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Assessment of Aspen Condition on the Okanogan and Wenatchee National Forests

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Introduction

Aspen, *Populus tremuloides*, commonly called quaking aspen and trembling aspen, is on all ranger districts on the Okanogan and Wenatchee National Forests in eastern Washington. Aspen exists in small scattered stands, typically in riparian areas and moist upland sites. The amount of aspen on the Forests is not well quantified.

Aspen's contributions to the Okanogan and Wenatchee National Forests far exceed its small stand acreage and relatively small number of stems. Aspen stands are important to many species of wild and domestic animals. It has tremendous aesthetic value. Aspen has never been harvested for timber products in significant volumes or numbers on the Okanogan and Wenatchee National Forests.

Practically all aspen regeneration results from asexual vegetative production of sprouts from roots following disturbances. Sprout production is controlled by the ratio of plant hormones auxin and cytokinin. High auxin-to- cytokinin ratios are maintained when living aspen stems are present, suppressing sprout production. When aspen stems are removed or killed, cytokinin predominates over auxin and sprout production is initiated on the roots. Almost all aspen exists as clones in which all the stems (ramets) are genetically identical because they all arise vegetatively from the same root system. Aspen clones can be hundreds, even thousands of years old, as they are perpetuated by episodes of sprouting. Regeneration of aspen stands by sexually produced seeds is an unusual phenomenon (Romme et al 1997). Conditions that impede or prevent aspen root systems from sprouting will lead to demise of the clones.

Concern has been expressed about widespread decline of aspen stands in the interior western United States (Kay 1997, Bartos and Campbell 1998). The decline is attributed to a combination of succession to conifers, reduction in area burned by fires, and overuse by wild and domestic ungulates. A survey of 27 aspen stands on the Little Pend Oreille National Wildlife Refuge in northeastern Washington found 18 stands were successional to conifers or decadent (Hadfield 2002). The condition of aspen stands on the Okanogan and Wenatchee National Forests was not known, leading to requests for a condition assessment survey.

Procedures

A request was made to each District to provide a map showing the location of at least 25 aspen stands. Aspen stands were to be representative of the spectrum of stands on the District. Districts were asked to include stands with at least two living stems and to not overlook stands with small numbers of stems. They were also asked to show aspen locations separated by at least 0.5 miles to reduce the potential of surveying the same clone more than once.

Each District provided a map displaying aspen locations. Each aspen stand was assigned a number and 15 stands were selected at random for field assessment on each District. Chelan District provided a map displaying only 14 stands so all were selected for assessment.

All field assessments of chosen stands were done in August and September 2003 while leaves were on the trees. A small number of stands selected for survey could not be located, so the aspen stand nearest was substituted. We walked through the stand to determine its size and shape. If the stand contained 25 or fewer aspen stems, all were examined. A transect that traversed the stand was laid out in stands with more than 25 stems. The width of the transect was adjusted for each stand in an attempt to make it extend from edge to edge and contain 25 aspen stems. The first 25 aspen stems encountered in the transect were examined. The following data were recorded for each stem: Size of each stem was classed as "seedling" (<1.0" DBH), "sapling" (1.0" – 4.9" DBH), "pole" (5.0" – 9.9"), and "mature" (10.0" and larger DBH). The stem was recorded as alive or dead. Roots, butt (lowest 2'), stem, and foliage were examined for damage. Damage-causing agents were identified. If no damage was seen the tree portion examined was classed as "ok".

If aspen sprouts were seen in the stand, four 1/500 acre circular plots were established to count and examine them. The first plot was placed in a location containing at least one sprout. Three additional 1/500 acre plots were established at 100' intervals along a compass line. All sprouts and seedlings inside the plots were examined. Each was classed as "sprout" (aspen stem that originated in 2003), "old sprout" (aspen stem at least one year old < 4' in height), and "seedling" (aspen stem at least one year old, $\geq$ 4' tall, <1.0" DBH). The stem was recorded as alive or dead. Each was rated as browsed or not browsed. We made no attempt to identify the animals responsible for browsing. Each stem was examined for damage, which were identified by causal agent, as best as possible.

The stand location was determined with a handheld GPS unit. The site was classed as riparian or upland. Sprouting was rated as active (several sprouts produced in the last 2 years) or not active. Conifers present in the stand were listed in order of predominance based on apparent numbers of stems. Conifer competition was rated as "none", "light" (conifers limited to the understory or 1-9% stems in codominant or dominant crown position), "moderate" (10-25% stems in codominant or dominant crown position), or "severe" (25% or more stems in codominant or dominant crown position). Estimates were made of the approximate acres occupied by aspen stems and number of stems in the stand. The area occupied by the aspen stand, based on living stems, was characterized as "stable", "expanding", or "retreating". The overall condition of the stand was assigned to one of three condition classes developed for characterizing condition of aspen stands in the Rocky Mountains by Bartos and Campbell 1998. "Stable" is characterized by the presence of multiple size aspen stems and young regeneration around the edges and little mortality (Figure 1). "Successional to conifers" is characterized as having conifers replacing aspen, some aspen regeneration may be present but it is not abundant (Figure 2). "Decadent" stands were characterized as having little to no aspen regeneration and ample aspen stem mortality. Decadent aspen stands have an open appearance with many dead aspen stems (Figure 3). Conifers may or may not be present in decadent aspen stands.

The presence of elk, deer, and cattle was recorded for each stand. This was done on the basis of droppings and tracks.

Results and Discussion

Districts provided locations of 279 aspen stands for assessment. Districts did not randomly select stands for survey from the entire population of aspen stands on the Okanogan and Wenatchee National Forests. We surveyed 105 aspen stands on the Okanogan and Wenatchee National Forests (Figure 4). We assumed the surveyed stands were representative of the spectrum of aspen stands on the Forests based on our sightings of hundreds of aspen stands while we did the assessment. A total of 2,537 aspen stems were examined in transects and 1,919 aspen sprouts and seedlings were examined in the 1/500 acre plots.

Stand Characteristics:

Most aspen stands surveyed were small (Figure 5). Twenty-seven stands (26%) were estimated to cover less than one acre. Fifty-six percent of the surveyed stands were estimated to cover no more than 2 acres. Twenty-eight percent of the surveyed stands were estimated to cover at least 5 acres. The size of aspen stands decreased from the northern to the southern Districts on the Okanogan and Wenatchee National Forests. The stands surveyed on Naches had the smallest average acreage followed by Leavenworth. The largest surveyed stands were located on Tonasket, Methow Valley, and Entiat. Several aspen stands on Methow Valley and Tonasket probably cover at least 25 acres.

Fifty-six percent of the aspen stands surveyed were located on upland sites and 44 percent were in riparian areas. All aspen stands were located in sites that appeared to be moist and well drained, but not dry or wet. Aspen was seldom seen growing next to standing or flowing water.

Twenty-six percent of the surveyed stands had no competition from conifers. Seventy percent of the aspen stands had light to moderate conifer competition. Only four stands were experiencing severe conifer competition (Figure 6). Douglas-fir was the most frequent conifer competition in the surveyed stands followed by ponderosa pine and grand fir.

The estimated number of aspen stems in stands ranged from a low of 2 in one stand to more than 1,500 in a stand at Tonasket. Nine surveyed stands had less than 25 aspen stems. Twenty stands were estimated to contain more than 1,000 aspen stems. The number of stems per stand varied greatly within and between Districts. However, the number of aspen stems per stand decreased from north to south on the Okanogan and Wenatchee National Forests (Figure 7). In the course of doing the survey we saw many aspen stands with very small numbers of stems that were not included in the lists of aspen locations provided to us by Districts. There are many aspen stands that appear to have fewer than five living stems.

Sapling was the most abundant stem size class encountered, with the notable exception of stands on the Naches District. Aspen stem size class distribution in surveyed stands varied considerably between Districts (Table 1). Only 2 percent of the aspen stems in transects on Chelan were classed as “mature” with DBHs of 10 inches or larger. In contrast, 57 percent of the stems surveyed in transects on Naches were classed as “mature”, and only 2 percent of the stems were classed as seedlings. The seedling size class was almost absent in stands surveyed at Naches.

Aspen sprouts were found in 85 percent of the surveyed stands. Active sprouting, characterized as having numerous sprouts originating in 2002 and/or 2003, was observed in 47 percent of the stands. New and old aspen sprouts were present in almost equal proportions when all 105 stands were considered (Table 2). Sixty-three percent of the sprouts in the Naches plots were classed as “old sprouts”. In contrast, 68 percent of sprouts in plots at Chelan were considered to be new sprouts, most developing after fires in 2002. Naches had the greatest average number of sprouts, but no seedlings were recorded in any of the 1/500 acre plots on the District.

Most aspen stands surveyed appeared to have the ability to produce sprouts, only those rated as decadent seemed to have lost that capacity. Decadent aspen stands transform into conifer stands or even into grass meadows as their root systems lose ability to sprout. The few stands with severe conifer competition had few sprouts. Several stands on Chelan and Entiat burned by wildfires had hundreds of sprouts and seedlings per acre. Most sprouts appeared to have emerged from the root system within one year after fires with much smaller numbers being formed after that. Some aspen stands on the Naches District with moderate conifer competition and relatively closed canopies had many aspen sprouts in their understories. Such shade grown sprouts seldom develop into larger stems.

Stand Condition:

Fifty-six percent of the surveyed stands were classed as stable, meaning they were vigorous and self-perpetuating with little to no mortality. Chelan and Leavenworth had the largest numbers of stable

stands. Naches had the fewest stands classed as stable. Forty-one percent of the stands were considered successional to conifers. Only 3 percent of the stands were rated decadent, even though portions of some stands rated stable and successional to conifers appeared to be decadent (Figure 8). Naches had the largest number of stands classed as successional to conifers, followed by Methow Valley and Tonasket.

