Pocket gophers can be excluded from small areas by creating a barrier. This is achieved by digging a trench 24-36 inches deep, and building a barrier of sheet metal, concrete, or hardware cloth. Remember, the barrier should also extend at least 12 inches above ground. Problems with exclusion include excessively rocky soil and the occasional creative gopher that will dig under the barrier. Raised garden beds can be lined with hardware cloth.

Old burrow systems should also be obliterated whenever possible. Existing burrows serve as pocket gopher highways that connect neighboring open space to your cultivated areas. Dogs and cats can act as biological control agents, but it really depends on the individual animal's hunting ability. Digging dogs can also be very destructive – maybe more so than the gopher. Sound emitting devices and windmills are generally ineffective as a control.

Effective pocket gopher management requires observation and persistence. Over time, you will reduce the gopher population on your property and minimize damage to your garden, orchard and landscape.



Jeff Schalau

Figure 1. Pocket gopher mound
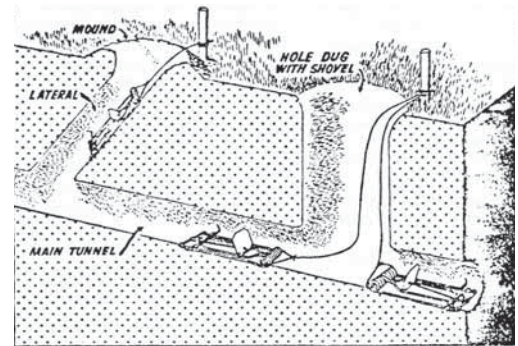


University of Nebraska

Figure 2. Setting traps for pocket gophers.

# Determining Ponderosa Pine Tree Density on Small Lots

Tom DeGomez, Forest Health Specialist, School of Natural Resources, University of Arizona

Past land management practices have often resulted in ponderosa pine stands that are overly dense, growing offsite, and prone to catastrophic wildfire, drought or bark beetle outbreaks[3,4,5.] Landowners and property managers in the Southwest now are faced with determining appropriate ways to prevent these potentially stand-replacing events. The best way to reduce wildfire threat, drought damage and attack by bark beetles is to lower stand density through mechanical thinning.

An additional benefit from reducing stand density is that remaining trees will grow more rapidly than when in an over-stocked condition. A century of research has shown that tree diameters increase at a faster rate in stands with lower densities, and ponderosa pine is no exception[7]. Thinning can greatly increase under story plant density in ponderosa pine forests[2,6.] Herbaceous plant growth, both grasses and forbes, typically increases when additional light reaches the forest floor.

A potential drawback to thinning may be the perception that the property's scenic beauty will be spoiled. Brown and Daniel (1986) found, in their study of predicting scenic beauty in ponderosa pine stands, that less dense (more open) stands had greater scenic value. The major components of higher preference were the increase in herbaceous plant growth and the remaining mature trees. (Refer to Figures 1a&b for a visual representation of various basal areas in a ponderosa pine stand with even-aged management.)

Figures 1a and 1b. Photos represent basal areas of approximately 60 and 120 square feet per acre, from an even aged stand in Flagstaff, Arizona.

## HOW TO DETERMINE IF THE STAND HAS THE PROPER STOCKING RATE

Foresters use the term basal area to describe this stocking rate (or trees per acre when including their size in diameter); it is the total cross-sectional area of the tree in square feet measured at breast height. On small lots of 1-3 acres each tree can be counted and measured to determine the basal area of the stand.

Table 1 will help determine the basal area of each tree in each plot or each tree on the property if every tree is being measured. Use a flexible measuring tape (inches) to determine the circumference of each tree at 4.5 feet above the ground. Then multiply the number of trees in each diameter class times the basal area per tree (found in Table 1). Totaling all the trees and basal areas will give the total number of trees and total basal area for each plot sampled. (Note that inches become square feet in the conversion.) Adding in other tree species such as oak and juniper can help in getting a total assessment of the property.

