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INCREASING POCKET GOPHER PROBLEMS IN REFORESTATION

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ABSTRACT: Concern over pocket gopher damage to conifer seedlings is increasing rapidly in the northwestern United States. The evolution of the pocket gopher (Thomomys spp.) has resulted in an animal that occurs throughout northwest forested areas and responds to site disturbances by increasing numbers and distribution. Pocket gophers kill or slow growth of conifer seedlings. More extensive logging, wildfires, and insect epidemics are resulting in more damage problem areas. This will continue. Current damage control is judged poor. Juvenile dispersal, high natural mortality rate, need for intensive treatment on entire damaged areas, current dependency on pesticides for control, increasing wood product values, and decreasing tolerance for reforestation delays are causing this increased concern. Integrated control appears necessary for the future.

THE POCKET GOPHER

The pocket gopher (Thomomys spp.) is found in the Pacific Northwest over most of Oregon, Washington, Idaho, and northern California. Six species of the genus Thomomys occur. Animals within these species vary considerably and ranges among species appear to overlap in many areas. The northern pocket gopher (T. talpoides) and the mazama pocket gopher (T. mazama) are the most widely distributed species in this region. They are almost impossible to distinguish by external characteristics (Ingle, 1965). The northern and mazama pocket gophers are the species identified most often in areas where the greatest amount of damage occurs to conifer plantations. Damage to trees in Christmas tree farms in Oregon's Willamette Valley (Northwest Forest Pocket Gopher Committee, In Press-a) probably is caused mostly by the giant pocket gopher (T. bulbivorus).

There are several characteristics of the northern and mazama pocket gophers which result in them being problems in northwestern forested areas. They are well distributed in forest lands. There are many areas where residual populations are found in natural openings all through extensive forest stands. They are socially intolerant. Gophers remain solitary except during the breeding season and when adult females are rearing young (Barnes, 1973). Burrow systems are constructed, and serve as the territory of individual animals during most of the year. Young are weaned and excluded from the parental burrow system. They must disperse and construct their own burrow system. This dispersal normally occurs in about a one month period in each area and is characterized by a peak in mound building. Juvenile dispersal of gophers serves to maintain and extend gopher distribution. This especially facilitates gophers taking advantage of newly created habitat following vegetation and soil disturbances.

Gophers in the Northwest have been characterized as requiring early successional stages. Forbs or fleshy-rooted grasses are preferred foods. On forest lands, canopy disturbances normally result in increased herbaceous vegetation (McConnel and Smith, 1970; Jameson, 1967). Since the pocket gopher appears dependent on herbaceous vegetation, this means young must find open areas where the forest canopy has been opened enough to stimulate herbaceous vegetation. Soil disturbances in opened areas appear to stimulate preferred gopher foods.

Social tolerance would reduce juvenile dispersal pressure. This would be detrimental to gophers because individual animals would continue to reside in increasingly poorer habitat (increasing forest canopy). Gophers have evolved taking advantage of natural disturbances or openings in tree stand.

Pocket gopher populations are dynamic and fluctuate naturally. Natural annual mortality is high with juveniles, animals (year old or younger) often comprising 75 percent or more of the population (Barnes, 1973).

Pocket gopher burrows are extended into the snow during winter. This is evidenced by occurrence of barking on coniferous trees up to 12' from the ground surface. This can facilitate occupancy of new areas by successfully crossing obstacles that are barriers the rest of the year. Closed canopy conifer stands apparently act as barriers to dispersal.