Area occupied by living aspen stems was rated as stable for 43 percent of the stands, expanding for 19 percent, and retreating for 38 percent of surveyed stands (Figure 9). Chelan and Entiat had the largest number of stands that were expanding in size. Most of the expanding stands on those Districts were located in areas burned in 2002 and 1994. Leavenworth and Cle Elum had the largest number of stands classed as stable in size. Fourteen of the 15 stands surveyed at Naches were classed as retreating in size. None of the stands in the successional to conifers and decadent condition classes were expanding in size and 85 percent were retreating in area occupied by living stems. In contrast, 98 percent of the stands in the stable condition class were stable or expanding in area occupied.

There was no apparent relationship between the estimated acreage of the surveyed stands and their condition class, with the exception of the three stands rated decadent which were all estimated to cover less than two acres. Several small acreage aspen stands, as well as large stands, were rated stable.

Analysis of survey data showed there was no apparent relationship between stand moisture type and condition class. In addition, stand moisture type did not appear to influence whether or not the stands were stable, expanding, or retreating in size.

The degree of conifer competition did influence the aspen stand condition rating. Stands rated as stable were predominantly experiencing no to light conifer competition. Stands rated successional to conifers and decadent were more likely than stable stands to be experiencing moderate and severe conifer competition. Similarly, aspen stands that were considered to be expanding or stable in area occupied were experiencing no to light conifer competition, whereas those classed as retreating experienced light to severe competition.

The small size of many aspen stands on the Okanogan and Wenatchee National Forests puts them at high risk of being lost, especially from conifer competition. Aspen stems cannot tolerate much shade (Perala 1990). Stands estimated to cover less than one acre were more likely to be retreating in size than larger stands. The small aspen stands, typically surrounded by conifers, are not obvious to the casual observer. When one or two aspen stems die in a small stand, typically from suppression, the effect is not especially visible. The small size of the stands means the root system is also quite limited and may not have enough energy to produce sprouts. There is high probability that many small aspen stands just slowly disappear and nobody notices.

It seems likely aspen occupied a considerably larger area on the Okanogan and Wenatchee National Forests in the past than now. Many of the aspen stands with few stems are probably remnants of larger stands that have been engulfed by conifers.

Damage:

Twenty-four percent of the aspen stems in the transects were dead. Chelan and Leavenworth had the largest average percent mortality (Figure 10). Many causes of aspen death were listed, but the largest category for stems on transects was “unknown” (Table 3). Fire was the second most common cause of tree death. Fire killed all stems in one stand on Leavenworth and three stands on Chelan. Fire killed all but one stem in another Chelan stand. Suppression was judged to be the cause of death of one percent of the transect stems. Fungal-caused diseases were responsible for killing less than one percent of the stems examined.

Overall, 7.4 percent of the aspen stems in the 1/500 acre plots were dead (Table 4). Sprout mortality varied greatly between stands. Browsing was a factor in the death of 78 percent of the dead sprouts

and seedlings. Browsing was a factor in the death of sprouts in 36 stands. The cause of death was unknown for 15 percent of sprouts and seedlings (Table 5).

Many types of damage were found in surveyed aspen stands.

Droppings and tracks of elk, cattle, and deer were seen in many surveyed stands (Table 6). Evidence of large animals varied greatly by District. Elk were almost totally limited to stands in Naches and Cle Elum. Twenty five out of 30 stands surveyed on those Districts had signs of elk. The only other stand with elk presence was on the southern portion of Leavenworth. All aspen stands on both Methow Valley and Tonasket had evidence of cattle. Five stands on Naches had signs of cows. No stands with cattle activity were seen on Chelan, Cle Elum, Entiat, and Leavenworth. Stands with deer signs were seen on all Districts. Detailed searches were not made for evidence of deer in the stands so their presence is probably considerably underestimated. Combinations of large animal presence were noted in some stands. Both elk and cow signs were observed in four stands on Naches. Cattle and deer evidence was seen in seven stands. We did not record the combined presence of elk, deer, and cattle in any stands.

Ungulates damage aspen stands by browsing sprouts and seedlings, rubbing stems, feeding on live bark, and trampling roots. Browsing of sprouts was found in 84 percent of the stands that had sprouts (Figure 11). All aspen stands with sprouts had been browsed on Naches, Methow Valley, and Tonasket and all but one stand on Cle Elum. About 60 percent of the stands with aspen sprouts on Chelan, Entiat, and Leavenworth experienced browsing. Fifty-eight percent of all sprouts examined had been browsed. The extent of browsing varied greatly between stands. Leavenworth, Chelan, and Entiat had the lowest amounts of sprouts browsed respectively at 19 percent, 24 percent, and 42 percent. Ninety-one percent of the sprouts examined on the Methow Valley District had been browsed. Seventy-seven percent of sprouts at Naches and 68 percent of sprouts at Cle Elum had been browsed (Table 7).

Old sprouts and seedlings experienced more browsing than new sprouts. Eighty-two percent of the old sprouts had been browsed, but only 32 percent of the new sprouts were browsed. Nearly all old sprouts examined at Naches, Methow Valley, and Cle Elum had been browsed. Many old sprouts appeared to have been browsed multiple years.

All evidence of types of animals responsible for browsing is circumstantial because we never saw animals eating aspen and we could not determine what type of animal was responsible for browsing by examining the damaged stems. There are numerous published studies documenting browsing of aspen by ungulates. Elk and cattle appeared to be responsible for more browsing than deer. Evidence of elk was found in 12 of 15 stands on Naches, 13 of 15 stands on Cle Elum, and one stand on Leavenworth. Evidence of cattle was seen at all 15 stands surveyed on both Methow Valley and Tonasket Districts and five stands on Naches. No signs of elk or cattle were seen on Chelan and Entiat and 15 of 16 stands at Leavenworth did not have evidence of elk or cattle.

We assumed that most of the browsing seen in aspen stands on the Naches and Cle Elum Districts was caused by elk. Elk signs were abundant in the stands. Most elk on the Okanogan and Wenatchee National Forest are on those Districts. Elk are probably the factor most responsible for the very small number of aspen stems in the seedling size category on those Districts. DeByle 1985, in a review of wildlife effects on aspen stated in regard to browsing by elk “Aspen is avidly sought from among the browse species. It is consumed in excess of its proportion in the vegetation and is often a major part of the elk diet.” He also wrote “where elk and aspen occur together, the elk appear to select the aspen type over several other available habitats”. It has been demonstrated that mule deer tend to avoid areas used by elk (Johnson, Kern, Wisdom, Findholt, and Kie 2000).

We did not collect data on severity of browsing of individual aspen sprouts. Our impression is sprouts browsed by elk were typically browsed almost to the ground while sprouts browsed by cows, and especially deer, were lightly nibbled. DeByle 1985 stated “In comparison to larger ungulates (elk),

deer carefully select leaves and succulent portions of forbs, browse, and some grasses. Coarse material is left".

Cattle appeared to have less impact on aspen stands on the Forests than elk. Evidence of cattle was seen in all stands surveyed on Methow Valley and Tonasket Districts. Aspen stems in the seedling size class were abundant in most of the stands on those two Districts so sprout browsing by cattle and deer was not severe enough to prevent the sprouts from growing into the larger stem sizes.

Aspen stems classed as "seedlings" were noticeably missing in stands surveyed on the Naches District. No seedlings were found on the sixty 1/500 acre plots and only two percent of the stems on the transects were classed as seedlings. The highest average sprout density per acre was on the Naches District. Very few sprouts at Naches grow into seedling-size stems because they are being severely browsed. The same condition exists in many aspen stands on the Cle Elum District. Many aspen stands at Naches and Cle Elum are not being perpetuated because sprouts are consumed and are not growing into larger size stems. Five aspen stands surveyed at Cle Elum were in talus areas which greatly limited access by large animals. Two of the talus aspen stands had sprouts and one of those had no browsing and the other had just one browsed sprout. The other more accessible stands at Cle Elum with sprouts experienced high percentages of browsed sprouts. Severe browsing by elk and other ungulates can eventually cause aspen root systems to lose the ability to sprout.

Many living aspens on the transects had stem wounds (Table 8). Overall, 36 percent of the living stems had wounds. The living bark of aspen is easily injured and many wounds become infected by fungi and infested by wood borers. The percentage of stems with wounds increased as stem size class increased from seedlings to mature. Naches and Cle Elum both had 68 percent of the living stems wounded, much higher wound rates than were recorded on the other Districts. Only 12 percent of the stems examined at Entiat were wounded.

Elk appeared to be responsible for high levels of stem wounding at Naches and Cle Elum. Elk will feed on the living bark on aspen stems. The feeding is concentrated between 2 and 5 feet above the ground. Few elk-scarred trees appear to be killed directly by the feeding. Elk also injured several stems by rubbing their antlers against the trees. Rubbing of stems by elk and deer was found in 32 stands. The incidence of stem wounding was lower in talus aspen stands at Cle Elum than the other surveyed stands on the District.

Elk on Naches and Cle Elum appeared to be intensively utilizing aspen stands. However, their presence also seemed to be a major factor in the declining condition of aspen stands. If aspen stands on the Naches and Cle Elum Districts are to be perpetuated they need to be regenerated by cutting or burning. Sprouts and seedlings need to be protected from elk browsing until they grow into sapling-size stems.

Several species of wildlife, in addition to elk and deer, use the aspen stands on the Okanogan and Wenatchee National Forests. We saw mature-size aspen stems that had been climbed by black bears leaving distinctive claw patterns in the bark. DeByle 1985 provided references to black bears feeding on aspen buds, leaves, and catkins and climbing aspen to rob bird nests. We saw rabbits and hares in a few aspen stands. They browse sprouts. We saw a very small number of aspen stems that had been chewed and felled by beavers. Many species of birds use aspen stands. Ruffed grouse intensively utilize aspen stands for forage, reproduction, and nesting.

Cavities excavated by birds in living aspen stems were found in 22 percent of the surveyed stands. Woodpecker cavities were found on all Districts except Chelan. Cavities were found in 37 mature-size trees and 3 pole-size trees. Nine of the 15 stands surveyed at Naches had aspens with cavities. Twenty-one aspens with cavities were found at Naches; three times more than any of the other Districts. Fourteen percent of the mature stems at Naches had cavities; twice the rate found on other Districts.

