to leaf out. The adjacent healthy trees may have not had the damage due to delay in cambium activity associated with differences in the seedling rootstocks. It appeared that the affected trees would not recover. However, I heard that some of the trees did form new epicormic sprouts.

**Recent Publications** (published or accepted since last meeting)

Dai, W., Jacques, V., Walla, J., Cheng, Z.-M. 2003. Plant regeneration of chokecherry (*Prunus virginiana* L.) from *in vitro* leaf tissues. (Abstr.) HortScience 38:718.

Dai, W., Johnson, C., Jacques, V., and Walla, J.A. 2004. *Agrobacterium*-mediated transformation of chokecherry (*Prunus virginiana* L.). (Abstr.) HortScience (In Press).

Guo, Y.H., Cheng, Z.-M., and Walla, J.A. 2003. Rapid PCR-based detection of phytoplasmas from infected plants. HortScience 38:1134-1136.

Walla, J.A. 2004. X-disease of chokecherry - the basics. Prairie Fruit Journal 11(1):9-12.

Walla, J.A. 2004. Field trials to evaluate for X-disease tolerance in chokecherries. Northland News (In Press).

Walla, J. A. 2003. Axenic culture of *Peridermium harknessii*, *Cronartium quercuum* f. sp. *banksianae*, and *Cronartium comandrae*. In: Xu, M.-Q., Walla, J.A., and Zhao, W.-X. (eds.) Proceedings of the Second IUFRO Rusts of Forest Trees Working Party Conference, 19-23 Aug., 2002, Yangling, China. Forest Research 16 (Suppl.):33-43.

Walla, J. A., Cheng, Z.-M., Guo, Y., and Dai, W. 2003. Aggressiveness of ash yellows (AshY) phytoplasmal isolates from North Dakota. (Abstr.) Phytopathology 93:S88.

Walla, J.A., and Dai, W. 2004. Developing X-disease tolerance in chokecherry. Prairie Fruit Journal (In Press).

Walla, J.A., Jacobi, W., and Schmidt, R.A. 2003. Forest Pathology for the Last Century: A Retrospective and Directions for the Future. Phytopathology 93:1037-1038.

Wang, C., Walla, J. A., Tuskan, G. A., Cheng, Z.-M., and McClean, P. 2003. Western gall rust symptom development on ponderosa pine seedlings. In: Xu, M.-Q., Zhao, W.-X., and Walla, J. A. (eds). Proceedings of the Second IUFRO Rusts of Forest Trees Working Party Conference. 19-23 Aug., 2002, Yangling, China. Forest Research 16 (Suppl.):80-90.

Xu, M.-Q., Walla, J.A., and Zhao, W.-X. (eds.) 2003. Proceedings of the Second IUFRO Rusts of Forest Trees Working Party Conference, 19-23 Aug., 2002, Yangling, China. Forest Research 16 (Suppl.):1-228.

# Forest and Shade Tree Disease Studies
# Spring 2004

**Bill Jacobi, Ronda Koski, And Graduate Students: Sheryl Costello, Sam Harrison, Betsy Goodrich, and Holly Kearns**
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## Shade Tree Disease Studies:

1. Continued a sixth season of monitoring tree growth, tree water potentials, soil moisture, under three irrigation treatments at the Tree and Turf Research Facility.
2. Continued a study of water potential and health of old growth cottonwoods along the High Line Canal in Denver CO.

**Results:**

1. **Tree and turf growth:** No new findings but we have a Hort PhD student who will take over this project this year

2. **Wood chip mulch**: A manuscript by Koski and Jacobi on this project has been accepted at the Journal of Arboriculture and Ronda presented a poster at APS. We also are interested in cooperating with others to study the risk potential for invasive pests in wood chip mulch from pallets and other foreign wood products.

3. **Wisconsin elm hybrids**: No new work accomplished on these Hybrids from the Wisconsin breeding program.

4. **High line Canal Cottonwoods:** Ronda and I are writing up our results from this study into a manuscript.

