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Forest Insect and Disease Conditions in the Southwestern Region, 2007

Cover photo: Defoliation caused by Douglas-fir tussock moth in Santa Clara Canyon, August 1, 2007. D. Ryerson.

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Conditions in Brief

The year 2007 was notable for major defoliation events in the forests of New Mexico and Arizona. Western spruce budworm activity expanded, new outbreaks of Douglas-fir tussock moth were reported, a fungal needle-cast affected piñon throughout much of southern New Mexico, and severe looper damage occurred near the Village of Cloudcroft. Other defoliators had significant—often dramatic—effects in more limited areas. Bark beetle activity continued at relatively high levels in the mixed conifer and spruce-fir types. White pine blister rust, an invasive exotic, was detected at several new locations in New Mexico.

Total bark beetle activity, mapped on 146,000 acres, was less than in 2006 (211,000 acres). Only about 38,000 acres of ponderosa pine were affected; as in the previous year, more than half this acreage was on the Gila National Forest. Mortality was mapped on about 70,000 acres of mixed conifer forest, attributed to fir engraver beetle (about 56,000 acres) and Douglas-fir beetle (14,000 acres). Mortality in the mixed conifer type was down only slightly from 2006 and has been at unusually high levels the past 4 to 5 years. Mortality increased in spruce-fir forests, most of it attributed to western balsam bark beetle (37,000 acres); a very significant die-off of corkbark fir has occurred over the past several years. Relatively little mortality was observed in the piñon-juniper type in 2007.

Western spruce budworm activity was high in 2007, with 455,000 acres mapped vs. 145,000 acres in 2006. As usual, most of the activity was in the mountains of north-central New Mexico, although budworm outbreaks also expanded in the Sacramento and Chuska Mountains. A Douglas-fir tussock moth outbreak in the Sandia Mountains continued for a fourth year, affecting 1,040 acres. New tussock moth outbreaks were detected on the Santa Clara Pueblo (200 acres) and the Tonto National Forest (1,540 acres). A looper (*Nepytia janetae*) outbreak continued in the Sacramento Mountains, affecting about 12,000 acres of mixed conifer in 2007, including stands directly adjacent to the village of Cloudcroft. Another looper (*Enypia griseata*) defoliated about 500 acres of spruce in Arizona's White Mountains. An outbreak of piñon needle cast was mapped on over 200,000 acres, mostly in southern New Mexico; the causal agent has been proposed as a new species of *Dothistroma*. Aspen defoliation and/or dieback was recorded on about 143,000 acres regionwide in 2007, a substantial increase from the previous year. Sawfly outbreaks affected ponderosa pine and piñon in portions of Arizona.

Dwarf mistletoes continue to have a major impact on growth and mortality of conifers in the Southwest. Over one-third of the ponderosa pine acreage and about one-half of mixed conifer acreage has some level of infection. Bark beetle activity is often associated with severe dwarf mistletoe infection. The incidence of dwarf mistletoe changes little from year to year, but is thought to have increased over the past century. Root diseases are widely distributed across the region, especially in higher-elevation forests. Root disease increases mortality in all size classes and creates hazard in heavily-used areas. White pine blister rust was detected for the first time on the Santa Fe National Forest and in the Zuni Mountains in 2007, and was found at several new locations on the Gila National Forest. Blister rust occurs throughout the Sacramento Mountains of southern New Mexico, where it is causing severe damage to southwestern white pine.

Status of Insects

Bark Beetles

Nearly all conifer mortality mapped during aerial surveys is attributed to bark beetles. Bark beetles are the primary tree killers in the region; however, mortality is most often a result of multiple factors, which may include disease, other insects, and especially drought. An additional consideration in interpreting aerial survey results is that the acreages reported represent areas where significant tree mortality occurred; often morality within these areas is quite scattered. The proportion of host trees actually killed within each area (polygon) varies from site to site. Estimates of number of trees killed are provided on our GIS maps.

Several different bark beetles attack ponderosa pine in the Southwest. In recent years, most of the pine mortality in Arizona has been attributed to *Ips* engraver beetles; in New Mexico, western pine beetle. Since both *Ips* and western pine beetle (and others, including roundheaded pine beetle) are often active in the same area (and frequently attack the same tree), the “mortality agent” attributed to a particular area is often a matter of interpretation. In the mixed conifer and spruce-fir forest types, distinguishing host trees (and hence, the particular beetle) can be difficult during aerial surveys. The accuracy of our determinations may vary—both from area to area and year to year—and are influenced by how much ground checking was accomplished.

The narratives which follow describe overall conditions and trends; site and landowner information is summarized in tables 2 and 3. In addition to reporting damage estimates for individual bark beetle species, we include summaries and recent trends by major **forest type**, which overcomes some of the difficulties inherent in identifying species from the airplane.

Western Pine Beetle

Dendroctonus brevicomis
Primary host: Ponderosa pine

Tree mortality attributed to this insect decreased dramatically in 2007, with only about 3,200 acres of activity mapped vs. about 80,000 acres in 2006. Similar levels of damage were reported from each State. In Arizona, the bulk of the activity was on the Coconino National Forest and vicinity, while in New Mexico the majority was on the Gila National Forest and the El Malpais National Monument.

Note that some of the apparent decrease in 2007 is a result of attribution: about 30,000 acres of scattered pine bark beetle activity on the Gila National Forest was attributed to *Ips* engraver beetles rather than western pine beetle as in previous years.

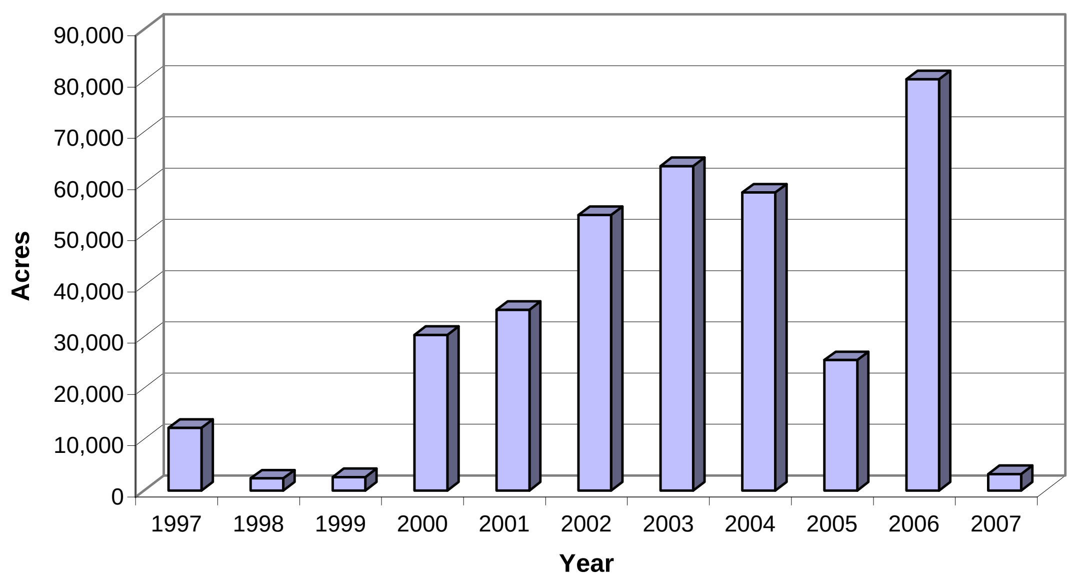


Figure 1. Western pine beetle activity in Arizona and New Mexico, 1997–2007

Mountain Pine Beetle

Dendroctonus ponderosae
Primary hosts: Ponderosa, limber and bristlecone pine

About 130 acres of activity was reported in Arizona, mostly on the north rim of Grand Canyon National Park. Historically, this insect has mostly been limited to the Kaibab Plateau in northern Arizona, although some activity (affecting limber pine) has been observed from the ground on the San Francisco Peaks and Kendrick Mountain near Flagstaff. Its occurrence in New Mexico has been infrequent; some of the 1997–2002 activity indicated in the graph below from northern New Mexico was probably western pine beetle.