We did not find enough cavities to determine if woodpeckers were preferentially excavating cavities in trees with *Phellinus tremulae* conks. Kilham 1971, Winternitz and Cahn 1983, and Keisker 1987, Hart and Hart 2000, reported sapsuckers and some other woodpecker species preferentially selected trees with conks for cavity excavation. Heartrot in mature-size living aspen is beneficial to woodpeckers. It is easier for the birds to excavate cavities in the heart-rotted wood and the outer rind of sound wood provides structural support and protection to the birds.

Carving of aspen stems by people was relatively common. Examples of trees with carving (dendroglyphs) were found in 13 stands. Stands in locations accessible to large numbers of people had the highest incidence of carving. The most artistic carvings were found on the Cle Elum District.

Conks of decay fungi were found on 122 living trees, 6.3 percent. *P. tremulae* conks were found on 120 living aspen stems. *P. tremulae* causes aspen trunk rot, also called white trunk rot. The incidence of *P. tremulae* conks increased with tree size. *P. tremullae* conks were found on 23 percent of the mature size trees, 5 percent of pole-size trees, and 0.3 percent of saplings. *Daldinia vernicosa* and *Ganoderma applanatum* were each found on just one living aspen.

Trees with *P. tremulae* conks were found on all districts except Chelan. Chelan had the smallest number of mature-size trees, the size most likely to have conks. The incidence of living trees with *P. tremulae* conks was much higher on the Naches District than other Districts. Twenty-one percent of the trees on Naches had *P. tremulae* conks and 38 percent of the mature trees on that District had conks.

Conks were found on 29 dead aspens. *P. tremulae* was the most frequently recorded decay fungus, being found on 21 dead trees. *D. vernicosa* was found on four trees killed by fires on the Chelan District. *G. applanatum* was found on three dead trees and *Pleurotus ostreatus* was seen on one dead tree.

Many mature aspen stems on the Okanogan and Wenatchee National Forests are infected by the decay fungus, *P. tremulae*. Other surveys of incidence of decay in aspen stands in North America have consistently found *P. tremulae* to be the most common stem decay fungus. Aspen trunk rot is especially significant to cavity excavating birds because the living heart-rotted stems provide high quality nesting opportunities. Because aspen is not harvested on the Okanogan and Wenatchee National Forests, stem decays have little to no impact on timber production.

Four types of fungal-caused cankers were found on aspen stems. Listed in decreasing order of occurance, the following canker diseases were observed: Cytospora canker caused by *Valsa sordida*, sooty-bark canker caused by *Encoelia pruinosa*, Ceratocystis canker caused by *Ceratocysistis fimbriata*, and Cryptosphaereia canker caused by *Cryptosphaeria lignyota*. Cankers were found on 161 trees, 6 percent of living stems examined in the transects. Nine trees had two types of cankers. Cankers were most commonly found on pole-size trees. Ages of stems were not determined in the survey but typically the incidence of cankers increases with stem age. Cytospora cankers were typically found on low vigor stems with many wounds and on suppressed trees. *V. sordida*, cause of Cytospora canker, does not appear to be an aggressive pathogen in aspen stands on the Okanogan and Wenatchee National Forests. Sooty-bark and Ceratocystis cankers were most common in stands on Methow Valley and Tonasket. Sooty-bark cankers were more likely to be found in stands considered to be successional to conifers and decadent than in stable stands. Cytospora, sooty-bark, and Ceratocysistis cankers were found more commonly in upland aspen stands than in riparian stands. *E. pruinosa* and *C. fimbriata*, causes of sooty-bark and Ceratocystis cankers respectively, are aggressive pathogens of aspens, especially those with stem wounds.

The incidence of stem cankers appeared to be greater where aspen was most abundant. Fungal inoculum, especially spores, is undoubtedly more abundant in areas with large numbers of host plants.

Wood borer holes were found on 32 stems in 21 stands. Most wood borer holes were seen in wood exposed by wounds, however, some wood borer attacks were made on unwounded portions of stems.

Several types of damage caused by insects and diseases were seen on aspen foliage and shoots. None of the 105 stands surveyed had foliage damage that was characterized as severe or in outbreak. Typically, infestations by insects, such as leaf miners, leaf rollers, and defoliators, involved a relatively small proportion of the aspen foliage in the stands. No stands were seen with defoliation of all stems. Only trace amounts of defoliation by insects were observed. In 1999 many aspen stands on the Tonasket District were severely defoliated by satin moth resulting in the death of hundreds of stems. In the past, aspen stands have experienced outbreaks of foliage diseases, especially following prolonged damp periods. Only minor amounts of aspen foliage disease were observed in 2003. Aspen shoot and leaf blight, caused by *Venturia macularis*, was the most frequently found foliage disease. It was found in 19 stands, primarily on sprouts and seedlings. Few stems were affected.

Aspen stands are considered to be low in flammability because of low fuel accumulations (Perala 1990). However, aspen stems are easily killed by wildfires. Several surveyed aspen stands surrounded and encroached upon by conifers had all aspen stems killed by wildfires. All such stands had abundant sprouts and seedlings, attesting to ability of the root systems to survive and produce sprouts. One aspen stand surveyed on Methow Valley had been lightly prescribed burned in the spring of 2002. Only 3 of the 25 aspen stems examined in the stand were killed by the fire, but several had fire scars; the overstory was still intact. Sprouting following the light prescribe burn was quite limited because not enough overstory aspen stems had been killed to reverse the auxin to cytokinin ratio. Light prescribed burns are not likely to stimulate prolific sprouting. There are many examples of vigorous, thrifty aspen stands in the 1994 Tyee Burn that sprouted after all the overstory aspen and conifers were killed.

Historically, wildfires probably maintained more and larger aspen stands than are present now on the Okanogan and Wenatchee National Forests. Wildfires killed the overstory trees and allowed the aspen root systems to sprout, renew, and enlarge the stands. Effective fire suppression has prevented many fires from spreading through aspen stands killing most, or all stems including competing conifers. Fire suppression has probably contributed to the large number of aspen stands being slowly, but steadily, replaced by conifers.

Many aspen stands surveyed on the Okanogan and Wenatchee National Forests are successional to conifers and shrinking in size. Major factors contributing to this condition are browsing by wild and domestic ungulates and exclusion of fires. Grazing of grasses and forbs by cattle also contributes to some aspen stands gradually being replaced by conifers, especially on the Methow valley and Tonasket Districts. Forage production, especially grasses, is significantly greater in aspen stands than in conifer stands. Cattle commonly graze on grasses and forbs in aspen stands allowing conifers to become established. Grazing reduces the fine fuels thereby reducing the risk of fires spreading into the stands killing aspen stems and small conifers. Diseases and insects, although relatively common in aspen stands, do not appear to be major factors in the decline of aspen.

We saw several examples of cultural treatments to perpetuate aspen stands in the process of doing the survey. Some stands had been treated by removing conifers, others had been clearcut. Both practices had resulted in production of aspen sprouts. One stand had been prescribed burned but few sprouts resulted. In contrast, the stands recently overrun by wildfires typically produced hundreds of sprouts and seedlings.

Aspen probably makes up less than one percent of the trees on the Okanogan and Wenatchee National Forests. However, aspen stands are especially valuable to wildlife and for their aesthetic contributions. If aspen stands, especially those successional to conifers, on the Okanogan and Wenatchee National Forests are to be perpetuated management actions need to be undertaken. Competing conifers need to be removed from aspen stands to be protected. Some aspen stands need to be regenerated by cutting all the stems or killing the stems with fire. Sprouts need to be protected from severe browsing, especially on the Naches and Cle Elum Districts.

Conclusions

Most aspen stands on the Okanogan and Wenatchee National Forests in north central Washington are small in size, with more than 50 percent covering less than two acres.

Slightly more than half the aspen stands surveyed were rated in stable condition, which means they are presently vigorous and self-perpetuating.

Almost half the aspen stands were rated successional to conifers and decadent. Practically all aspen stands rated successional and decadent are retreating in area occupied by living aspen stems.

Several aspen clones on the Forests have a high potential of dying out and being lost if no actions are undertaken to protect them.

Most aspen stands on the Forests have the ability to produce sprouts.

Aspen stands killed by wildfires produce abundant sprouts one year after the overstory has been killed by fires. Sprouts in the wildfire areas develop into seedlings and saplings.

Many species of wildlife utilize aspen stands.

Ungulates extensively browse aspen stands on the Forests.

Elk appear to be responsible for severe browsing and high levels of stem wounding in aspen stands on the Naches and Cle Elum Districts.

Aspen stands on the Naches and Cle Elum Districts are unlikely to be able to perpetuate themselves unless sprouts and seedlings are protected from severe browsing by elk.

Browsing by cattle and deer, although common, is not severe enough to prevent many aspen sprouts from developing into larger stem sizes.

Competition from conifers is the major factor contributing to the deterioration of aspen stands on the Leavenworth, Entiat, Chelan, Methow valley, and Tonasket Districts. Elk browsing and competition from conifers are the major factors contributing to decline of aspen stands on the Naches and Cle Elum Districts.

References

Bartos, D.L.; Campbell, R.B. 1998. Decline of quaking aspen in the Interior West – Examples from Utah. Rangelands 20(1): 17-24.

DeByle, N.V. 1985. Wildlife. *In* Aspen ecology and management in the Western United States. p135-152. Eds. DeByle, N.V.; Winokur, R.P. USDA-Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. General Technical Report RM-119.

Hadfield, J.S. 2003. Little Pend Oreille National Wildlife Refuge aspen condition assessment survey. U.S. D.A. Forest Service, Forestry Sciences Lab, Wenatchee, WA. 11 p.

Johnson, B.K.; Wisdom, M.J.; Findholt, S.L.; Kie, J.G. 2000. Resource selection and spatial separation of mule deer and elk during spring. Journal of Wildlife Management 64: 685-697.

Kay, C.E. 1997. Is aspen doomed? Journal of Forestry. 95(5): 4-11.