Table 2 can assist in choosing the target basal area for thinning the property. Once the target basal area is determined for the stand, refer back

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to Table 1 with the overall stand data to determine whether the stand has more or less basal area than is recommended for your location. If you have a lower basal area than recommended, no action is needed. However, if the basal area for the stand is more than the optimal amount listed in Table 2, it is recommended the stand be thinned.

Depending on what your goals are for the stand, determining which trees need to be removed can be complex. Removing trees from a group of diameter classes (i.e. the smallest trees) may cause the stand to look more even-aged versus selecting trees in clusters that can lead to a more natural clumpy, uneven-aged look. For additional information on determining which trees to remove refer to: *Guidelines for Thinning Ponderosa Pine for Improved Forest Health and Fire Prevention,* University of Arizona, College of Agriculture and Life Sciences Bulletin AZ1397. It is available on the web at http://cals.arizona.edu/pubs/natresources/az1397.pdf or at your local county Extension office.

## REFERENCES

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[7]Ronco, F., Jr., and C.B. Edminster. 1985. Growth of ponderosa pine thinned to different stocking levels in northern Arizona. Rocky Mtn. Forest and Range Experiment Station, USDA Forest Service, RM-469:10

Figure 1a. Basal area of about 60 square feet per acre.



Figure 1b. Basal area of about 120 square feet per acre.

Table 1. Tree circumference in inches as it relates to diameter at breast height (DBH) and basal area (BA). (Use this form to tally all the trees in each diameter. To calculate total basal area for a diameter class: multiply the number of trees in each diameter class times the corresponding basal area per tree divided by the number of acres.)

| Circumference in inches at breast height (4.5' above the ground) | Diameter classes (inches in diameter at breast height -DBH) | Basal area (BA) per tree | Number of trees in each diameter class | Total basal for diameter class |
|---|---|---|---|---|
| 12.6 | 4 | 0.09 | | |
| 15.7 | 5 | 0.14 | | |
| 18.9 | 6 | 0.20 | | |
| 22.0 | 7 | 0.27 | | |
| 25.2 | 8 | 0.35 | | |
| 28.3 | 9 | 0.44 | | |
| 31.5 | 10 | 0.55 | | |
| 34.6 | 11 | 0.66 | | |
| 37.8 | 12 | 0.79 | | |
| 40.9 | 13 | 0.92 | | |
| 44.1 | 14 | 1.07 | | |
| 47.2 | 15 | 1.23 | | |
| 50.3 | 16 | 1.40 | | |
| 53.4 | 17 | 1.58 | | |
| 56.5 | 18 | 1.77 | | |
| 59.7 | 19 | 1.97 | | |
| 62.8 | 20 | 2.18 | | |
| 65.9 | 21 | 2.41 | | |
| 69.0 | 22 | 2.64 | | |
| 72.1 | 23 | 2.89 | | |
| 73.3 | 24 | 3.14 | | |
| 76.4 | 25 | 3.41 | | |
| 79.5 | 26 | 3.69 | | |
| 82.6 | 27 | 3.98 | | |
| 85.7 | 28 | 4.28 | | |
| 88.8 | 29 | 4.59 | | |
| 92.0 | 30 | 4.91 | | |
| 95.1 | 31 | 5.24 | | |
| Totals: | | | | |

Table 2. Recommended basal area (square feet per acre) for ponderosa pine stands in Arizona when matching elevation to precipitation. This table was prepared by several experts on growth and development of ponderosa pine. It is designed to be a guide to help landowners determine good stocking density for their particular location.

| Precipitation | ELEVATION | | | | |
|---|---|---|---|---|---|
| | 5,500' | 6,000' | 6,500' | 7,000' | 7,500' |
| 16" | 35 | 40 | 45 | 50 | 55 |
| 18" | 40 | 45 | 50 | 55 | 60 |
| 20" | 45 | 50 | 55 | 60 | 65 |
| 22" | 50 | 55 | 60 | 65 | 70 |
| 24" | 55 | 60 | 65 | 70 | 75 |

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