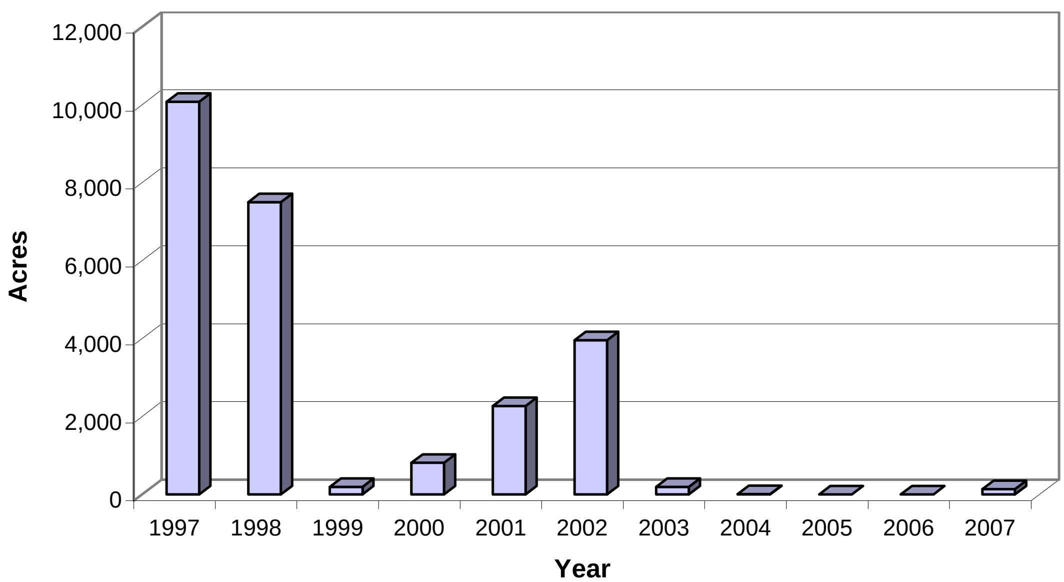


Figure 2. Mountain pine beetle activity in Arizona and New Mexico, 1997–2007

Roundheaded Pine Beetle

Dendroctonus adjunctus
Primary host: Ponderosa pine

Activity remained at low levels, with about only about 120 acres of activity observed in 2007, compared with 380 acres in 2006, all in southeastern Arizona. Areas affected include the Coronado National Forest and the Saguaro National Park (Rincon Mts.). Ground observations have indicated some recent activity west of the San Francisco Peaks.

Roundheaded pine beetle has a fairly wide distribution in the region, is often associated with other bark beetles, and may be active in areas where mortality is attributed to other species. However, southeastern Arizona and the Sacramento Mountains of southern New Mexico have been the primary foci of this insect.

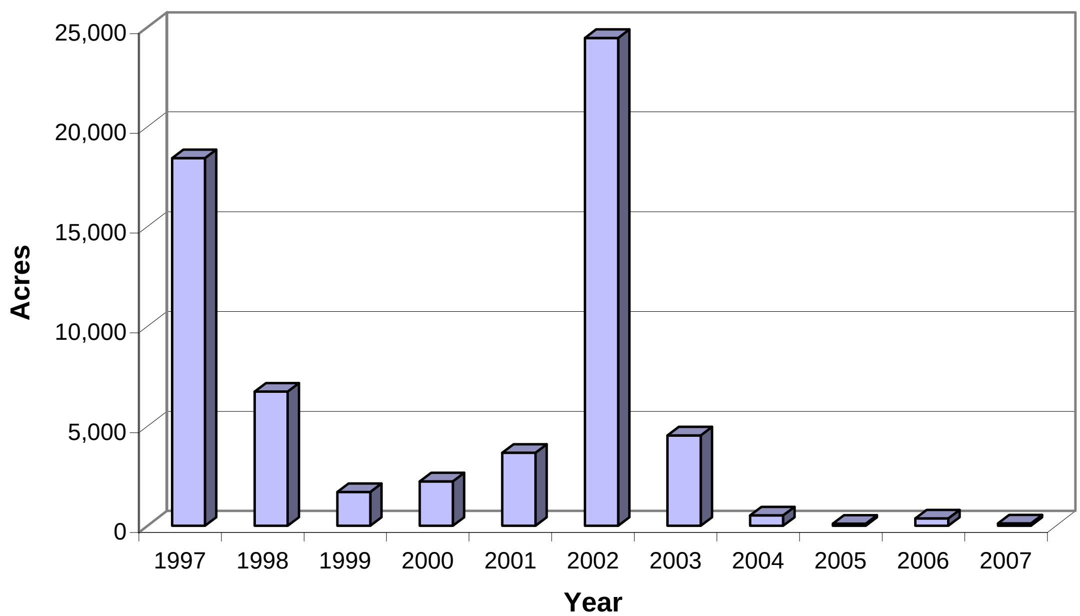


Figure 3. Roundheaded pine beetle activity in Arizona and New Mexico, 1997–2007.

Ips Beetles

Ips spp.
Primary hosts: Ponderosa pine, piñon

Ponderosa pine mortality attributed to *Ips* beetles increased regionwide in 2007, with about 34,000 acres mapped vs. 18,000 acres in 2006. However, this apparent increase is mostly due to a change in attribution on the Gila National Forest, where much of the 2007 ponderosa pine mortality was mapped (see Western Pine Beetle section). Overall activity in Arizona actually decreased substantially in 2007, although an upswing did occur on the Apache-Sitgreaves National Forest. Some late season activity was observed (from the ground) on the Prescott National Forest. Activity apparently increased in northern New Mexico, although this could also be due to attribution.

Ips and *Dendroctonus* beetles frequently occur in the same area, and often attack the same tree. In recent years, several species of *Ips* have been found attacking ponderosa pine in Arizona, including *I. lecontei*, *I. pini*, *I. calligraphus*, *I. latidens*, *I. knausi*, and *I. integer*.

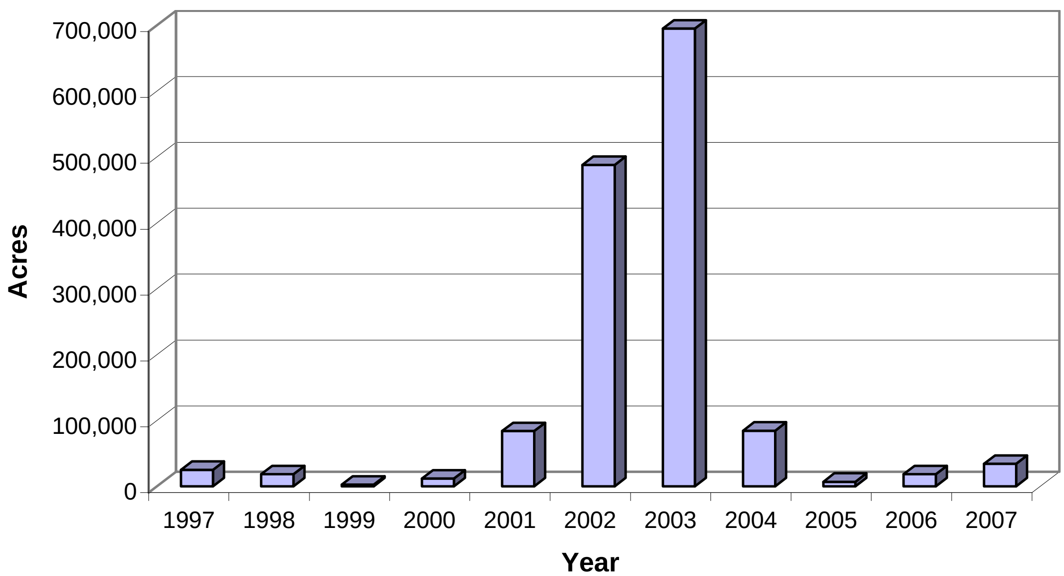


Figure 4. *Ips* beetle activity in ponderosa pine in Arizona and New Mexico, 1997–2007.

Piñon mortality, caused primarily by *Ips confusus*, was detected on about 4,500 acres regionwide, compared with 5,800 acres in 2006. Most of the recorded activity in 2007 occurred on Hualapai tribal lands in Arizona. Piñon mortality decreased substantially in most other areas affected in 2006, including Navajo and Zuni tribal lands.

Douglas-fir Beetle

Dendroctonus pseudotsugae
Host: Douglas-fir

Douglas-fir beetle activity continued at relatively high levels regionwide, with about 14,000 acres of activity observed in 2007 vs. 15,400 acres the previous year. Overall, activity increased in Arizona but decreased in New Mexico, although New Mexico continued to have more total acreage affected. Notable upswings were recorded on the Apache Sitgreaves, Coronado, and Kaibab National Forests in Arizona, and on the Gila National Forest and Valles Caldera National Preserve in New Mexico.

Note that some acreage depicted in the graph from peak years 2003–2005 was later determined to represent fir engraver beetle (white fir mortality) rather than Douglas-fir beetle. Also note that while Douglas-fir mortality is generally attributed to Douglas-fir beetle, other agents including dwarf mistletoe, armillaria root disease, Douglas-fir engraver (*Scolytus monticolae*), and Douglas-fir pole beetle (*Pseudohylesinus nebulosus*) may also contribute significantly on some sites.