Keisker, D.G. 1987. Nest tree selection by primary cavity-nesting birds in south-central British Columbia. Wildlife Report No. R-13. Ministry of Environment and Parks, British Columbia, Canada. 67p.

Kilham, L. 1971. Reproductive behavior of yellow-bellied sapsuckers. I. Preference for nesting in Fomes-infected aspens and nest role interrelations with flying squirrels, raccoons, and other animals. Wilson Bulletin 83: 159-171.

Perala, D.A. 1990. Populus tremuloides Michx. Quaking aspen. *In* Silvics of North America. Volume 2 Hardwoods p. 555-569. Burns,R.m.; Honkala, B.H. Technical Coordinators. U.S. Department of Agriculture Forest Service, Agriculture Handbook 654, Washington, DC.

Romme, W.H.; Turner, M.G.; Gardner, R.H.; Hargrove, W.W.; Tuskan, G.A.; Despain, D.G.; Renkin, R.A. 1997. A rare episode of sexual reproduction in aspen (*Populus tremuloides* Michx.) following the 1988 Yellowstone fires. Natural Areas Journal 17: 17-25.

Winternitz, B.L.; Cahn, H. 1983. Nest holes in live and dead aspen. Snag habitat management: Proceedings of a symposium. U.S. Forest Service General Technical Report RM-99: 102-106.

Appendices

Figure 1. Stable aspen stand on the Tonasket District.

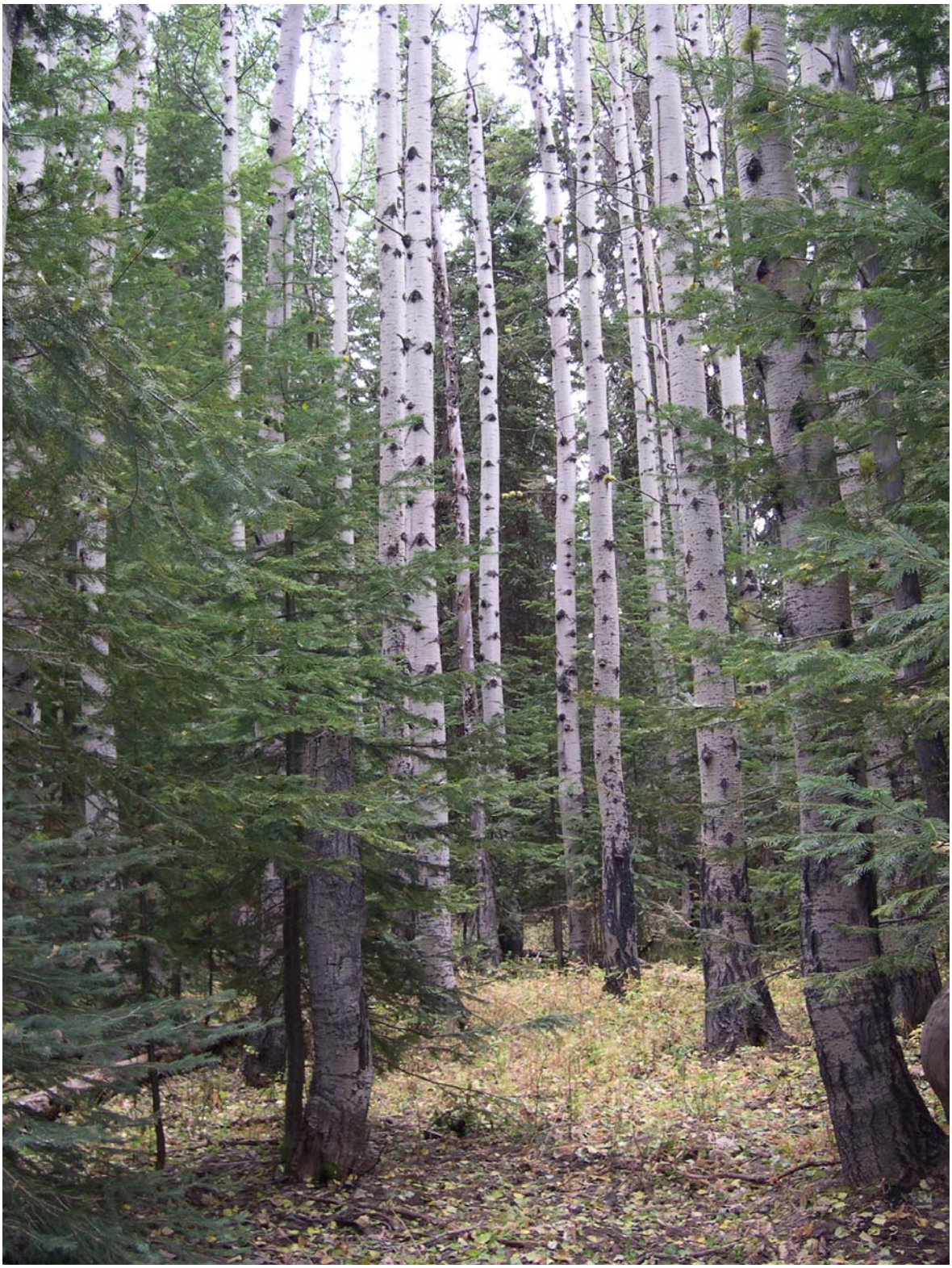

Figure 2. Aspen stand rated successional to conifers on the Cle Elum District.

Figure 3. Decadent aspen stand on the Naches District.

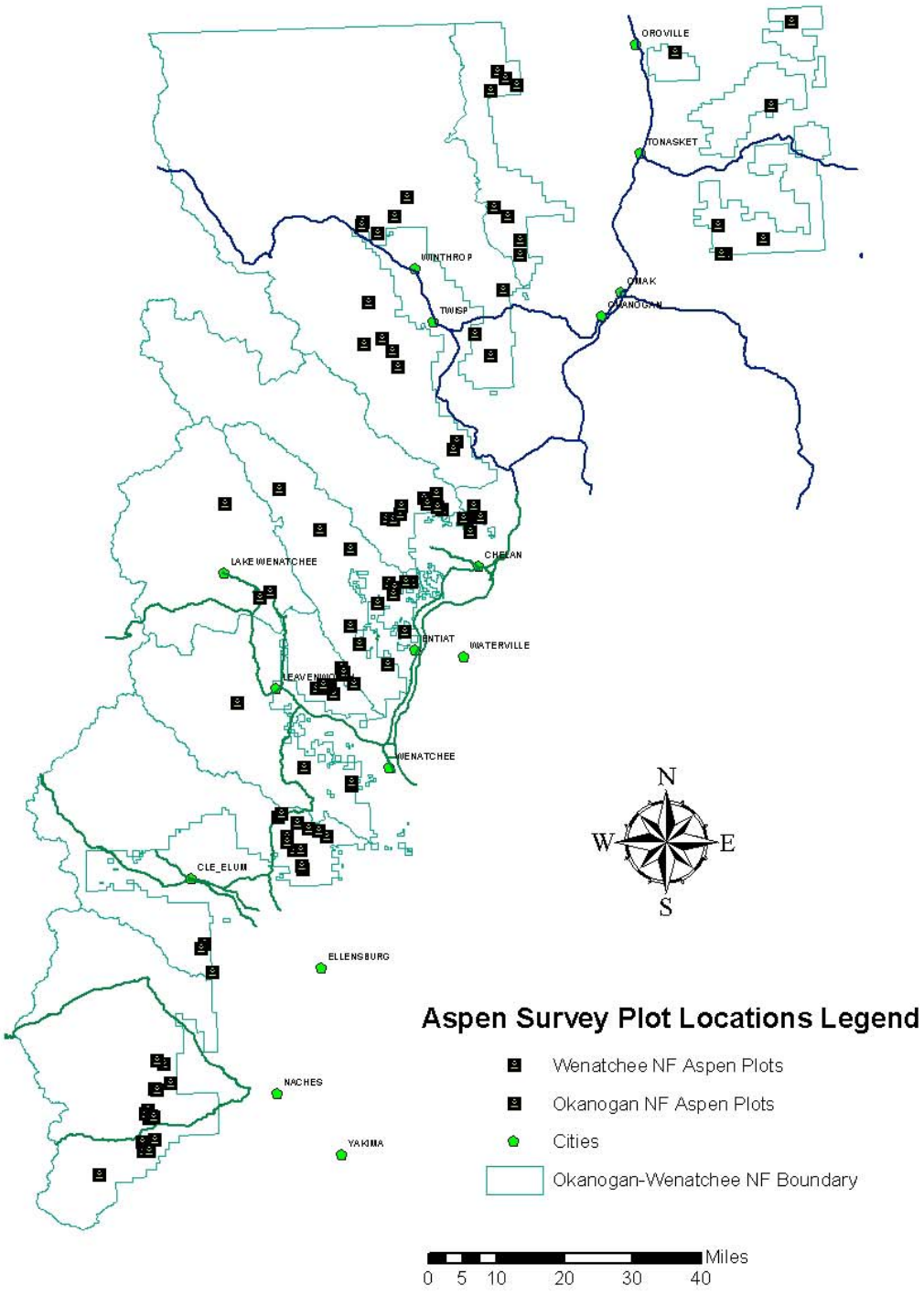
OROVILLE
TONASKET
WINTHROP
OMAK
OKANOGAN
TWISP
LAKE WENATCHEE
CHELAN
ENTIAT
WATERVILLE
LEAVENWORTH
WENATCHEE
CLE ELUM
ELLENSBURG
NACHES
YAKIMA
N
W
E
S
Aspen Survey Plot Locations Legend
Wenatchee NF Aspen Plots
Okanogan NF Aspen Plots
Cities
Okanogan-Wenatchee NF Boundary
Miles
0 5 10 20 30 40

Figure 4.