DAMAGE

Pocket gophers damage coniferous trees by barking or girdling above and below ground level and by removing small seedlings (Barnes, 1973). This may cause tree mortality or reduced growth. Trees can be damaged by root exposure to air in burrows (Tevis, 1956). In some areas, gopher mounds or castings cover small seedlings and cause mortality or tree deformity (Kuck, 1969; Patee (1976). All these factors cause reforestation failures, necessitating replanting, and often, repeated site preparation. Damage is extensive. The Northwest Forest Pocket Gopher Committee (In Press-a) surveyed public and private land managers in the Pacific Northwest. The Committee sent a questionnaire to National Forests, Bureau of Land Management Districts, State Wildlife, Forestry, and Extension agencies, commercial Christmas tree farmers, and Industrial Foresters in Oregon, Washington, Idaho, and northern California. Damage reportedly occurred on all types of land ownerships surveyed, and in all of the merchantable timber vegetative types found east of the Cascade Mountain Crest. Excessive damage reportedly has or is occurring on approximately 200,000 acres. A majority of these acres are administered by the U.S. Forest Service.

Ponderosa pine appears as the conifer species most often damaged (Crouch, 1969). Although in many areas of intensive damage, pocket gophers are generally indiscriminate as to conifer species damaged, as in South Central Oregon (Crouch, 1971). Damage to lodgepole pine will increase in concern (Barnes, 1973). Other authors describe damage to conifers (Moore, 1940; Larrison, 1942; Dingle, 1956; Tevis, 1956; and Black et al., 1969). Pocket: gophers can have very significant effects on other tree species, including California white oak in this very area (Griffin, 1971).

DAMAGE CONTROL TECHNIQUES

Most damage control efforts to protect conifers in the Northwest have involved direct population reductions. Trapping and poisoning were used most often. Poisoning has been used most in extensive treatment areas; because trapping is more labor intensive and slower (Frank, 1972; Barnes, 1973). Strychnine Alkaloid has been used most, as this has been the treatment measure recommended most often by the U.S. Fish and Wildlife Service. Barnes (1973) described other treatment measures used in the past. On rangeland, gopher populations have been reduced drastically through modification of vegetative communities with herbicide (Turner, et al. 1973). Herbicide used to control pocket gopher damage on forested land is being tested in Oregon by Oregon State University and the U.S. Fish and Wildlife Service.

Poison has been applied by hand or by machine ground application. Hand baiting has been used for many years, described as early as 1942 (Crouch, 1942). Toxic bait is placed in burrow systems currently occupied by gophers, and the opening used is blocked. Work has been accomplished by use of trowels, spoons, probes, and mechanical bait dispensers. The mechanical bait dispensers, similar to that described by Hansen (1956), have increased the speed of hand treatment. All occupied systems must be treated. The success of hand baiting in reducing damage is relatively unknown.

The burrow-builder was introduced in the late 1950's and has proved very useful and effective in treating pocket gopher damage areas. The machine creates an artificial burrow and dispenses bait in piles along the burrow. Earliest machines were described by Ward and Hansen (1960), Kepner et al. (1960, and Marsh and Cummings (1968). These machines were used on rangelands or croplands. Canutt (1969) described the development and use of a burrow-builder for Forest lands. A more rugged machine was necessary. Barnes, Martin, and Tietjen (1970) found that the Forest land machine was successful in greatly reducing gopher populations in south-central Oregon. Barnes (1974) indicated machine treatments can be used to protect trees.

DAMAGE CONTROL DIFFICULTIES ON PROBLEM AREAS

It appears damage control efforts to date have been unsuccessful. At least they are considered so by people involved. The Northwest Forest Pocket Gopher Committee (In Press-a) reported that in the Northwest, almost 80 percent of public and private land managers conducting control programs rated their efforts ineffective or only partially effective in reducing damage. Respondents to the Committee's questionnaire indicated that in 1974, control measures were being applied to only 10 percent of the acreage reportedly incurring damage. Factors disclosed as primary causes of this ineffectiveness were insufficient budget, personnel, equipment, control technique, and damage detection.

There are several factors which make damage control very difficult on problem areas:

- 1) Natural high annual mortality must be exceeded
- 2) Pocket gophers reproduce well and reinvade rapidly
- 3) Treatments must be done annually
- 4) Entire occupied areas must be treated
- 5) Each occupied burrow must be treated
- 6) Hand treatment must be accomplished when occupied burrow systems are indicated by above-ground disturbances, resulting in large number of personnel needed for a very short period.
- 7) Machine treatment is dependent on specific soil moisture and obstruction-free conditions.
- 8) Damage may occur immediately after tree planting.