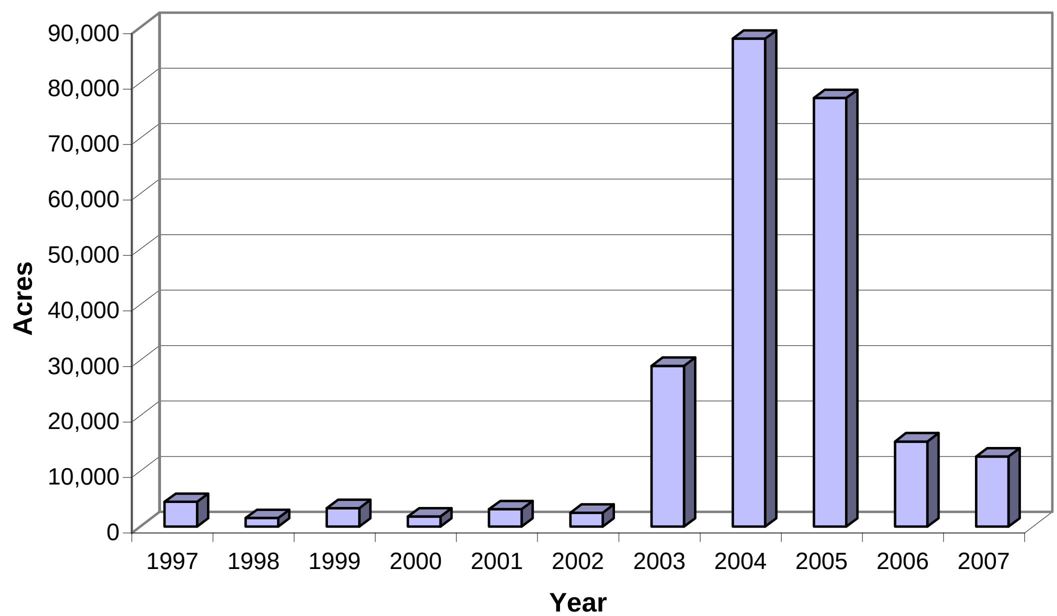


Figure 5. Douglas-fir beetle activity in Arizona and New Mexico, 1997–2007.

True Fir Beetles

Fir Engraver, *Scolytus ventralis*
Host: White fir

Western balsam bark beetle, *Dryocoetes confusus*
Hosts: Subalpine/corkbark fir

Mortality of true firs continued at high levels throughout the region in 2007, increasing overall to about 92,000 acres affected compared to 71,000 acres in 2006. New Mexico, with the lion's share of the mixed conifer and spruce-fir types, continued to sustain most of this damage. There, fir engraver activity was mapped on about 49,000 acres, and western balsam bark beetle on about 35,000 acres. Mortality of true firs increased throughout most of northern New Mexico, particularly on the Santa Fe National Forest (with nearly 30,000 acres affected), while generally decreasing in the south, especially on the Gila National Forest. In Arizona, notable increases in true fir mortality were observed on the Apache-Sitgreaves and Coronado National Forests. Past research has shown that fir mortality is often associated with root disease.

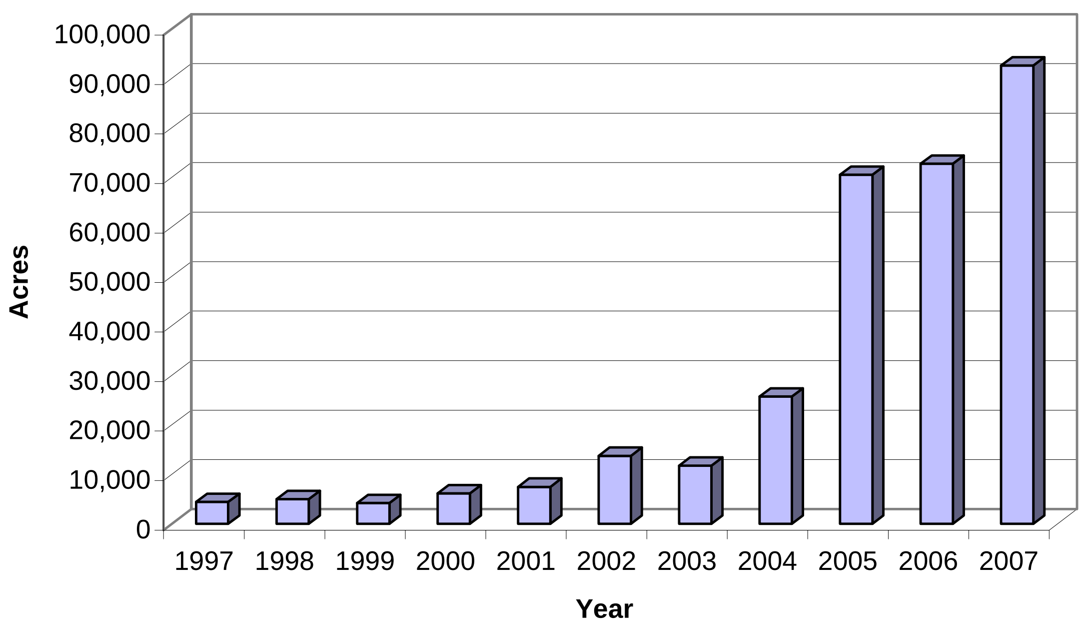


Figure 6. Fir engraver and western balsam bark beetle activity in Arizona and New Mexico, 1997–2007.

Spruce Beetle

Dendroctonus rufipennis
Host: Spruce

Spruce beetle activity mapped by aerial survey decreased to only 870 acres in 2007, compared to about 7,000 acres in 2006. Much of the apparent decrease is a result of attribution: recent ground checking has confirmed that faders in spruce-fir type have usually been corkbark fir rather than spruce. (This situation may somewhat detract from the overall validity of the graph below.) Most of the spruce beetle activity mapped in 2007 was on the Santa Fe National Forest, in northeastern portion of the Pecos Wilderness.

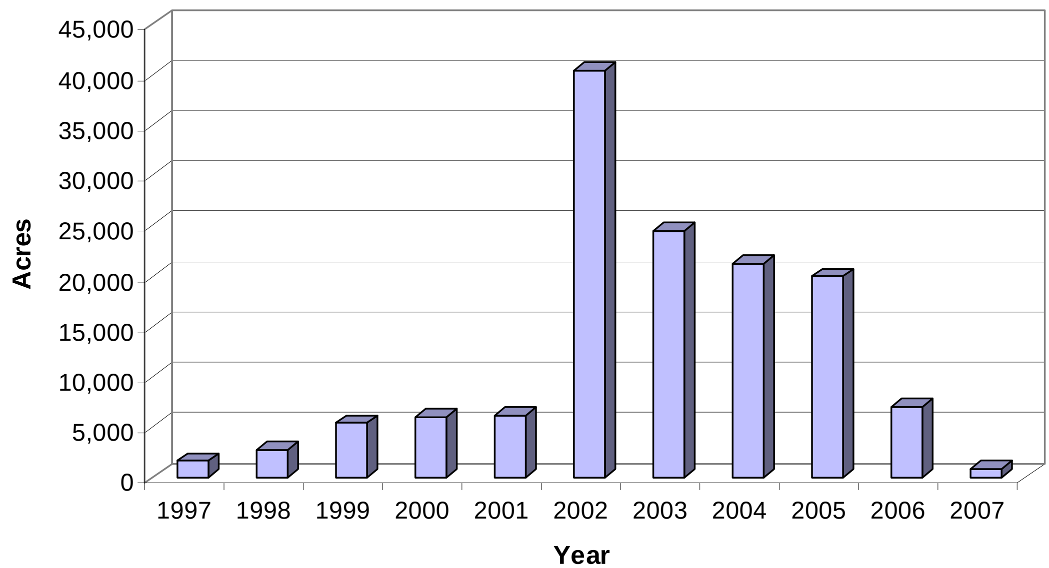


Figure 7. Spruce beetle activity in Arizona and New Mexico, 1997–2007.

Summary by Major Forest Types

In comparing damage (acres affected) and trends within and among forest types, one should keep in mind the relative proportion of land within each type. In Region 3, these are approximately: ponderosa pine 70%, mixed conifer 25%, and spruce-fir 5%. Clearly 1,000 acres of damage in the mixed conifer or spruce-fir type represents greater relative damage (a higher mortality rate) than 1,000 acres in the ponderosa pine type.

Figure 8. White fir mortality in the Black Range of the Gila NF.

Ponderosa pine: Regionwide, ponderosa pine mortality decreased in 2007, with about 38,000 acres mapped compared with 99,000 acres in 2006. (In 2003, near the end of severe drought, 763,000 acres were mapped.) As in 2006, much of the mortality observed was widely scattered, affecting large areas but relatively few trees. More than one-half of the affected area in 2007 was on the Gila National Forest, although even here bark beetle activity and pine mortality decreased considerably.

Mixed conifer: Mixed conifer forests continued to experience high mortality levels in 2007. An estimated 66,000 total acres were affected in 2007, similar to that mapped in 2006 (approx. 72,000 acres). A peak of about 141,000 acres was mapped in 2005. New Mexico, which has the greater share of this forest type, has sustained most of this damage, although both states have seen similar trends. Overall, white fir has experienced the greatest and most widespread mortality, but Douglas-fir has also been impacted in many areas.

Regionwide, mortality in the mixed conifer type has occurred at perhaps the highest rate ever observed over the past 4 to 5 years. Interestingly, after 2003, as mortality in the ponderosa pine and piñon types tapered off to pre-drought levels, mortality in the higher-elevation forests accelerated—and has remained at relatively high levels to the present. In general, heavy mortality in the higher-elevation forests was somewhat delayed compared to that in the lower-elevation forests (which peaked in 2002-2003), but has been more prolonged.

Spruce-fir: Significant mortality was mapped on about 38,000 acres of spruce-fir type in 2007, an increase from 22,000 acres in 2006. Ground checking on both national forest and private lands has confirmed that most faders observed from the air have been corkbark fir, rather than spruce. High levels of corkbark fir mortality have occurred throughout much of the region the past few years, more or less synchronous with that observed in white fir. Most of this damage has occurred in New Mexico (which has the most host-type), but the high-elevation forests of Arizona have also been affected.