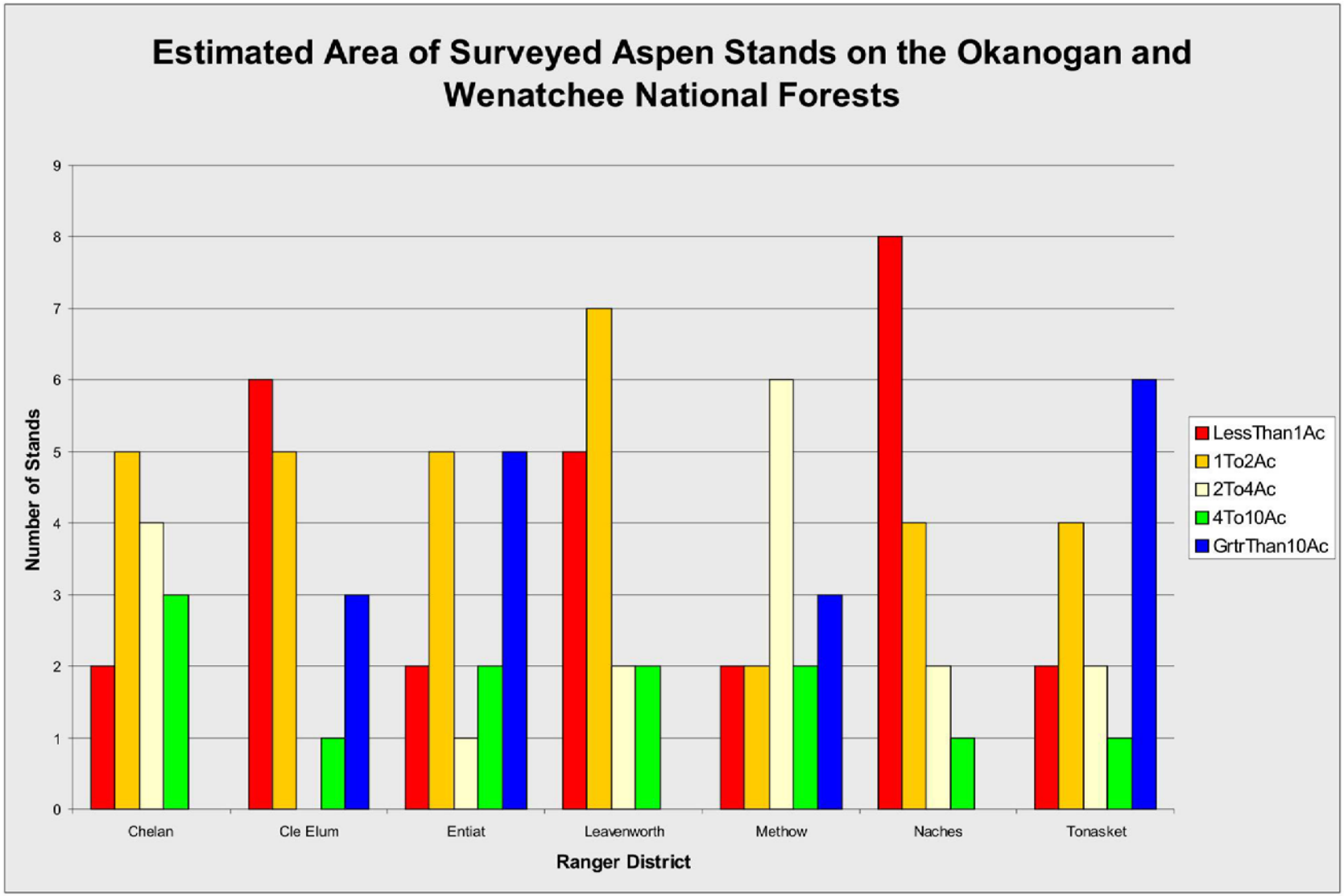
Estimated Area of Surveyed Aspen Stands on the Okanogan and Wenatchee National Forests
Number of Stands
0
1
2
3
4
5
6
7
8
9
Chelan
Cle Elum
Entiat
Leavenworth
Methow
Naches
Tonasket
Ranger District
LessThan1Ac
1To2Ac
2To4Ac
4To10Ac
GrtrThan10Ac

Figure 5.

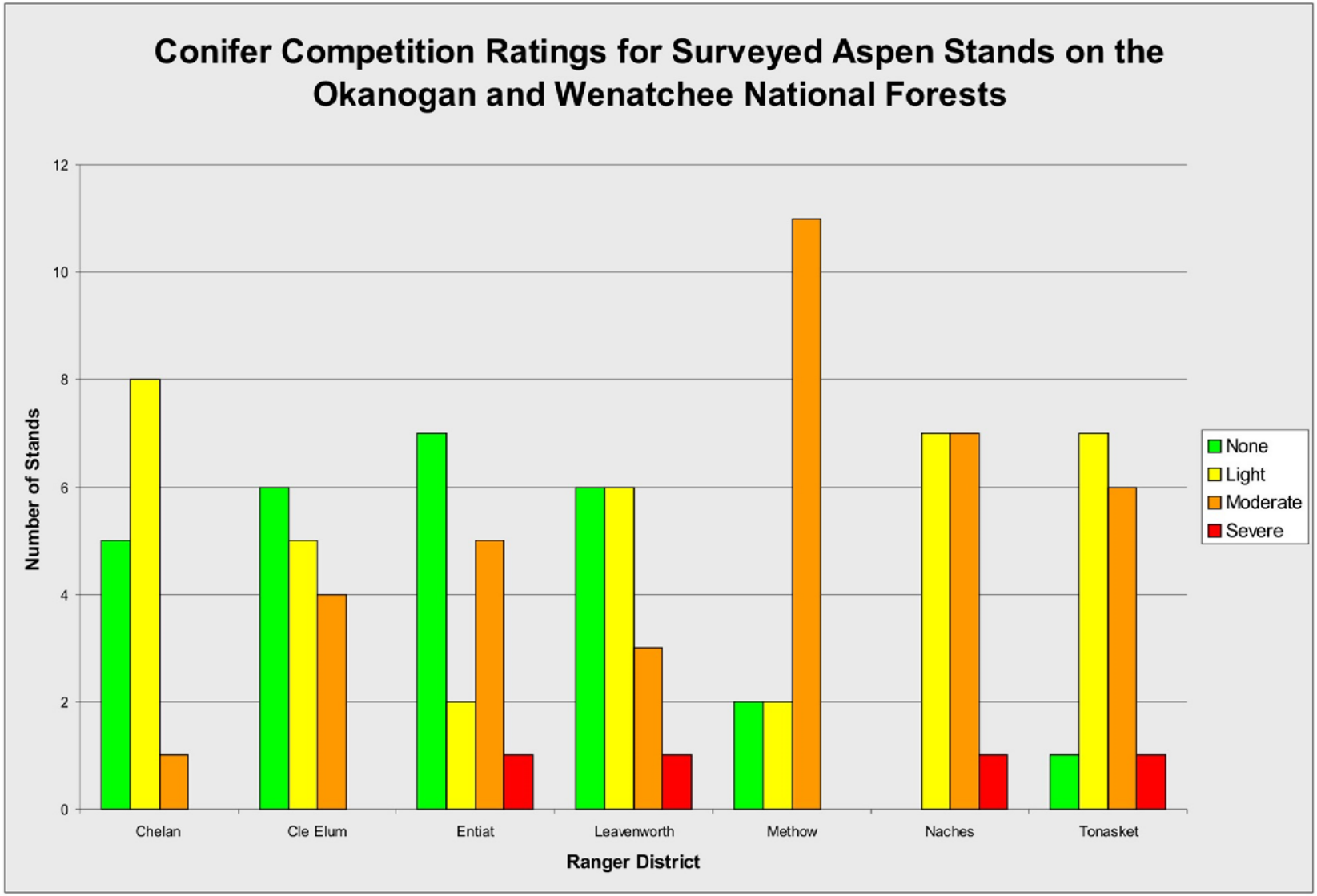
Conifer Competition Ratings for Surveyed Aspen Stands on the Okanogan and Wenatchee National Forests
Number of Stands
0
2
4
6
8
10
12
Chelan
Cle Elum
Entiat
Leavenworth
Methow
Naches
Tonasket
Ranger District
None
Light
Moderate
Severe

Figure 6.

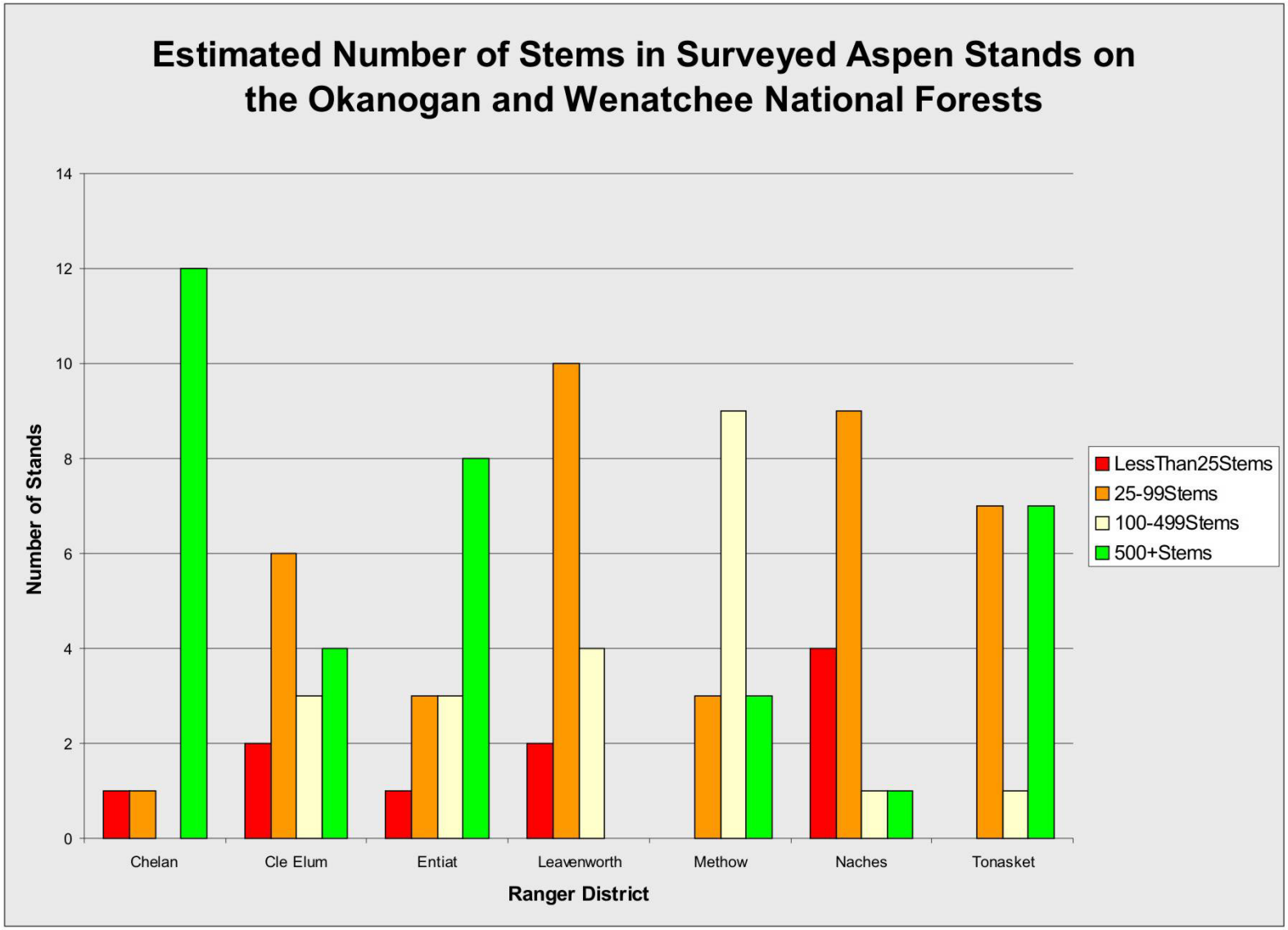
Estimated Number of Stems in Surveyed Aspen Stands on the Okanogan and Wenatchee National Forests
Number of Stands
0
2
4
6
8
10
12
14
Chelan
Cle Elum
Entiat
Leavenworth
Methow
Naches
Tonasket
Ranger District
LessThan25Stems
25-99Stems
100-499Stems
500+Stems