**Plans for 2004 Shade Tree Disease Studies:**

1. Continue mulch and canker studies at the Tree and Turf Research site.
2. We will manage data taken by Denver Water and write a summary for Denver Water on the High Line Canal cottonwood study.
3. Start a National Elm Trial in cooperation with NCR- 193 members and other cooperators.
4. Help coordinate EAB efforts in the state

**Forest Tree Insect/Disease Studies**

1. **Armillaria Root Disease:** We finished working on spatial relationships of Armillaria root disease and site features in the Black Hills of SD. We have one manuscript that is almost ready to submit.

2. **Black stain root disease on pinyon pine**: Kearns and Jacobi have two manuscripts that will be submitted this spring. Sam Harrison is still working slowly on his thesis on black stain.

3. **White Pine Blister Rust**: We (Kearns, Goodrich, Koski and Jacobi) are developing a hazard-rating model for white pine blister rust on white pine populations in the Central Rocky Mountain Region. Plots (450) were established on federal lands throughout southeastern Wyoming in the summer of 2002 and 2003 to assess the distribution, intensity, and severity of white pine blister rust. Large-scale Ribes plots were also established to evaluate the distribution and density of the alternate host. Meteorological analysis of this disease is progressing we will continue to maintain a system of meteorological monitoring sites in WY and CO this year.

4. **Ponderosa Pine Wood Borers:** Jose Negron at the Rocky Mt Station is funding Sheryl Costello to look at the best trap design and attractants to monitor wood borers in fire damaged ponderosa pine in the Black Hills. Sheryl spent the 2003 summer collecting insects with two trap designs and four attractants combinations

**Plans for 2004 Forest Insect/Tree Disease Studies:**

1. Publish the final paper on landscape scale distribution of Armillaria root disease on ponderosa pine in the Black Hills.

2. Complete Sam Harrison's thesis and wrap up the landscape scale research project on black stain root disease of pinyon pines. Publish Holly's two papers on the small-scale ecosystem impact of the disease section of this project.

3. Continue to facilitate coordination of folks working on white pine blister rust on five needle pines of the Central Rocky Mountains. We hope to find funding to study other aspects of limber and bristle cone pine health.

4. Continue to develop a preliminary hazard model of white pine blister rust to five needle pines in Colorado. Fieldwork in 2003 will be focused on determining where the rust front is in Colorado, Ribes species and their distribution in Colorado, obtaining additional incidence data near reliable meteorological stations. Continue to survey for blister rust in Colorado

5. Help with the wood borer study in the Black Hills

6. Research on the impact of MgCl on woody plants and riparian zones in Colorado will start this summer with Betsy Goodrich and Ronda Koski- with funding from two local counties.

**Publications:**


Walla, J. A., Jacobi, W. R. and R. A. Schmidt. 2003. Forest Pathology for the last century: An overview of the symposium. Phytopathology 93: 1037-1038.

Bishop, R. J., and Jacobi, W. R. 2003. Insects associated with black stain root disease centers in pinyon pine stands. Southwestern Entomologist 78:55-61

Kallas, M. A., Reich, R. M., Jacobi, W. R., and Lundquist, J. E. 2003. Modeling the probability of observing Armillaria root disease in the Black Hills. Forest Pathology 33:241-252.

Jacobi, W. R., Geils, B. W. and Taylor, J. E. 2002. Frequency of comandra blister rust infection episodes on lodgepole pine. USDA Forest Service, Rocky Mountain Research Station. RMRS RP-36:13 p.

W.R. Jacobi, S. Zeglen$_2$, J.A. Muir, R. S. Hunt. 2002. Black Stain Root Disease Mortality Rates on Douglas-fir in Coastal British Columbia. In: Proceedings of the 50th Annual Western International Forest Disease Work Conference. (Abstr.)

Holly S. J. Kearns, William R. Jacobi, and Jeri Lyn Harris·. 2002. The Distribution of White Pine Blister Rust in Southeast Wyoming In: Proceedings of the 50th Annual Western International Forest Disease Work Conference. (Abstr.)