Defoliators

Western Spruce Budworm

Choristoneura occidentalis
Hosts: True firs, Douglas-fir, spruce

Budworm activity was high in 2007, with about 455,000 acres of defoliation mapped regionwide, compared with 145,000 acres in 2006. As usual, the bulk of the activity occurred in northern New Mexico, which has the largest share of the region's host type and where budworm has been chronic for decades. A significant outbreak also developed in the Sacramento Mountains of southern New Mexico, where about 48,000 acres of defoliation were detected. An outbreak on Navajo tribal lands (Chuska Mountains) expanded, affecting almost 8,000 acres in 2007. Although not detected by aerial survey, low to moderate budworm activity was observed from the ground on the Kaibab Plateau in northern Arizona.

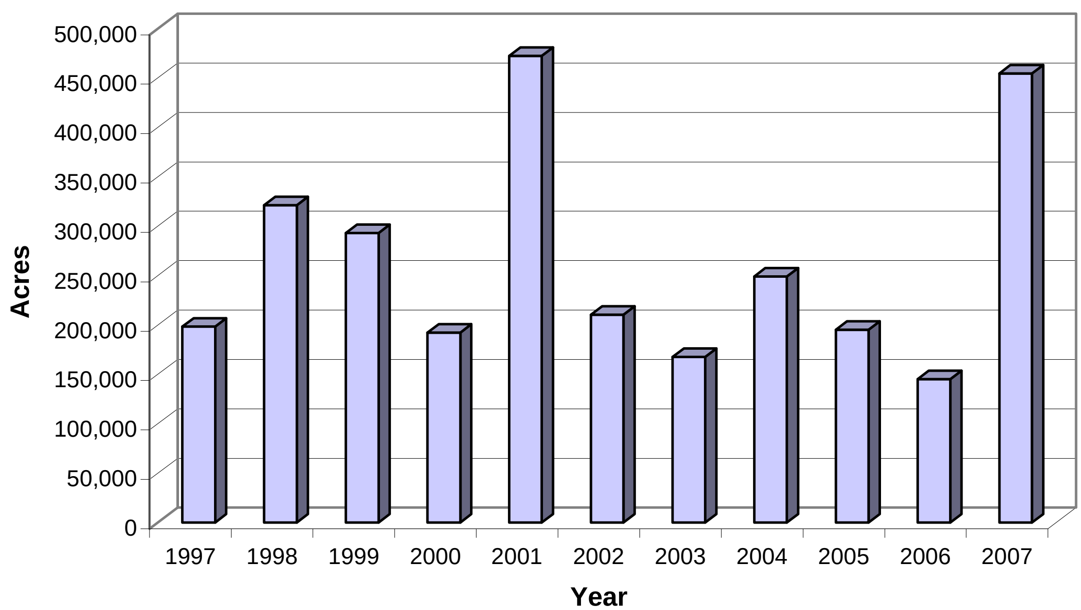


Figure 9. Western spruce budworm activity in Arizona and New Mexico, 1997–2007.

Douglas-fir Tussock Moth

Orgyia pseudotsugata
Hosts: White fir, Douglas-fir, spruce

A significant outbreak continued for a fourth year in the Sandia Mountains near Albuquerque, with 1,040 acres of defoliation mapped in 2007 vs. 1,230 acres in 2006. Activity appeared to have collapsed in areas affected in 2006 (mostly south of the scenic highway), shifting to previously unaffected stands to the north. This outbreak began in "stringers" on drier, west-facing side of the mountain in 2004, apparently crossing over to the heavily-forested east side in 2006. Considerable tree mortality has occurred within affected areas each year.

New tussock moth outbreaks were detected in 2007 on the Santa Clara Pueblo in northern New Mexico and the Tonto National Forest in Arizona. The Santa Clara outbreak extends along the bottom of Santa Clara Canyon (see cover photo), with about 200 acres of defoliation recorded. On the Tonto, two separate locations (≈ 40 miles apart), were affected: the Sierra Ancha Mountains and the Pinal Mountains. There, a total of 1,540 acres of defoliation were mapped, mostly in the Sierra Anchas.

Nepytia janetae

Hosts: Douglas-fir, white fir

An outbreak of this looper (no accepted common name) in the Sacramento Mountains expanded in the winter of 2006/2007, affecting about 12,000 acres, compared to about 7,000 acres the previous year. Much of the recent damage was in areas not previously affected, including stands directly adjacent to the village of Cloudcroft. Monitoring conducted in late 2007 indicates that population levels of this insect may have since decreased substantially.

Figure 10. Aerial view of defoliation caused by *Nepytia janetae* in Cloudcroft area.

Enypia griseata

Hosts: Engelmann spruce

Figure 11. Adult *Enypia* looper collected from Mt. Baldy.

A looper outbreak affecting about 500 acres of high-elevation spruce was detected in the White Mountains of Arizona (Mt. Baldy area). Some defoliated trees were subsequently attacked by spruce beetle. Both Apache-Sitgreaves National Forest and White Mountain Apache tribal lands were affected. Collections of this insect were sent to taxonomists and have been identified as *Enypia griseata*. This appears to be the first report of significant forest damage from this insect in the Southwest.

Spruce Aphid

Elatobium abietinum
Host: Spruce

A notable upswing in activity was detected in 2007, with almost 900 acres of damage mapped on the Apache-Sitgreaves National Forest in Arizona. An outbreak was also observed (from the ground) on the Gila National Forest in New Mexico, on the south side of Bearwallow Mountain, where at least a few hundred acres were affected.

Ponderosa Pine Needle Miner

Coleotechnites ponderosae

No needle miner activity was detected by aerial survey in Arizona or New Mexico in 2007.

Pine sawflies

Neodiprion spp., *Zadiprion* spp.

A large outbreak of summer-feeding pine sawflies defoliated ponderosa pines in the White Mountains of Arizona (Apache-Sitgreaves NF). More than 700 acres along Highway 260 between Pinedale and Overgaard were affected. Many trees in this area had previously been damaged in the 2002 Rodeo-Chediski wildfire. Another sizable outbreak of pine sawflies was reported on San Carlos tribal lands.

An even larger outbreak of piñon sawflies was detected on Navajo Tribal lands (3,800 acres) and within Canyon de Chelly National Monument (4,600 acres).

Figure 12. Sawflies on ponderosa pine in Arizona, June 2007.

Piñon Needle Scale

Matsucoccus acalyptus

Scale has been a chronic defoliator of piñon at several locations in the woodlands of Arizona and New Mexico, with intensities varying from year to year. About 33,000 acres of defoliation attributed to needle scale were mapped in 2007 on the Magdalena Ranger District of the Cibola National Forest and adjacent private lands in New Mexico. In Arizona, a dramatic increase in scale populations was observed in the Payson area.

Aspen Dieback/Defoliation

Weather-related Damage
Western Tent Caterpillar, *Malacosoma californicum*
Other Insects and Diseases

Figure 13. Leaf rust, one of several agents affecting aspen in 2007.

Aspen damage was detected on about 143,000 acres regionwide in 2007, a substantial increase from 86,000 acres reported in 2006. Arizona again suffered the majority of this damage (99,000 acres), some of which has been a continuing problem related to severe drought of recent years. Significant mortality has been occurring, especially within lower-elevation clones. Various biotic agents have also been affecting aspen, including western tent caterpillar and leaf rust (*Melampsora*), which was observed throughout portions of the White Mountains in 2007.

As in previous years, most of the damage in New Mexico has been defoliation attributed to western tent caterpillar (36,000 acres). However, over the past couple of years, especially in 2007, discrete patches of aspen mortality were observed throughout the state. Efforts were made during the 2007 aerial surveys to distinguish these areas from those affected by defoliation alone, and almost 7,000 acres of aspen mortality/dieback were mapped. This was our first attempt to identify specific areas of aspen mortality; although most of it appeared to be recent, some locations may include mortality from previous years.

Status of Diseases

Mistletoes

Dwarf Mistletoes

Arceuthobium spp.
Hosts: Most conifers, especially pines and Douglas-fir

Dwarf mistletoes are the most widespread and damaging forest pathogens (disease-causing organisms) in the Southwest. There are eight species in the region, each with a different primary tree host. Three species—those affecting ponderosa pine, piñon, and Douglas-fir—are found throughout most of the ranges of their respective hosts, while the other species have more limited distributions. Regionally, over one-third of the ponderosa pine type and up to one-half of the mixed conifer type, have some level of infection.

Figure 14. Female ponderosa pine dwarf mistletoe plant with fruit.

Damage from dwarf mistletoes includes growth reduction, distortion (i.e. witches' brooms), and decreased longevity. Essentially, these parasites re-allocate growth to infected portions of the tree at the expense of the rest of the tree. Severe infection can kill trees directly or predispose them to other agents, especially bark beetles. All size classes are affected; the effects on regeneration can be substantial.

Regionwide, dwarf mistletoes cause an estimated 25 million cubic foot loss in timber production annually. In most years, dwarf mistletoe infestation represents more loss to timber resources in the Southwest than do insects. Extensive dwarf mistletoe infestation can also increase fire hazard. On the other hand, as a natural part of the forest, dwarf mistletoes have an ecological role and benefit some species.