Pocket gophers produce one litter per year, of 4-8 young. The dispersing young search for areas unoccupied by gophers. It is probably during this period or when animals are traveling through snow that the greatest mortality occurs (Howard and Childs, 1959; Turner *et al.*, 1973). Weather and herbaceous vegetation also greatly affect population levels (Turner *et al.*, 1973; Black and Hooven, 1974). The direct relationships between population levels and damage to conifers are unknown. One level of damage may be caused by few gophers, or many gophers - depending on habitat conditions. Therefore, probably in most problem areas, direct population reductions by man must exceed the natural mortality rate. Natural mortality rate is probably 70-75 percent per year (Hansen, 1960). I estimate a 90 percent plus population reduction is necessary as a general rule to significantly reduce damage.

Pocket gophers invade rapidly into suitable available habitat. If occupied areas are partially treated, dispersing young not poisoned or trapped, will quickly occupy empty burrow systems nearby (Barnes, 1974). Therefore, the entire occupied area must be treated. This means each occupied burrow must be treated - especially since a 90% plus mortality is sought. To locate each occupied burrow system, treatment must be done during the peak in mound-building activity. This is when it appears gophers in most to all occupied systems create mounds. Few mounds are made at other times of the year. Many occupied systems at other times of the year cannot be located by observing above-ground sign. Hand treatments at those times probably miss many gophers, but can be used in combination with machine treatments or hand treatments during peak in mound building. Location of mounds during the peak in mound building can be especially difficult if the occupied areas are large or covered by dense herbaceous vegetation which makes gopher disturbances difficult to locate. The larger the area, the greater chance treating personnel will miss occupied burrow systems. Frank (1972) concluded personnel morale was significantly reduced when treating large areas; as they believed they would never finish the area. Treatments became inadequate, as personnel wanted to hurry up and finish large areas. Morale, plus the great number of acres presently needing treatment, have caused achievement to be measured in acres treated instead of acres where control has significantly reduced damage. Where intensive treatment of the entire occupied area is difficult, annual treatments are necessary. Annual treatment, where treatment occurs, is now the standard practice where damage has been most severe on national forests in Oregon.

Location and hand treatment of each occupied burrow system must be accomplished in a short period of time, as the peak in mound building generally lasts for about one month. Therefore, treatment personnel are needed only for a short period of time. This can be an extreme problem if large acreages need treatment. If areas can be trapped at a rate of only 1.6 acres per person per day as experienced by Frank (1972), or 5 acres baited per person per day reported by Canutt (1969), 4,000 acres needing treatment, would require, for the one month period, 125 trained trappers or 40 baiters. This is very difficult to do, even with adequate money due to training required and short term availability of personnel. The burrow builder requires one person to operate and 2.5-6.0 acres can be treated per hour (Canutt, 1969). The machine normally is not practicable on most of the areas needing treatment. It is not useable in areas where soils are heavy clay, where concentrations occur of surface debris (logs, limbs, browse), or where recently dead or large tree roots are present. Also, soil conditions must be right (Canutt, 1969). Pocket gopher damage may occur as soon as trees are planted. This requires close coordination between planting and control administrators. Often, successful control cannot be conducted

when it is best for planting. Barnes (1976) found that in Fall, 1973, gophers damaged 2 percent of ponderosa pine within 24 hours of planting on the Cave Mountain Burn in south central Oregon. Approximately 14 percent were destroyed within 1 month. Black (1976) reported pocket gophers destroyed about one third of all conifer seedlings planted within six months after planting east of Medford, Oregon. Treatments from the previous year, or in the spring preceeding fall planting, probably will not protect newly-planted seedlings, due to young dispersal and reinvasion.