Geils, B.W., Conklin, D., Frank, K., Guyon, J., Harris, J. L., Hoffman, J., Jacobi, W., Kearns, H., Newcomb, M., Smith, E., Van Arsdel, E., and D. Vogler. 2002. New Information on the Distribution of White Pine Blister Rust for 2002., Proceedings of the 50th Western International Forest Disease Work Conference. (Abstr.)

Smith, E.L.; Geils, B.W.; Kearns, H.S.; and W.R. Jacobi. 2002. The biogeography of blister rust invasions: the challenges of new outbreaks. 2002 Ecological Society of America Annual Meeting; Symposium on "The Rapid Decline of White Pine Ecosystems of the West: Causes, Consequences, and Restoration Strategies"; August 5-9, 2002, Tucson, AZ. (Abstr.)

Kearns, H.S.J. and W.R. Jacobi. 2002. Final report on the small scale analysis of the impact of black stain root disease centers in pinyon pine. In: Jacobi, W.R. (ed.), Final report for cooperative agreement number RMS-98103and cost share agreement number 00-CS-11020000-026. Unpublished report delivered to USDA Forest Service, Rocky Mountain Region, Colorado State University, Fort Collins, CO: p 1-110.

Draft: 3/29/04

Proposed Emerald Ash Borer Exterior Quarantine:

A. A quarantine is imposed against the importation into Colorado for the following categories of nursery stock, logs and firewood:

1) All ash trees being brought into Colorado shall have documentation containing a declaration indicating where the ash trees were grown.
2) All ash trees grown, during any portion of their existence, in any area that is covered by the Federal Emerald Ash Borer Quarantine or any state quarantine for emerald ash borer is prohibited from entering Colorado.
3) After August 1, 2004, all ash trees grown during any portion of their existence in any state east of the Mississippi River and not covered by the Federal Emerald Ash Borer Quarantine or any state quarantine for emerald ash borer shall be treated for emerald ash borer according one of the following treatment protocols and shall be accompanied by an official treatment certificate issued by the appropriate certifying agency in the state of origin attesting to the facts concerning the application of the required pesticide as outlined below:

a) Soil drench treatment (for live ash trees): Trees must receive a soil drench application of imidacloprid (Marathon) at the full rate for borer control between June 1 and July 1; or

b) b. Trees must receive two applications of chlorpyrifos (Dursban) applied as a drenching trunk spray at rates labeled to control coleopteran borers. The first application must be made between May 20 and June 10, the second application during the first two weeks of July.

c) Records of these applications must be supplied with the shipped trees and a record of the shipment will be faxed or mailed to the Colorado Department of Agriculture, Division of Plant Industry as well (700 Kipling Street, Lakewood, Colorado 80217, FAX: 303-239-4177).

d) These records will be maintained in the office headquarters for the present calendar year plus the two previous years as well.

e) These applications (a) or (b), above, must be made in the growing season prior to shipment if shipment of the trees into Colorado occurs before June 1st.

f) If shipments of ash trees occur after June 1st, and before September 30th, then these applications (a) or (b), above, must have occurred in the present year plus treatments in the previous year as well.

g) Fumigation (for live ash plants and ash logs and firewood): to be supplied by Pat McPherren USDA APHIS

h) For the shipping season of 2004, no prophylactic treatments will be required, but will be a requirement after 2004. The prophylactic treatments required for the 2005 season will need to be applied in May, June and/or July of 2004.

4) All ash logs, whether whole logs or portions thereof, and ash firewood (split and un-split) and originating in any area that is covered by the Federal Emerald Ash Borer Quarantine or any state quarantine for emerald ash borer is prohibited from entering Colorado.

5) All ash logs, whether whole logs or portions thereof, and ash firewood (split and un-split) and originating in any area east of the Mississippi River must have the entire bark removed before entering Colorado.

6) Written notification to the CDA must occur within 24 hours of delivery of any shipment of ash trees coming into the state when said trees were grown for any portion of their existence east of the Mississippi River.

7) Records of the planting location of ash trees in Colorado is required for any tree shipped after January 1, 2004 into the state when said trees were grown for any portion of their existence east of the Mississippi River planted in Colorado.

8) This quarantine will be reviewed every 6 months based on available information and modified if necessary