On both the stand and landscape level, the distribution of dwarf mistletoes is usually patchy, with more or less discrete infection centers surrounded by areas without the disease. Infection centers expand very slowly, and overall incidence changes little from year to year. Thus, infestation is best described as a chronic situation rather than an outbreak or epidemic. However, because of fire suppression and selective cutting, the overall incidence of dwarf mistletoes has probably increased over the past century.

True Mistletoes

Phoradendron spp.
Hosts: Junipers, various hardwoods

Several species of true mistletoe occur in the Southwest. *P. juniperinum* (on juniper) is probably the most widespread and abundant mistletoe (true or dwarf) in the region. Mistletoes are common on oaks in southern portions of the region and are locally abundant in desert woodlands and lower-elevation riparian areas. Heavy infection reduces host longevity, especially during periods of drought.

Root Diseases

Root diseases are often associated with mortality attributed to bark beetles. They can also predispose trees to windthrow, an obvious concern in campgrounds and other heavily-used areas. Root diseases are generally more common in mixed conifer and spruce-fir forests than in ponderosa pine forests. Like dwarf mistletoes, root diseases spread slowly, so overall incidence changes little year to year. Because of its chronic nature, root disease is often described as a “disease of the site.” Root disease can exacerbated by certain activities.

Figure 15. Tomentosus root/butt rot associated with windthrow on San Francisco Peaks.

Armillaria Root Disease

Armillaria spp.
Hosts: Most conifers, aspen

Armillaria is the most common root disease in the Southwest and may account for up to 80 percent of the root disease-associated mortality in the region. All size classes can be affected. Previous surveys on the North Kaibab Ranger District found the fungus on about 30 percent of the standing live trees. In addition to causing disease, the fungus is a common decayer of dead woody material (a saprophyte).

Annosus Root Disease

Heterobasidion annosum
Hosts: Most conifers

Annosus root disease is probably the second most common root disease in the Southwest. It is found most often on true firs, although most conifers are susceptible. All size classes can be affected. Like *Armillaria*, *Heterobasidion* is a common decayer of dead woody material as well as a pathogen.

Other common root diseases…

in the Southwest include **Schweinitzii root/butt rot**, *Phaeolus schweinitzii*, often found on older Douglas-fir and occasionally ponderosa pine; **Tomentosus root/butt rot**, *Inonotus tomentosus,* on spruce; and **Ganoderma butt rot**, *Ganoderma applanatum*, found in many aspen stands. **Black Stain root disease**, *Leptographium wageneri,* appears to be rare in the Southwest.

Stem Decays

Stem decays are common in older trees throughout the region. Decay represents an economic loss in terms of timber production and can increase hazards on developed sites. On the other hand, decayed trees provide important habitat for many wildlife species, particularly cavity nesters. The most common stem decays in the Southwest include **red rot**, *Dichomitus squalens*, of ponderosa pine; **red ring rot**, *Phellinus pini,* affecting most conifers; **rust-red stringy rot**, *Echinodontium tinctorium*, on white fir; **aspen trunk rot**, *Phellinus tremulae*; and *Inonotus dryophilus* on oak.

Aspen Stem Cankers

The soft, living bark of aspen is highly susceptible to canker-causing fungi. One or more of these diseases are common in most aspen stands. The most common include **sooty bark canker**, *Encoelia pruinosa*; **black canker**, *Ceratocystis fimbriata*; **Cryptosphaeria canker**, *Cryptosphaeria populina*; and **Cytospora canker**, *Cytospora chrysosperma*. Cankers are one of the main reasons that aspen is a relatively short-lived tree.

Figure 16. Sooty bark canker on aspen.

Stem Rusts

White Pine Blister Rust

Cronartium ribicola
Host: Southwestern white pine

Figure 17. Topkill from white pine blister rust.

Blister rust was found in several new locations in New Mexico in 2007. During a 2-day (ground) survey of the Gila National Forest, we found very low levels (< 1 percent white pines infected) in the Silver Creek, Bearwallow Mtn., and Signal Peak areas. Numerous rust-infected trees were found in Johnson Canyon, the site where the disease was first detected on the Gila in 2005. Rust was also found for the first time on the Santa Fe National Forest—in the Jemez Mountains just south of the Valles Caldera. An additional sighting was made in the in the Zuni Mountains, near Mt. Sedgwick—the second known rust location on the Cibola National Forest.

Rust damage continues to increase in the Sacramento Mountains of southern New Mexico, where the disease has now been established for over 30 years. More than 40 percent of the white pines there are currently infected, based on a representative set of monitoring plots. Incidence is very high (> 90 percent) within several thousand acres of mesic mixed conifer forest.

Blister rust has yet to be observed in Arizona, despite ongoing surveys.

Broom Rust

Melampsorella caryophyllacearum
Host: True firs

Chrysomyxa arctostaphyli
Host: Spruces

Broom rusts are found at low levels throughout most of their host's ranges in the Southwest. High concentrations of fir broom rust occur in the Sandia and Manzano Mountains of central New Mexico and a few other locations. Damage from these easily recognized diseases has not been well quantified; however, infection can result in topkill, especially in spruce. Occasionally, falling brooms or stem breakage at the point of infection present a hazard.

Limb Rust

Cronartium arizonicum
Host: Ponderosa pine

This disease is fairly common in parts of Arizona and can be quite damaging to individual trees. The fungus causes progressive branch mortality, usually from the center of the crown. Waves of new infection typically occur at intervals of several years. This disease is uncommon in New Mexico.

Comandra Blister Rust

Cronartium comandrae
Host: Pines

This disease has caused extensive branch dieback and mortality of nonnative Mondell/Afghan pine (*Pinus eldarica*) in the Prescott, Payson, and Sedona areas of central Arizona. It occasionally infects native ponderosa pines in this area, but has caused minimal damage to this species.

Western Gall Rust

Peridermium (Endocronartium) harknessii
Host: Pines

This is an occasional disease of ponderosa pine in the Southwest, where it is usually found as the white-spored form, rather than the orange-spored form common in other parts of the West.

Figure 18. White-spored gall rust infection on ponderosa pine.

Foliage Diseases

Piñon Needle Cast

A major outbreak of piñon needle cast was observed in southern New Mexico in 2007. It occurred throughout most of the host type in the Sacramento Mountains and was also widespread on the Gila National Forest. It was seen much less frequently in northern and central New Mexico, but was found as far north as Raton. Entire landscapes near Ruidoso, Mescalero, Mayhill, and Weed (Sacramento Mts.) were affected. Overall, more than 200,000 acres of damage were mapped by aerial survey.

Little is known about this disease, and the taxonomy of the causal agent(s) has been obscure. Signs and symptoms resemble those of the better known *Dothistroma* needle blight on hard pines (subgenus *Pinus*); the primary pathogen appears to be a previously undescribed species within this genus. Another fungus, a *Pestalotia sp.*, has also been consistently found in our samples and may well be an accomplice.

Figure 19. Piñon needle cast near Ruidoso.

A very wet summer in 2006 may have provided ideal conditions for this outbreak, with symptoms becoming most apparent the following spring. Most affected trees are expected to recover. A similar, but somewhat less severe outbreak of piñon needle cast occurred in New Mexico in the early 1990s.

We thank Roger Peterson, Amy Rossman and Jack Rogers for helping us identify the fungi.

Ponderosa Pine Needle Cast

Lophodermella cerina and other species

About 4,900 acres of affected area were mapped in 2007, mostly on state and private lands in northeastern New Mexico. Ground checking in some of these areas confirmed that a fungal disease was the most likely cause of the discoloration and defoliation. In southern New Mexico, only occasional ponderosa pine needle cast was observed (from the ground); this is perhaps surprising given the extensive outbreak in piñon (see above). No needle cast was detected in Arizona in 2007.

Abiotic Damage

Wind Damage

A large windthrow event in the Pecos Wilderness of northern New Mexico, probably in June, leveled more than 2,400 acres of high-elevation forest, including spruce. The largest area was near Pecos Baldy, with three smaller areas mapped to the east. Notable wind damage also was reported at the Arizona Snowbowl near Flagstaff, where a few hundred trees, mostly spruce, were broken or uprooted during an October storm.

Figure 20. Aerial view of 2007 windthrow in the Pecos Wilderness.

Salt

Damage from dust abatement salt (magnesium chloride) was noted in the White Mountains of Arizona, affecting ponderosa pines, spruces, aspens, and other species near the communities of Greer, Nutrioso, and Alpine. Damage from deicing salts was observed along major roadways throughout Arizona.

Drought

Discoloration and damage of ponderosa pine and other vegetation attributed to drought was mapped on approximately 9,400 acres in northern and central Arizona.

Other Forest Insect and Disease Reports

Cypress/juniper bark beetle (*Phloesinus* spp.) activity was generally much lower in 2007 than in previous years, with only 70 acres of damage mapped during aerial surveys, mostly on San Carlos tribal lands. Scattered juniper mortality was also observed in the Sedona area and in the vicinity of Show Low, Arizona.