Figure 7.

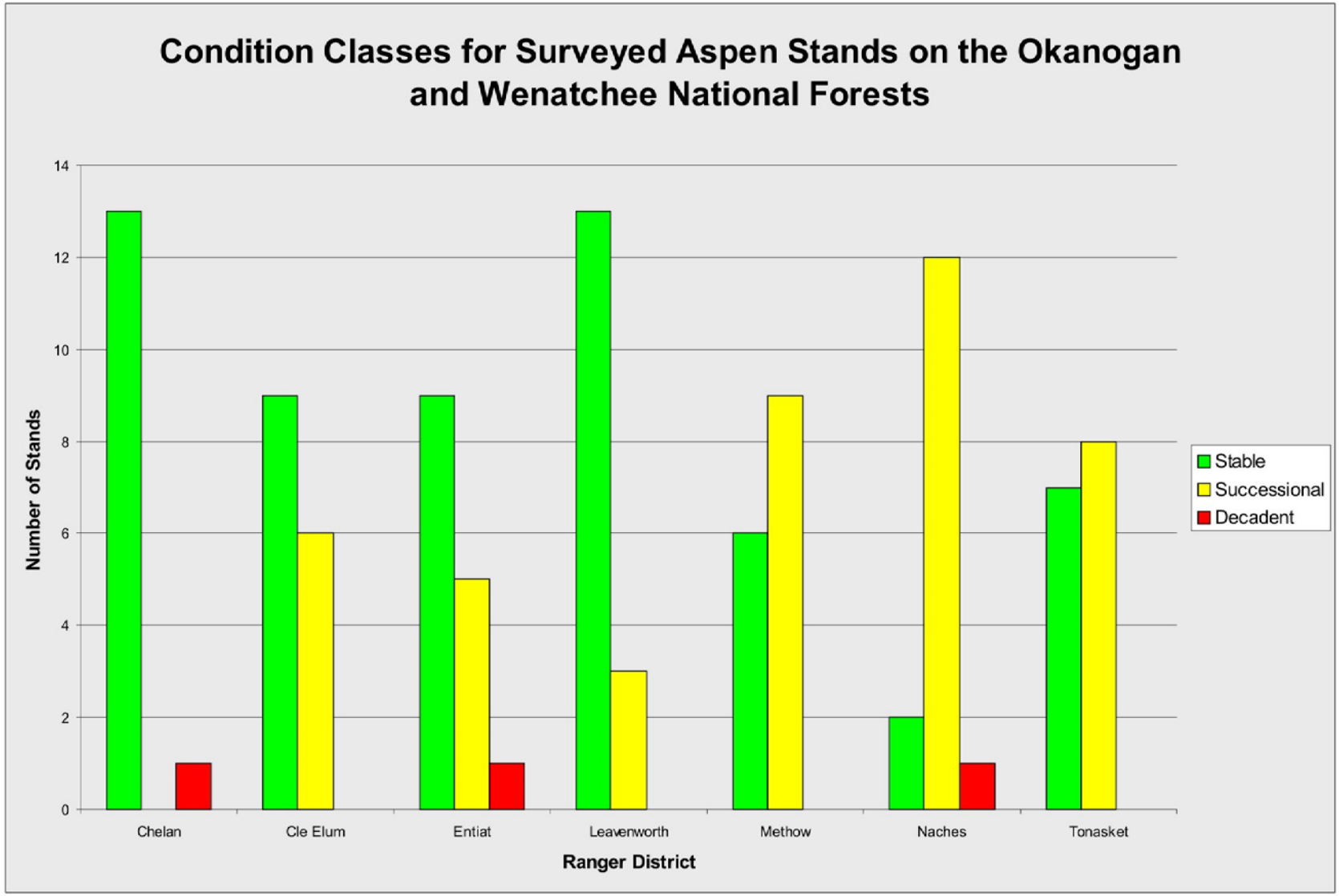
Condition Classes for Surveyed Aspen Stands on the Okanogan and Wenatchee National Forests
Number of Stands
0
2
4
6
8
10
12
14
Chelan
Cle Elum
Entiat
Leavenworth
Methow
Naches
Tonasket
Ranger District
Stable
Successional
Decadent

Figure 8.

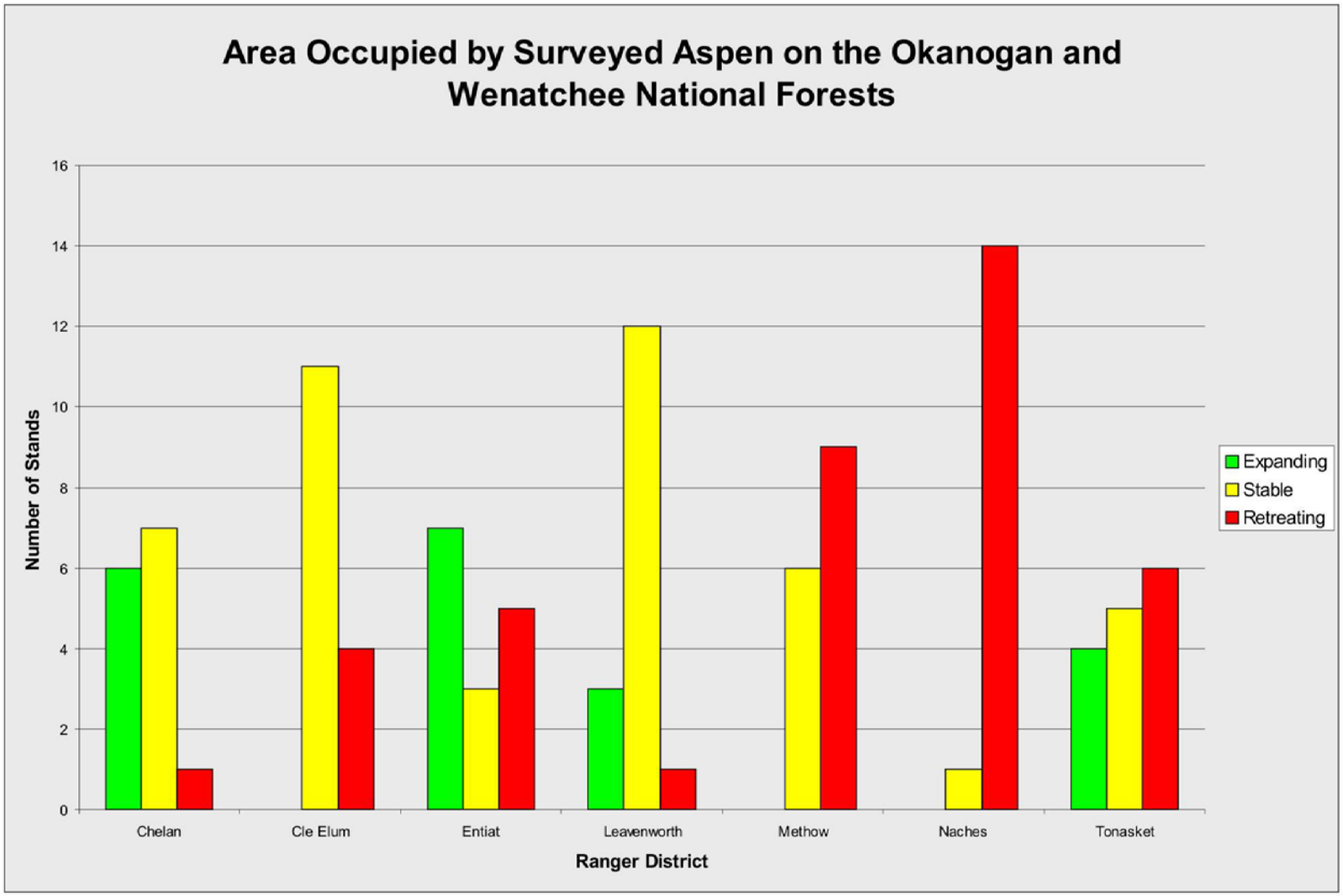
Area Occupied by Surveyed Aspen on the Okanogan and Wenatchee National Forests
Number of Stands
16
14
12
10
8
6
4
2
0
Chelan
Cle Elum
Entiat
Leavenworth
Methow
Naches
Tonasket
Ranger District
Expanding
Stable
Retreating

Figure 9.