THE POCKET GOPHER CONIFER DAMAGE PROBLEM WILL INCREASE

Disruptions in forested areas create more suitable habitat for pocket gophers. Logging, road building, wildfire, and insect attacks all create habitat the gopher has evolved to take advantage of. These disruptions will continue; as logging and associated disturbances will accelerate. As they do, gopher distribution will increase and invasion or dispersal potential will increase. The increased damage potential will be combined with decreased tolerance for losses. This will include higher elevation sites, especially true fir zones. There will be less room for damage in the future forest intensively managed for production of wood products. The primary specific reasons for this increasing conflict are:

- 1) Wood fiber will increase in relative economic value; therefore damage will have a greater economic impact.
- 2) We will need to reforest areas now not successfully reforested due to gopher damage.
- 3) We will need to intensively harvest trees in areas now avoided due to gopher damage potential.
- 4) Wildfire, insect outbreaks, and "blowdowns" will continue; with less reforestation delay tolerated.
- 5) Damage complicates management and reduces flexibility in timber harvest and management of other resources.
- 6) Increasing encounters of residual gopher populations, as timber harvesting becomes more extensive.
- 7) Less opportunity to provide forested buffer zones among harvest areas; we will be cutting the strips or blocks among present problem areas.
- 8) Increasing acreage of damage will mean greatly increased numbers of personnel needed for the short term treatments.
- 9) Increasing pesticide use restrictions, affecting use of herbicides, rodenticides, repellents, preventative treatments, and pesticide development.
- 10) Lack of necessary data on damage appraisals, treatment efficacy in terms of change in damage, and secondary hazards of operational direct control efforts.
- 11) We will identify more of the existing negative impacts of gophers due to more intensive timber management evaluations and less misidentification of gopher damage as other problems like porcupine damage, disease, insects, soil deficiencies, or "poor nursery stock."

Harvestable trees will continue to increase in relative economic value. Wood products are increasing in demand. Increasing human populations, and the need for wood fiber, will mean more and more fiber will be harvested and be of economic value, including fiber now uneconomic to bring in from the woods. Much of the forested areas, especially privately owned land, will enter intensive management for wood products. The uncut areas or areas covered by over-mature trees will mostly disappear on publicly-owned commercial forest acres. The recently-released study by Oregon State University (Bueter, 1976) predicts western Washington and Oregon timber yield will probably decrease around the year 2000. Increasing pressure will be on pine forests to compensate for this drop. It will certainly be very difficult to reduce yields from any public land. This means intensive management for wood production will occur and be taken to the more difficult and less-productive timber stands. Acreage of tree harvest and tree planting will increase. For example, conifer seedlings will be planted on approximately 110,000 acres in 1976 and 160,000 acres in 1985 on National Forest lands in Washington and Oregon (Nicholson, 1976). Economic allowances for reforestation efforts will be more difficult, as products will be worth more, economic returns will be more important, damage control needed will cost much much more, and slimmer economic margins will prevail in many areas. There will be less tolerance for reforestation delays. Lost growth due to tree injuries or mortality will be calculated in economic terms.

Presently, there is a large backlog of reforestation needed. On National Forest land in Oregon and Washington, for example, this backlog presently consists of approximately 276,000 acres (Nicholson, 1976). A primary reason for this backlog is animal damage. Concern of the increasing reforestation backlogs is evidenced by the recent Congressional action to almost double reforestation funds for public land for fiscal year 1976.

The potential for pocket gopher damage has resulted in postponement or cancellation of timber harvest for many areas. On many lodgepole pine sites in central Oregon, for example, gopher damage has prevented successful reforestation. Areas have been planted up to five times; and each time pocket gophers have been responsible for plantation failure. Damage control attempted failed. Some of these sites have not been growing conifers since trees were cut 8-10 years ago. New harvest designs were tested in nearby sites, still resulting in damage-caused failures. This has resulted in cessation of timber sales in the general area. There will be increasing interest in timber cutting in these areas, and I am convinced they soon will be cutover. Economic pressures will be too great. Also, these sites, if not logged, will be "harvested" by insects or wildfire, as is being experienced in the current lodgepole pine bark beetle epidemics in East-Central Idaho - NW Wyoming and NE Oregon.