Juniper rust (*Gymnosporangium* spp.) infections appeared to be causing considerable branch flagging on rocky mountain juniper along Canjilon Creek on Carson National Forest.

Tiger moth (*Lophocampa ingens*) activity was low throughout the Southwest in 2007.

Fall webworm (*Hyphantria cunea*) thrived at several locations in Arizona in 2007, including the Camp Verde area (on cottonwoods) and in Gila County (on walnuts). This insect was also found at several locations above the Mogollon Rim, and has perhaps increased its range in recent years in response to mild winters. In New Mexico, notable webworm activity continued to be seen on riparian hardwoods and landscape trees in many areas.

Figure 21. Fall webworm caterpillar on walnut.

Walnut anthracnose (*Gnomonia leptostyla*) infections were notable for second consecutive year in central Arizona, especially in the Prescott area.

Leaf beetles (*Chrysomela* spp.) caused noticeable defoliation of aspen on a site on the Santa Fe National Forest in 2007.

Dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) was found on an Austrian pine in Strawberry, Arizona, only the 2nd report of infection on this species. Other non-native landscape trees with known susceptibility include Mugho and Scotch pines.

Twig beetles (*Pityophthorus* spp., *Pityogenes* spp., *Pityotrichus* spp., *Pithocanthus erectus*), which, along with Ips, caused extensive damage to piñons during the recent drought years, have generally been much less active the past 2 to 3 years. About 40 acres of activity was mapped during 2007 aerial survey in the Manzanita Mountains and adjoining Isleta tribal lands in central New Mexico, with an additional 10 acres on state and private lands in nearby Torrance County. Scattered activity was also observed (from the ground) on Mount Taylor.

Table 1. Prominent 2007 forest insect and disease activity (acres) in Arizona and New Mexico*.

Agent	State	National Forest	Tribal Lands	Other Federal	State & Private	Total
Bark beetles in ponderosa pine	AZ	4,350	280	390	180	5,200
	NM	30,020	210	760	1,320	32,320
Ips beetle in piñon pine	AZ	< 5	3,990	500	< 5	4,500
	NM	30	< 5	–	20	40
Douglas-fir beetle	AZ	5,020	10	60	20	5,110
	NM	3,890	1,710	80	3,230	8,910
True fir beetles	AZ	8,400	20	10	10	8,450
	NM	64,450	7,670	–	11,980	84,100
Western spruce budworm	AZ	–	7,710	–	–	7,710
	NM	332,240	34,670	90	80,290	447,290
Aspen defoliation	AZ	83,890	2,200	13,320	160	99,570
	NM	20,790	210	10	15,160	36,180
Root disease	AZ	219,000	**	**	**	219,000
	NM	860,000	**	**	**	860,000
Dwarf mistletoes	AZ	1,174,000	674,000	**	25,000	1,873,000
	NM	1,144,000	348,000	**	581,000	2,073,000

* Values rounded to the nearest 10; sum of individual values may differ from totals due to rounding.
** Significant activity observed/known, but acreage not determined.
– No acreage detected.

Table 2. 2007 Bark beetle incidence by site (acres) from aerial detection surveys*.

	Western Pine Beetle	Mountain Pine Beetle	Round-headed Pine Beetle	Ponderosa Ips	Piñon Ips	Douglas-fir Beetle	Spruce Beetle	True Fir Beetles	Cypress & Cedar Bark Beetles	Bark Beetle Totals
Apache-Sitgreaves NFs	70			2,250	< 5	1,640	< 5	4,440	< 5	7,010
Coconino NF	900			340		1,960		1,880		5,070
Coronado NF	10		80	10	< 5	1,100		1,820	< 5	3,020
Kaibab NF	10	< 5		210	< 5	250		250		730
Prescott NF				350		40				390
Tonto NF	< 5			120		40		< 5		150
Canyon De Chelly NM	< 5			< 5	< 5				< 5	< 5
Chiricahua NM									< 5	< 5
Grand Canyon NP	120	120		30		60		10		230
Lake Mead NRA	< 5			< 5					< 5	< 5
Saguaro NP			30							30
Sunset Crater NM				< 5						< 5
Walnut Canyon NM				< 5						< 5
BLM	190			< 5	500				< 5	700
Fort Huachuca	< 5			< 5				< 5	< 5	< 5
Fort Apache Tribal	50			60	10	< 5	< 5	20	< 5	150
Hualapai Tribal	10			20	3,970				< 5	4,000
Navajo Tribal	40			30	10	< 5	< 5		< 5	90
San Carlos Tribal	20			50	< 5	< 5		< 5	60	130
Hopi Tribal					< 5				< 5	< 5
State & Private	90		< 5	90	< 5	20		10	< 5	220
Arizona Total	**1,510**	**130**	**120**	**3,570**	**4,500**	**5,110**	**10**	**8,450**	**80**	**21,940**
Carson NF				3,760		340		18,000		22,100
Cibola NF	200			1,280	< 5	80		4,460		6,020
Gila NF	420			22,700	< 5	1,190		4,900	< 5	27,960
Lincoln NF	40			40	20	30		7,940		8,020
Santa Fe NF	160			1,340		2,060	840	29,150		33,540
Valles Caldera NP				90		190		< 5		280
BLM	10			< 5		< 5				10
Bandelier NM				< 5		80				80
El Malpais NM	750									750
Acoma Pueblo	< 5									< 5
Isleta Pueblo				< 5						< 5
Jemez Pueblo				190						190
Jicarilla Apache	< 5			< 5		1,280		180		1,460
Mescalero Apache	< 5			< 5				4,690		4,690
Other Tribal						20				20
Picuris Pueblo				< 5						< 5
Santa Clara Pueblo				< 5		290		40		330
Taos Pueblo				< 5		120		2,760		2,880
Zuni Pueblo	20				< 5					20
State & Private	170			1,150	20	3,230	20	11,980		15,580
New Mexico Total	**1,760**	**0**	**0**	**30,550**	**40**	**8,910**	**860**	**84,100**	**< 5**	**123,920**
SW Region Total	**3,270**	**130**	**120**	**34,120**	**4,540**	**14,010**	**870**	**92,550**	**80**	**145,860**

* Values rounded to the nearest 10; multiple counting of acres may occur between damage agents if an area is observed to have simultaneous multiple damage agents. Totals represent the “footprint” or affected area on the ground with no multiple counting. Values for Federal administrative units include only federally owned lands (state and private inholdings summarized in State & Private).

Table 3. 2007 Defoliation incidence by site (acres) from aerial detection surveys*.

	Western Spruce Budworm	Spruce Aphid	Aspen Damage	Loopers	Needle Cast	Douglas-fir Tussock Moth	Piñon / Ponderosa Sawflies	Defoliation Total**
Apache-Sitgreaves NFs		880	2,650	120			770	4,410
Coconino NF			5,020					5,020
Coronado NF								
Kaibab NF			76,190					76,190
Prescott NF			10					10
Tonto NF			20			1,540		1,560
Canyon De Chelly NM							4,640	4,640
Chiricahua NM								
Grand Canyon NP			13,320					13,320
Lake Mead NRA								
Saguaro NP								
Sunset Crater NM								
Walnut Canyon NM								
BLM								
Fort Huachuca								
Fort Apache Tribal			2,200	380				2,580
Hualapai Tribal								
Navajo Tribal	7,710						3,800	11,500
San Carlos Tribal							20	20
Hopi Tribal								
State & Private			160				30	180
Arizona Total	**7,710**	**880**	**99,570**	**500**	**0**	**1,540**	**9,260**	**119,450**
Carson NF	156,450		13,160					169,070
Cibola NF	12,130		2,730		27,170	1,040		74,980
Gila NF	820		1,730		57,710			60,260
Lincoln NF	26,470		300	11,710	59,130			97,550
Santa Fe NF	119,450		7,800					127,250
Valles Caldera NP	16,930		990					17,930
BLM	90		50		670			800
Bandelier NM			70					70
El Malpais NM								
Acoma Pueblo								
Isleta Pueblo					70			70
Jemez Pueblo								
Jicarilla Apache	5,580		110					5,690
Mescalero Apache	21,540		20		37,900			59,760
Other Tribal								
Picuris Pueblo								
Santa Clara Pueblo	1,190					200		1,380
Taos Pueblo	6380		80					6460
Zuni Pueblo								
State & Private	80,290		16,100	440	25,230	130		120,510
New Mexico Total	**447,290**	**0**	**43,160**	**12,150**	**207,880**	**1,370**	**0**	**741,770**
SW Region Total	**455,000**	**880**	**142,730**	**12,650**	**207,800**	**2,900**	**9,260**	**861,210**

* Values rounded to the nearest 10; multiple counting of acres may occur between damage agents if an area is observed to have simultaneous multiple damage agents. Totals represent the “footprint” or affected area on the ground with no multiple counting. Values for Federal administrative units include only federally owned lands (state and private inholdings summarized in State & Private).