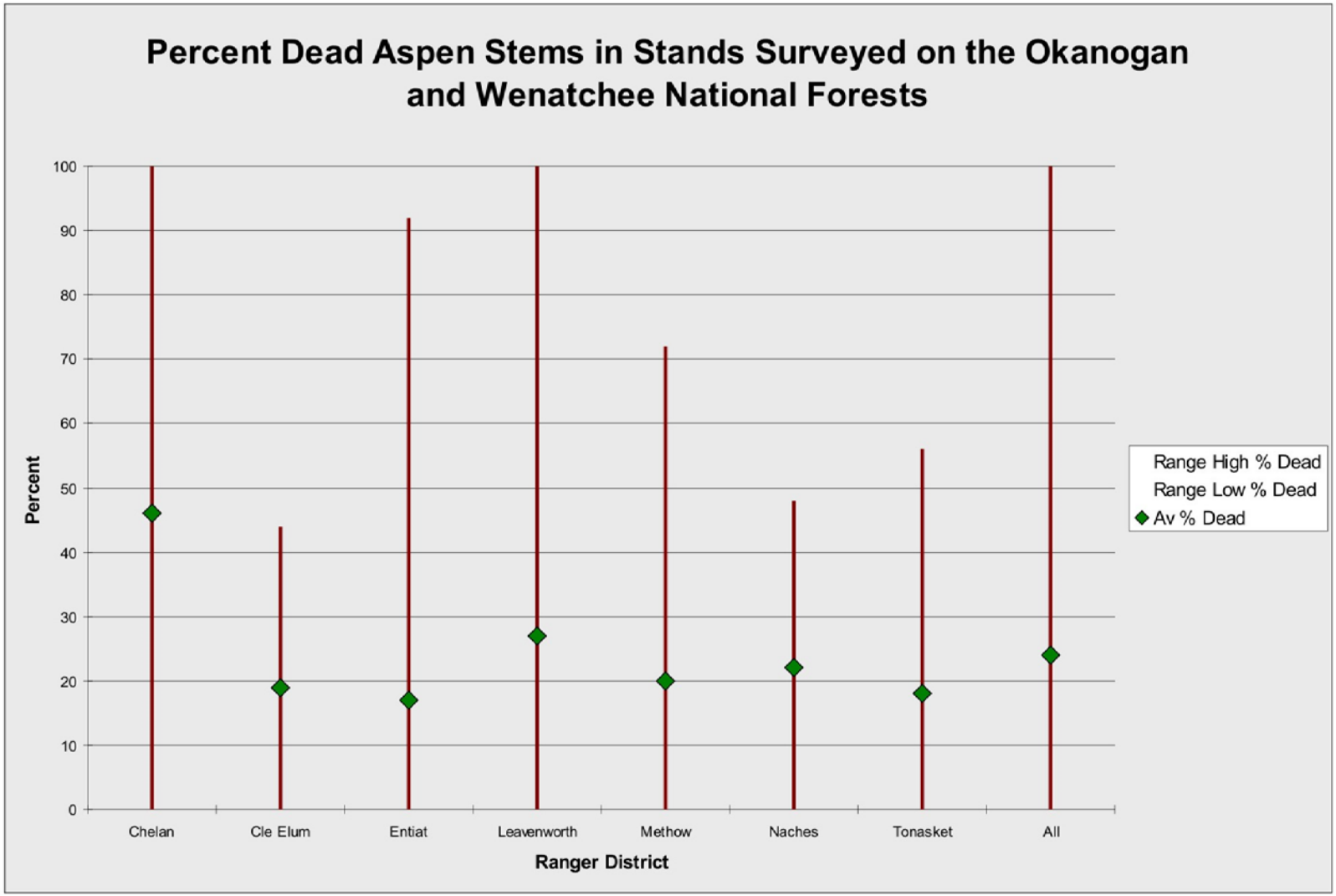
Percent Dead Aspen Stems in Stands Surveyed on the Okanogan and Wenatchee National Forests
100
90
80
70
60
50
40
30
20
10
0
Percent
Chelan
Cle Elum
Entiat
Leavenworth
Methow
Naches
Tonasket
All
Ranger District
Range High % Dead
Range Low % Dead
Av % Dead

Figure 10.

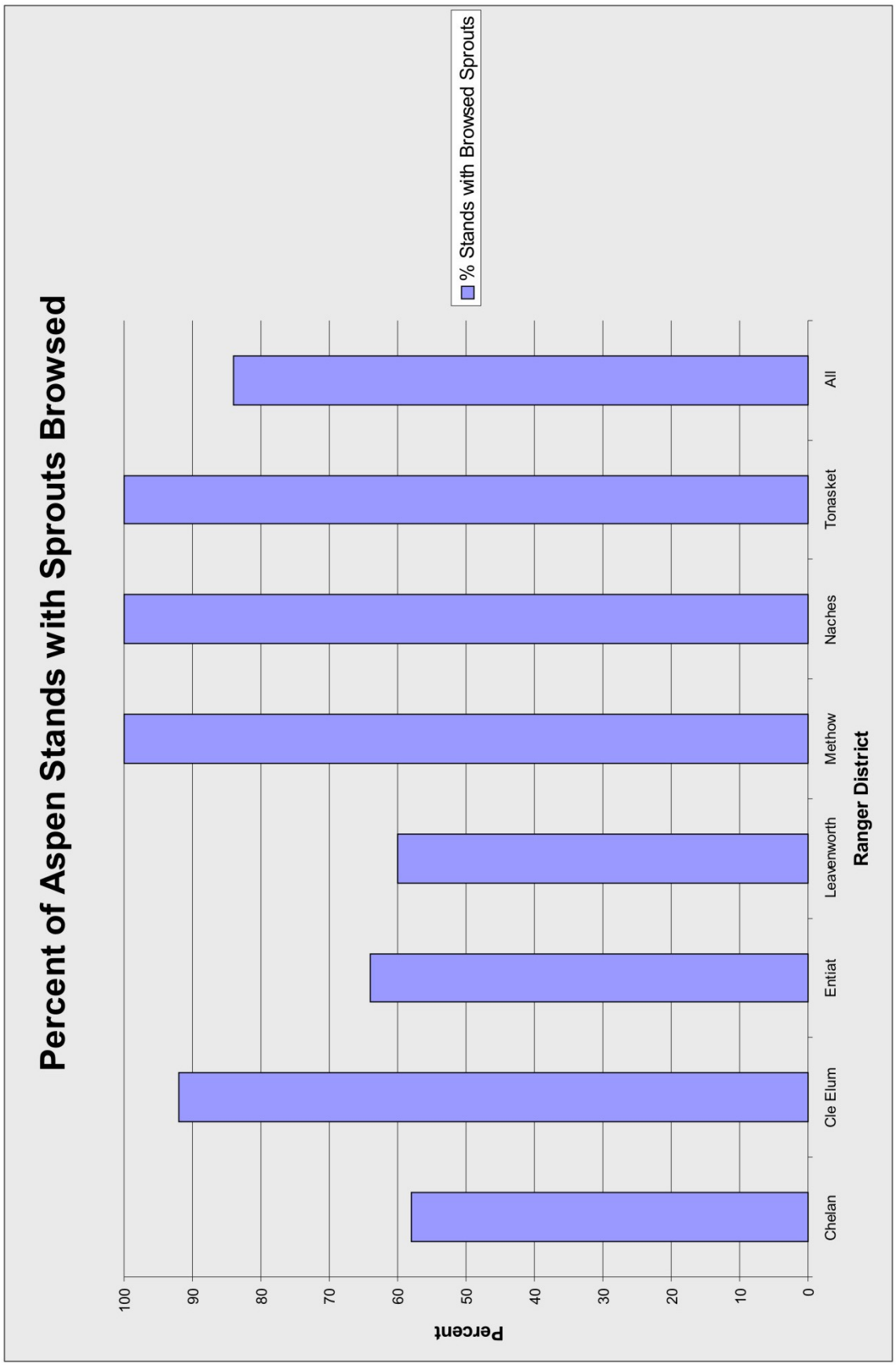
Percent of Aspen Stands with Sprouts Browsed
% Stands with Browsed Sprouts
Percent
100
90
80
70
60
50
40
30
20
10
0
Chelan
Cle Elum
Entiat
Leavenworth
Methow
Naches
Tonasket
All
Ranger District

Figure 11.

Table 1. Mean percent aspen stems in different size classes sizes in surveyed stands on the Okanogan and Wenatchee National Forests.

Districts	No. Stands	Stem Sizes			
		Seedlings %	Saplings %	Poles %	Matures %
Chelan	14	16	57	25	2
Cle Elum	15	22	34	27	17
Entiat	15	17	56	18	9
Leavenworth	16	6	46	33	15
Methow Valley	15	11	45	33	11
Naches	15	2	26	14	57
Tonasket	15	18	33	23	19
All	105	13	42	25	19

Table 2. Mean number of aspen sprouts and seedlings per acre in surveyed stands on the Okanogan and Wenatchee National Forests.

Districts	No. Stands	Mean Number per Acre		
		Sprouts	Old Sprouts	Seedlings
Chelan	14	1679	536	250
Cle Elum	15	1050	1100	158
Entiat	15	858	717	400
Leavenworth	16	672	938	23
Methow Valley	15	600	933	533
Naches	15	1317	2258	0
Tonasket	15	1033	900	917
All	105	1020	1058	206

Table 3. Causes of aspen mortality recorded on transects surveyed on the Okanogan and Wenatchee National Forests.

Causes of Mortality	Number Dead Stems
Unknown	389
Fire	133
Suppression	35
Cytospora canker	13
Mechanical damage	13
Windthrow	12
Drought	8
Sooty-bark canker	4
Sapsucker	1
Root trampling	1
Cryptoshaeria canker	1
Total	610

Table 4. Average percent aspen sprout, old sprouts, and seedling mortality in surveyed stands on the Okanogan and Wenatchee National Forests.