Pocket gopher damage results in more disruptions or loss of flexibility in management. Damage normally means more restrictions on harvesting.

One present technique used to reduce or prevent damage in some areas is to avoid cutting in or adjacent to areas presently occupied by gophers. Barnes (1974) presents data on rate of gopher invasion of newly logged areas contiguous to gopher occupied sites. Invasion is rapid and often gophers are well established when planted seedlings are most vulnerable. Occupied areas include openings in tree canopies, meadows, road and railroad cleared areas, stream courses, and present cutover areas. Timber harvesting was located slightly "away" from these areas, leaving a buffer (uncut) area between. However, now the "away" areas are disappearing and the buffer areas are becoming a significant portion of the uncut stand. Little data are available on what forested distance is required to prevent gopher invasion. Barnes (1974) has estimated 500 feet for Central Oregon lodgepole pine areas. It is now apparent that with an increasing number of gopher-occupied areas and the increasing relative value of wood products, 500 foot buffer zones will generally not be practicable, especially as a primary damage prevention technique.

In the Northwest, soil disturbances during or following logging are common. Disturbances are made to reduce vegetative competition for new conifer seedlings, to reduce fire hazard of post-logging debris, or simply due to logging equipment operation. Soil disturbances normally improve gopher habitat because of resultant herbaceous vegetative growth and loose soil. Generally, plant species that are preferred food of gophers invade the disturbed areas. Therefore, in many areas, managers have been restricted to harvest practices that result in less soil disturbance. Restrictions have resulted also from the need to maintain enough tree canopy density to discourage growth of herbaceous vegetation. Often, what is best silviculturally cannot be done.

The restrictions in harvest, plus the reforestation delays, have impacted other resource activities. The lost flexibility and reduced wood fiber production has meant a reduction in opportunities to design timber harvest to benefit such resources as visual and wildlife. For example, on the Winema National Forest, long strip cutover areas were made in gopher damage areas. This was done so natural seeding would be greatly encouraged and hopefully counteract gopher damage. The strips caused adverse reactions from airplane passengers and other observers, plus game managers. The strips were used as long distance shooting ranges for deer. Public concern for visual, wildlife, and other affected resources is increasing. We have seen this recently in the courts and in Congress, especially relative to clearcutting.

I view this loss of flexibility as a land management problem - not a Forester's problem. Wildlife Biologists better become involved and work to solve it. Increased flexibility means more opportunities to structure timber management to benefit wildlife. Also, Foresters are not very happy to have the Biologist turn away from animal-reforestation conflicts or condemn pesticide uses, and then demand that snags be saved, or cutting units be structured in very specific designs!

Pocket gopher conifer damage will increase also due to pesticide restrictions. Presently, the only accepted and practicable damage control technique is use of rodenticides. Strychnine alkaloid is used most. Yet this chemical, in 1972, was banned for use on public

land. No damage control tools were then available to public land managers. Use of strychnine alkaloid on public land was recently restored; but the chemical is still being questioned. I see no new rodenticides being developed or registered to replace strychnine alkaloid for use on public land. Presently, there is no accepted substitute for reducing damage on existing publically-owned problem areas.

FUTURE DAMAGE CONTROL

Solutions to, or even substantial progress in solving the problem of pocket gopher damage to conifers in the Northwest, are dependent on the combined occurrence of:

1. Increased awareness of the problem and its implications. Managers must make better and more frequent inspections and evaluations of damage. Personnel transfer often, especially in governmental agencies, and awareness of damage and resultant impacts in new personnel takes time. In the meantime, extensive damage has occurred or new problem areas are created. Degree and significance of damage must be considered at a higher management level. Many Foresters are content to discount reforestation problems. Public understanding of the impact of damage and gopher population manipulations must be increased. Educators must provide more training on vertebrate pest problems. In surveying the National Forests in Oregon and Washington, I concluded pocket gopher damage is the number one vertebrate animal damage problem there. Patee (1976) stated gopher damage is the number one reforestation problem on cutover areas on National Forest lands in Utah, Southern Idaho, and Western Wyoming. A primary reason for this conclusion is increased awareness of the damage. Patee (1976) indicated Forest Service damage control efforts will be increased dramatically in 1976 in those three states, using baiting and altered harvest practices.