** Defoliation total includes agents not shown in the table; see text for additional agents.

Biological Evaluations and Technical Assistance

Arizona Zone

1. Assessment of deicing salt damaged trees on the Mogollon Ranger District, Coconino National Forest; 5/02/07.
2. Pine engraver beetle activity associated with Arizona Department of Transportation project, North Kaibab Ranger District, Kaibab National Forest; 5/09/07.
3. Evaluation of the Devils Head Electronic Site Fuels Reduction project, Peaks Ranger District, Coconino National Forest; 6/18/07.
4. Evaluation of southwestern dwarf mistletoe infection in the Jacob/Ryan Analysis area, North Kaibab Ranger District, Kaibab National Forest; 7/02/07.
5. Sawfly defoliation of ponderosa pine along highway 260, Black Mesa Ranger District, Apache-Sitgreaves National Forests; 7/22/07.
6. Decomposition of fire-killed snags and hazard tree situation in Warm Fire burn area, North Kaibab Ranger District, Kaibab National Forest; 7/26/07.
7. Proposed forest health projects within the Mormon Lake Basin Fuels Reduction project area, Mormon Lake and Peaks Ranger Districts, Coconino National Forest; 9/12/07.
8. Bark beetle activity and potential forest health projects in the Munds Park Fuel Reduction area, Mormon Lake and Peaks Ranger Districts, Coconino National Forest; 9/14/07.
9. Bark beetle activity in the wildland fire use portion of the Warm Fire, North Kaibab Ranger District, Kaibab National Forest; 9/17/07.
10. Sawfly defoliation of pinyon along south rim, Canyon del Chelly National Monument; 9/18/07.
11. Evaluation of Douglas-fir tussock moth outbreak in Workman Creek, Pleasant Valley Ranger District, Tonto National Forest; 9/20/07.
12. Bark beetle activity in recreation sites on the Black Mesa Ranger District, Apache-Sitgreaves National Forests; 9/25/07.
13. Bark beetle activity in recreation sites on the Lakeside Ranger District, Apache-Sitgreaves National Forests; 9/26/07.
14. Insect and disease conditions in CEEMS silvicultural certification stand, Coconino National Forest; 9/27/07.
15. Proposed Malay Gap dwarf mistletoe suppression project, San Carlos Apache Reservation; 9/27/07.
16. Proposed Prairie Knolls forest health project, Williams Ranger District, Kaibab National Forest; 10/05/07.

17. Insect and disease conditions in the proposed Huffer Forest Health Protection Project area, Mogollon Ranger District, Coconino National Forest; 10/25/07.

18. Spruce beetle and hazard tree conditions at Snowbowl Ski Area, Peaks Ranger District, Coconino National Forest; 11/15/07.

19. Potential forest health projects, Black Mesa Ranger District, Apache-Sitgreaves National Forests; 11/16/07.

New Mexico

1. Suggested modifications to 16 North thinning units, Sacramento Ranger District, Lincoln National Forest; 3/23/07.

2. Evaluation of Douglas-fir tussock moth in Santa Clara Canyon, Santa Clara Pueblo; 5/09/07.

3. Examination of La Cueva fuelbreak for potential forest health projects that would also produce material for utilization by biomass energy plant, Pecos Ranger District, Santa Fe National Forest; 6/20/07.

4. Proposed FY 2008 dwarf mistletoe suppression project, Mescalero Apache Indian Reservation; 7/06/07.

5. Proposed FY 2008 dwarf mistletoe suppression project, Jicarilla Aache Indian Reservation; 8/17/07.

6. Evaluation of forest health funded projects in Mesa Poleo WUI, Coyote Ranger District, Santa Fe National Forest; 8/31/07.

5. Potential FY 2008 forest health projects in the Chaparral WUI, Cuba Ranger District, Santa Fe National Forest; 9/11/07.

6. Potential FY 2008 forest health projects in the Los Griegos WUI, Jemez Ranger District, Santa Fe National Forest; 10/02/07.

7. Proposed FY 2008 El Porvenir Forest Health project, Pecos/Las Vegas Ranger District, Santa Fe National Forest; 10/05/07.

7. Pre- and post-suppression monitoring of *Nepytia janetae*, Sacramento Ranger District, Lincoln National Forest; 12/17/07.

8. Summary of Douglas-fir tussock moth activity and trapping results, Sandia Ranger District, Cibola National Forest; 12/20/07.

Publications

DeGomez, T. E., C. Hayes, K. M. Clancy, J. D. McMillin, and J. A. Anhold. 2007. Evaluation of insecticides for protecting Arizona cypress (*Cupressus arizonica*) and one-seed juniper (*Juniperus monosperma*) from attack by *Phloeosinus* bark beetles. Journal of Arboriculture & Urban Forestry. 33: 162–167.

United States Department of Agriculture Forest Service, 2007. Environmental Assessment for *Nepytia janetae* winter defoliator spray project, Lincoln National Forest. USDA Forest Service, Southwestern Region. 71 pp.

Other Entomology and Pathology Activities in 2007

Contribution of Bark Beetle Outbreaks to Fuel Loading and Fire Behavior

Previous studies suggest that bark beetle outbreaks can increase fuel loads and influence fire behavior; however, these relationships have not been well-documented in pine forests of the Southwest. A network of plots was established in Arizona in 2003–2004 to monitor impacts from the landscape-level outbreaks which occurred from 2001–2003 in both ponderosa pine and piñon. Plots were distributed across a wide range of stand conditions and site characteristics, and encompass an array of tree mortality levels. Using Forest Health Monitoring funding, we remeasured the ponderosa pine plots in 2007. Data on canopy and surface fuels were collected from 133 plots on the Prescott, Kaibab, Coconino, Apache-Sitgreaves, and Tonto National Forests. Preliminary analysis revealed mortality plots had 55 percent greater total surface fuels and 60 percent greater fuels litter depth than no mortality plots. Using these and other data, we will model predicted fire behavior under moderate and extreme fire weather conditions using the NEXUS Fire Behavior and Hazard Assessment system to estimate fire intensity, spread, flame length, wind speeds required for fires to transition from surface to crown fires, and the proportion of various fire types (such as surface or crown). In 2008, we will use the same design for piñon-juniper woodlands.

For more information, contact Joel McMillin.

Effects of Underburning on Dwarf Mistletoe

Fire has long been considered an important natural control of dwarf mistletoe, although relatively little quantitative information has been available. Monitoring conducted on the Santa Fe and Cibola National Forests since 1995 has quantified: (1) survival of scorched ponderosa pine, and (2) reduction in tree and stand dwarf mistletoe severity, following low-intensity fire (underburning). A sanitation model, based on the mortality and scorch pruning observed on our study plots, provides an "expected reduction" in average DMR for a given average crown scorch and initial DMR. For example, the model estimates that a group/stand with an initial DMR of 3 experiencing 50 percent average crown (needle) scorch will show a reduction of about 0.7 three years after fire. Longer-term monitoring indicates that 50 percent average crown scorch should provide about 10 years of control, i.e., 10 years of stand growth before average DMR returns to its pre-burn level. Burns generating little or no crown scorch can be expected to have little or no effect on mistletoe, and may also have little effect on fuel-loading or other forest conditions. Results of this study should apply generally for both management-ignited and wildland fires that burn at relatively low intensity.

For more information, contact Dave Conklin.

Effects of Fire on Bark Beetles

Damage from fire can weaken a tree's defenses, making it more likely to be attacked and killed by bark beetles. Bark beetle activity is elevated to a greater or lesser extent following most fires. Forest Health Monitoring projects are underway in northern Arizona to quantify post-fire bark beetle activity in ponderosa pine. Tree mortality has been monitored in the Birds and Burns Network sites (coordinated by the Forest Service Rocky Mountain Research Station) for the first three growing seasons (2004–2006) after experimental implementation of prescribed fire treatments. Part of this study will continue to monitor these sites for an additional 3 years. A second part of this study will establish additional sites on the Coconino NF that will monitor pre-burn bark beetle populations and stand conditions. This portion of the study will provide data prior to the burn cycle that identifies potential indicators of future high levels of bark beetle caused mortality. This is a 3-year study which started in 2007. Results should help managers develop more effective prescriptions for use of fire.

For more information, contact John Anhold.

Santa Clara Pueblo Aerial Application of TM-Biocontrol

An application of TM-Biocontrol, the Douglas-fir tussock moth virus, was conducted in Santa Clara Canyon in mid-June 2007. An expanding tussock moth population had been found here only a few weeks earlier, providing what appeared to be a good opportunity for control of this damaging insect. Pueblo leaders supported treatment since the outbreak was located within a valuable recreational and cultural area; moreover, over the past decade, the tribe had lost much of its forest to wildfire. Since an extremely compressed timeline made completion of an EA impossible, the Pueblo agreed to pay treatment costs, while the Forest Service provided the virus and technical assistance. Despite good spray deposition, subsequent defoliation was considerable. Visits to the treatment block showed that caterpillars were slow to succumb, although bioassays conducted by Dr. Imre Otvos of the Canadian Forest Service showed this population to be very susceptible to the tank mix. A fall post-suppression visit showed a marked decline in cocoons and egg masses, giving hope that additional damage may have been averted.

For more information, contact Terry Rogers.