Districts	No. Stands	Percent Dead		
		Sprouts	Old Sprouts	Seedlings
Chelan	14	0	0	4
Cle Elum	15	7	14	21
Entiat	15	11	21	4
Leavenworth	16	3	4	0
Methow Valley	15	10	4	5
Naches	15	4	5	0
Tonasket	15	6	15	18
All	105	7	8	7

Table 5. Causes of mortality of aspen sprouts and seedlings on circular plots surveyed on the Okanogan and Wenatchee National Forests.

Causes of Mortality	No. dead stems
Browsing	111
Unknown	22
Drought	12
Shoot blight	6
Trampling	3
Animal rub	1
Snow break	1
Sooty-bark canker	4

Table 6. Number of surveyed aspen stands with large animal evidence on the Okanogan and Wenatchee National Forests.

Districts	No. Stands	Ungulates				
		Elk	Cattle	Deer	Elk & Cattle	Cattle & Deer
Chelan	14	0	0	3	0	0
Cle Elum	15	13	0	1	0	0
Entiat	15	0	0	5	0	0
Leavenworth	16	1	0	2	0	0
Methow Valley	15	0	15	2	0	2
Naches	15	12	5	1	4	0
Tonasket	15	0	15	5	0	5
All	105	26	35	19	4	7

Table 7. Average percent of aspen sprouts browsed in surveyed stands on the Okanogan and Wenatchee National Forests.

Districts	No. Stands	No. sprouts examined	% sprouts browsed
Chelan	14	276	24
Cle Elum	15	277	68
Entiat	15	237	42
Leavenworth	16	209	19
Methow Valley	15	248	91
Naches	15	429	77
Tonasket	15	243	66
All	105	1919	58

Table 8. Percent of living aspen stems by size class with wounds in surveyed stands on the Okanogan and Wenatchee National Forests.

Districts	No. Stands	Stem Sizes				
		Seedlings	Saplings	Poles	Mature	All
Chelan	14	5	26	27	14	22
Cle Elum	15	27	90	80	74	68
Entiat	15	5	11	24	12	12
Leavenworth	16	5	29	23	22	24
Methow Valley	15	0	30	25	44	26
Naches	15	50	78	65	63	68
Tonasket	15	5	25	27	47	29
All	105	11	36	39	50	36

Table 9. Aspen Stand Summaries

District	Stand	Condition Class	Area Occupied	Riparian / Upland	Conifer Competition	Active Sprouting	Est. No. Stems	Elk, cattle, deer
Chelan	01C	Stable	Stable	Riparian	Light	No	500	
	02C	Stable	Stable	Upland	Light	Yes	500	d
	03C	Stable	Stable	Upland	Light	Yes	500	d
	05C	Stable	Expanding	Upland	Light	Yes	500	
	06C	Stable	Stable	Upland	Light	Yes	750	d
	07C	Stable	Expanding	Upland	None	Yes	1,000	
	08C	Stable	Expanding	Riparian	None	Yes	1,000	
	09C	Stable	Expanding	Riparian	None	Yes	1,000	
	10CS	Stable	Expanding	Upland	None	Yes	500	
	11C	Stable	Expanding	Upland	None	Yes	1,000	
	12C	Stable	Stable	Upland	Light	No	800	
	13C	Decadent	Retreating	Upland	Moderate	No	30	
	14CS	Stable	Stable	Upland	Light	No	500	
	15C	Stable	Stable	Upland	Light	Yes	20	
Cle Elum	03CE	Successional	Stable	Riparian	Light	No	200	e
	04CE	Successional	Stable	Riparian	Moderate	No	100	e
	05CE	Successional	Retreating	Upland	Moderate	Yes	1,000	e
	06CE	Stable	Stable	Upland	None	Yes	100	e
	07CE	Stable	Stable	Upland	Light	Yes	1,000	
	08CE	Stable	Stable	Upland	None	Yes	16	e
	09CE	Successional	Retreating	Riparian	Moderate	Yes	23	e
	10CE	Stable	Stable	Riparian	Light	No	40	e
	11CE	Stable	Stable	Upland	None	Yes	50	e
	12CE	Stable	Stable	Upland	None	No	50	
	13CE	Stable	Stable	Riparian	Light	No	50	e
	15CES	Stable	Stable	Upland	None	No	30	e
	16CE	Stable	Stable	Upland	None	No	30	e, d
	24CE	Successional	Retreating	Riparian	Moderate	No	1,000	e
	25CE	Successional	Retreating	Upland	Light	No	500	e
Entiat	01E	Successional	Retreating	Riparian	Moderate	Yes	30	d
	05E	Successional	Retreating	Upland	Moderate	No	16	
	08E	Stable	Expanding	Riparian	None	No	1,000	
	10E	Stable	Expanding	Riparian	None	No	1,000	
	11E	Stable	Expanding	Riparian	None	No	500	
	12E	Stable	Expanding	Riparian	None	No	1,000	
	14E	Stable	Expanding	Riparian	Light	Yes	1,000	
	17E	Stable	Expanding	Riparian	None	No	500	
	20E	Successional	Retreating	Riparian	Moderate	No	30	d
	25E	Decadent	Retreating	Upland	Moderate	No	50	
	26E	Successional	Retreating	Upland	Severe	Yes	100	d
	28E	Stable	Stable	Upland	Light	Yes	250	d
	29E	Stable	Stable	Riparian	None	No	1,000	
	30E	Successional	Stable	Upland	Moderate	No	100	d
	32E	Stable	Expanding	Riparian	None	Yes	1,000	
Leavenworth	01L	Successional	Stable	Riparian	Moderate	Yes	30	d
	05L	Stable	Stable	Riparian	Moderate	Yes	300	d
	07L	Successional	Retreating	Upland	Severe	No	40	
	10L	Successional	Stable	Riparian	Moderate	Yes	2	
	13L	Stable	Stable	Upland	Light	No	75	
	14L	Stable	Stable	Upland	Light	No	25	
	15L	Stable	Stable	Upland	None	Yes	30	
	16L	Stable	Stable	Riparian	None	No	24	
	17L	Stable	Stable	Riparian	Light	No	40	
	18L	Stable	Stable	Upland	Light	Yes	40	
	19L	Stable	Stable	Upland	None	No	50	
	20L	Stable	Stable	Upland	None	Yes	75	
	24L	Stable	Expanding	Upland	Light	Yes	300	
	30L	Stable	Stable	Upland	Light	No	200	e
	34L	Stable	Expanding	Upland	None	Yes	200	
	36L	Stable	Expanding	Upland	None	Yes	40	

District	Stand	Condition Class	Area Occupied	Riparian / Upland	Conifer Competition	Active Sprouting	Est. No. Stems	Elk, cattle, deer
Methow	02M	Stable	Stable	Riparian	None	No	250	c
	04M	Successional	Retreating	Riparian	Light	No	100	c
	06M	Stable	Stable	Riparian	Moderate	Yes	250	c
	19MS	Successional	Retreating	Riparian	Moderate	No	200	c
	20M	Stable	Stable	Upland	Moderate	Yes	1,000	c
	22M	Successional	Retreating	Upland	Moderate	No	500	c
	25M	Successional	Retreating	Upland	Moderate	No	100	c
	28M	Successional	Retreating	Riparian	Moderate	No	400	c
	45M	Stable	Stable	Riparian	None	No	30	c
	53M	Successional	Retreating	Riparian	Moderate	Yes	500	c
	65MS	Successional	Retreating	Upland	Moderate	No	40	c
	67M	Stable	Stable	Riparian	Light	No	200	c, d
	69M	Stable	Stable	Riparian	Moderate	No	250	c
	74M	Successional	Retreating	Upland	Moderate	No	50	c, d
	76M	Successional	Retreating	Riparian	Moderate	Yes	200	c
Naches	02N	Successional	Retreating	Upland	Moderate	No	40	
	05N	Successional	Retreating	Riparian	Light	Yes	22	e, c
	06N	Stable	Retreating	Riparian	Light	No	12	c
	08N	Stable	Stable	Riparian	Light	No	1,000	e
	09N	Successional	Retreating	Riparian	Moderate	Yes	35	e
	13N	Decadent	Retreating	Upland	Light	Yes	40	e, c
	14N	Successional	Retreating	Riparian	Light	No	24	e
	16NR	Successional	Retreating	Riparian	Moderate	Yes	100	e, c
	17N	Successional	Retreating	Riparian	Light	Yes	40	e, c
	19N	Successional	Retreating	Riparian	Moderate	Yes	30	e
	22N	Successional	Retreating	Upland	Moderate	No	50	e, d
	23N	Successional	Retreating	Riparian	Moderate	Yes	50	e
	24N	Successional	Retreating	Riparian	Severe	No	25	e
	29N	Successional	Retreating	Upland	Moderate	No	5	
	31N	Successional	Retreating	Riparian	Light	Yes	75	e
Tonasket	01T	Stable	Expanding	Upland	Light	Yes	1,000	c
	02T	Successional	Stable	Upland	Moderate	Yes	30	c
	03T	Stable	Expanding	Upland	Light	Yes	1,000	c, d
	08T	Stable	Stable	Upland	Light	Yes	1,000	c, d
	12T	Successional	Stable	Upland	Moderate	Yes	1,000	c
	13T	Successional	Retreating	Upland	Moderate	No	500	c
	20T	Successional	Retreating	Upland	Moderate	No	30	c
	22T	Successional	Retreating	Upland	Moderate	No	30	c, d
	28T	Successional	Retreating	Riparian	Severe	No	100	c
	29T	Stable	Stable	Upland	Light	No	30	c
	36T	Stable	Stable	Upland	Light	No	35	c, d
	44T	Successional	Retreating	Upland	Moderate	No	40	c
	46T	Successional	Retreating	Upland	Light	No	40	c, d
	49T	Stable	Expanding	Upland	Light	Yes	500	c
	50T	Stable	Expanding	Upland	None	Yes	1,500	c