2. Increased research and evaluations of pesticide use impacts are needed. We know very little about field rodenticide primary and secondary effects. In the absence of data, pesticides are considered guilty until proven innocent. These questions must be answered. Research is in progress on pocket gophers (NW Forest Pocket Gopher Committee, In Press-a); but much more research is needed.

3. Managers must consider damage control an integral part of all other planning for affected areas. Too many times, I have observed where damage, and other reforestation problems, are not a part of land use or timber sale planning. Damage control costs should, be compared to values protected or values that could be produced elsewhere for the same cost. Often, damage is not considered a future problem in areas affected by wildfire or insect epidemics. Gophers are causing significant damage on areas recently decimated by the Douglas-fir Tussock moth in NE Oregon and the bark beetle in east central Idaho and northwest Wyoming.

Pocket gopher damage control must be considered a major commitment of resources. Problem areas must be inspected and probably treated annually for the first 8-10 years. Gopher sign and damage is there, for inspectors to see, not only of residual populations before site disturbances, but after disturbances. The measure of success must not be acres treated or percent of gopher population reduced, but the reduction in damage. We must demand evaluations of direct population control work, and in terms of change in damage.

4. Combining the following preventative techniques where damage is expected or likely:

a. Locate timber harvest or disturbances at least 500 feet from gophers. In some areas, this can be accomplished by making harvest units small, as circle shaped as possible to reduce amount of border and extensity of gopher distribution, and rotating harvest to where areas are not disturbed until the area around it (500 feet) has been reforested and gopher habitat has diminished enough to exclude or severely reduce gopher populations.

b. Directly reduce existing gopher populations at least 90%, in and around areas to be disturbed, prior to disturbance. Delay population buildups.

c. Design timber harvest and post-logging debris manipulation so tree canopy, soil, and browse disturbances are minimized. Barnes (1974) describes such implications from his studies. Partial cutting may be necessary rather than clearcutting.

d. Plant areas sooner, and use more and larger trees to reduce the period trees are susceptible to mortality from gophers. Tree losses seem to occur steadily, year by year. Soon the tree density is below standard. Reforestation success should be increased by getting more trees in the ground immediately. Larger trees seem to incur less mortality.

e. Prepare sites for machine baiting. Debris can be manipulated and trees can be planted in rows or spaced wide enough to accommodate the burrow builder.

f. Learn what soil types or plant communities are associated with pocket gopher occurrence and suitability. Volland (1974) described such relationships he developed in Central Oregon. He suggested that plant communities can be grouped according to incidence of gophers in natural and disturbed stands plus potential for gopher occupancy after disturbance. He suggested tree harvest practices and preventative techniques by plant community classes to minimize damage. These data are available to managers and useful in preventing or planning for damage.

g. New control measures, especially herbicide use and direct seedling protectors. Gopher populations have been reduced by herbicides (Turner et al., 1973; Black and Hooven, 1974). The plastic seedling protectors described by Campbell and Evans (1975) are being tested now by Barnes (1976) for use in repelling gophers. These techniques may be used in the future in the areas already occupied by gophers that are scheduled for reforestation. Encouraged predation on gophers may help reduce populations, but cannot, I believe, be depended on by itself in controlling damage. Initial results of contract baiting are encouraging (Patee, 1976).

5. There is not now or never will be an easy answer to this damage problem. I believe the problem will magnify in the next 20 years. Integrated control will be required. Pocket gopher populations are very dynamic and resilient. They will be present in forested areas for as far as I can see into the future. They will continue to take advantage of our manipulations of the forests. We must realize when we harvest timber or create other site disturbances, the animals react similarly as the vegetation does. In planning these disturbances and dealing with the resulting adverse consequences, we must realize we have to work within the system and not with the philosophy we are masters of the system.

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