Aerial Application of *Btk* to Suppress *Nepytia janetae* on the Lincoln NF

Because of intense public concern about recent, severe looper (*Neptytia janetae*) defoliation near the Village of Cloudcroft, an aerial application of *Bacillus thuringiensis* var. *kurstaki* (*Btk*) was conducted in early November 2007. About 4,400 acres of the affected mixed conifer forest adjacent to the village were treated. Timing of the project was carefully chosen to avoid exposing larvae of the Sacramento Mountain checkerspot butterfly (*Euphydryas anicia cloudcrofti*), a sensitive species, to *Btk*. Weather conditions were favorable and good deposition of the *Btk* was achieved. We expect that the combination of treatment effect and natural population decline usually observed in the third year of geometrid outbreaks will result in a reduction in observable defoliation in 2008.

For more information, contact Debra Allen-Reid.

Aspen Monitoring

Aspen sites in decline on the Coconino NF and Apache-Sitgreaves NF have been surveyed over the past several years. On the Coconino NF, aspen on low-elevation xeric sites (< 7500 ft) have sustained 95 percent mortality since 2000. Mid-elevation sites (7500–8500 ft) lost 61 percent of aspen stems during the same time period while only 16 percent mortality was observed on more mesic high-elevation sites (> 8500 ft). Sites surveyed on the Apache-Sitgreaves NF were all above 7500 ft and mortality has reached 40 percent in both mid- and high- elevation sites. Low-elevation sites are located on northerly aspects while mid- and high-elevation sites are located on various aspects. Overall, diameter distributions showed mortality was not skewed to any particular size class, however, trees with diameters > 9 inches generally took longer to die than smaller size classes. Several insects and pathogens were associated with aspen mortality but appeared to be acting as secondary agents on stressed trees. Although aspen ramet production occurred to some degree on all sites with the death of mature trees, aspen sprouts were nearly nonexistent by the summer of 2007 due to ungulate browsing.

For more information, contact Mary Lou Fairweather.

Visit Us Online

In an effort to better serve the Internet user, we continue to expand our online information base. The Forest Service Southwestern Region hosts a Forest Health Web site at http://www.fs.fed.us/r3/resources/health. Technical information posted on this site includes annual forest insect and disease conditions reports, literature on pest biology and management, and general information on forest health in the Southwest. In 2007 we posted an electronic version of our "Field Guide to Insects and Diseases of Arizona and New Mexico Forests". This web version contains all of the photographs and information of the printed guide. Access to PDFs of individual sections of the guide are available for downloading and printing.

Additionally, our Forest Health Protection national office maintains a Web site at http://www.fs.fed.us/foresthealth which includes program overviews and publications links.

Appendix

Instructions for Submitting Insect and Disease Specimens for Identification

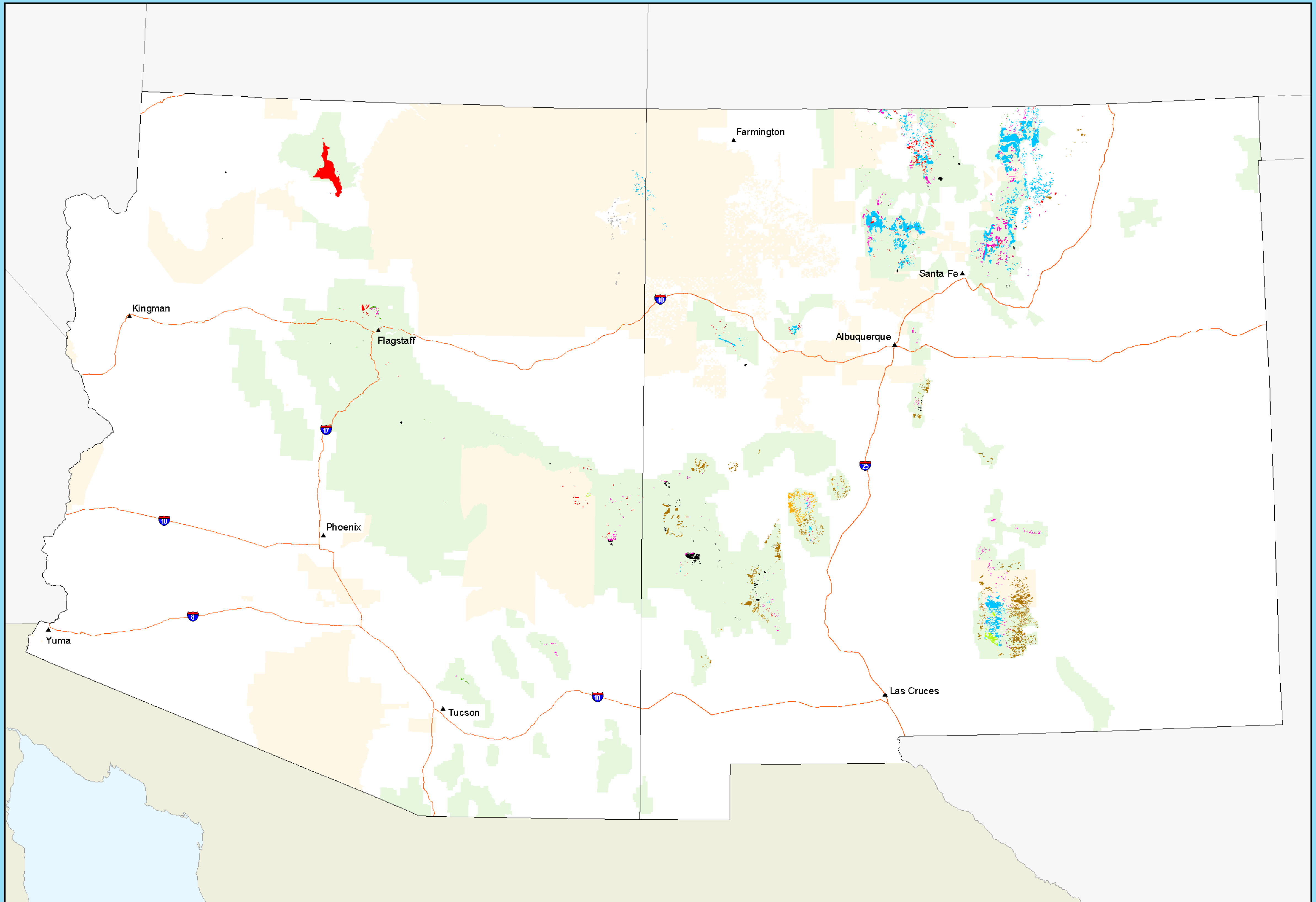
Both zone offices are equipped to receive forest insect or disease specimens submitted from the field for identification. Specimens may be shipped to the appropriate zone office as listed on the title page of this report. The following procedures for collecting and shipping specimens should be used.

Collecting

1. Adequate material should be collected
2. Adequate information should be recorded, including:
    a. location of collection
    b. when collected
    c. who collected the specimen
    d. host description (species, age, condition, etc.)
    e. area description (forest type, site conditions, etc.)
    f. unusual conditions (frost, poor drainage, etc.)
3. Personal opinion of the cause of the problem may be helpful.

Packing

1. **Larvae and other soft-bodied insects** should be shipped in small screw-top vials or bottles containing at least 70 percent isopropyl (rubbing) alcohol. Use only enough alcohol to fully immerse the specimens; shipping regulations limit the amount to 30 ml (2 tablespoons or about 1 ounce) per vial. Make sure lids are well sealed. Place all vials in a sealed plastic bag, using packing materials between vials to minimize movement. Ship in a sturdy box.
2. **Pupae and hard-bodied insects** may be shipped either in alcohol or in small boxes. Specimens should be placed between layers of tissue paper in the boxes. Pack carefully and make sure there is little movement of material within the box. Do not pack insects in cotton.
3. **Needle or foliage diseases**: Do not ship in plastic bags as condensation can become a problem. Use a paper bag or wrap in newspaper. Pack carefully and make sure there is little movement within the box.
4. **Mushrooms and conks**: Do not ship in plastic bags. Either pack and ship immediately or air-dry and pack. To pack, wrap specimens in newspaper and pack into a shipping box with more newspaper. If on wood, include some of the decayed wood.



The forest mortality and defoliation depicted here is based on aerial detection surveys and should only be used as a general indicator of incidence. This map represents the mortality and defoliation that has occurred since the previous surveys in 2006. Depending upon the timing of survey, the entire extent of some insect and disease activity may not have been detected. In addition, most diseases cause gradual declines in tree health that are not typically detectable during aerial surveys. Intensity of damage is variable, thus not all trees within a mapped area are dead or defoliated. Caution should be used in interpreting these results due to the scale and subjective nature of aerial sketch mapping. Areas of particular concern should be ground-checked for precise determination of location and causal agent.

Arizona

Surveys conducted July through September, 2007, by Steve Dudley, Bobbe Fitzgibbon, and Daniel Ryerson, Forest Health Office, Southwestern Region, US Forest Service; Aaron Green, Arizona State Land Department, Forestry Division.

New Mexico

Surveys conducted July through September, 2007 by Daniel Ryerson and Bobbe Fitzgibbon, Forest Health Office, Southwestern Region, US Forest Service; Stephani Sandoval, New Mexico State University Cooperative Extension Service; William Ciesla, Forest Health Management International.

Significant Forest Mortality and Defoliation Detected through Aerial Survey

Southwestern Region - 2007

Forest Health Staff
Southwestern Region
US Forest Service
4 February 2008