Survivor Aspen: Can We Predict Who Will Be Voted Off The Island?

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Abstract

During the past few years, aspen have been dying at rates that appear to exceed normal rates. We believe that this mortality should not be unexpected, given the severe drought of the past 10 years. We examine the literature and FIA data and identify several factors that indicate such mortality should be expected.

Aspen, *Populus tremuloides*, is a tremendously successful species. It produces abundant seeds (sexual reproduction) and suckers from its roots (asexual reproduction). In the western US, establishment by seed is thought to be rare, thus suckering is usually considered the most important means of reproduction. Maximum sucker production, however, requires disturbance. Fire and harvesting are the most common disturbance types, but wildfire control and a limited market for aspen products in the west has limited the amount of disturbance in aspen stands in the last 100 years.

This 100-year time frame is important, because aspen is a relatively short- lived species. Baker (1925) stated that "even on the best sites rotations of more than 80 years will be infrequent", and, "On poorer sites decay is the limiting factor, and trees should seldom be grown for longer than 70 years." Krebill (1972) noted for Utah that "senility" occurs with aspen at about 120 years of age. and Meinecke (1929) states that "wild aspen forest as a whole does not reach much beyond 130 years." Schier (1975) suggests that aspen matures in 80-100 years and declines rapidly with decreasing age. DeByle (1989) reports that trees older than 100 years are common, but stands begin to break up between 120 and 140 years. Jones (1967), however, states that aspen lives much longer and grows more slowly in the southern Rocky Mountains than in the east. He notes working in two stands older than 200 years. This apparent contradiction maybe due in part to the author's concept of, as succinctly stated by Meineke (1929) "the wild aspen forest as a whole". Mueggler (1989) concludes that aspen stands mature between 60 and 80 years, and deteriorate "rather rapidly" after about 120 years. With the exception of Jones' observation, these estimates of the demise of aspen stands coincide with the time since effective fire control.

Mueggler (1989) found that 94% of randomly selected aspen stands were mature or overmature. We used the USDA Forest Service Forest Inventory and Analysis (FIA) data to examine the age of aspen stands in Arizona, Colorado and Utah. Most of the aspen in these areas is older than Baker's (1925) suggested maximum rotation age of 80 years (Figure 1), and many are older than 110 years, well beyond the rotation ages recommended by Baker (1925).

Mortality is a constant factor in aspen stands, especially in their early years. It is stand mortality in later years that is of interest to this discussion. Trees begin dying at a relatively early age, and mortality continues (Figure 2). The mortality rate in the Site Index 57 stand was about 7% for a ten-year period. Mueggler (1994) reported that as stands aged, the number of trees decreased by at least 90% over 60 years (Figure 3). Mortality was greatest among the smaller diameter stems. Average mortality on the best site in Mueggler's (1989) study was 14% for a ten-year period. We are analyzing FIA data to characterize long term and recent aspen mortality rates. Shields and Bockheim (1981) characterized factors affecting longevity of aspen stands in the midwestern United States (Table 1. Their longevity index was calculated as the difference between predicted basal area and observed basal area; that is, stands with greater basal area would be expected to live longer. In general, they found environmental variables much more useful than soil variables. Of the environmental variables examined, mean annual temperature was the best predictor of aspen longevity. The variables correlated

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In: McWilliams, M. G., comp. 2008. Proceedings of the 55th Western International Forest Disease Work Conference; 2007 October 15-19; Sedona, AZ. Salem, OR: Oregon Department of Forestry.

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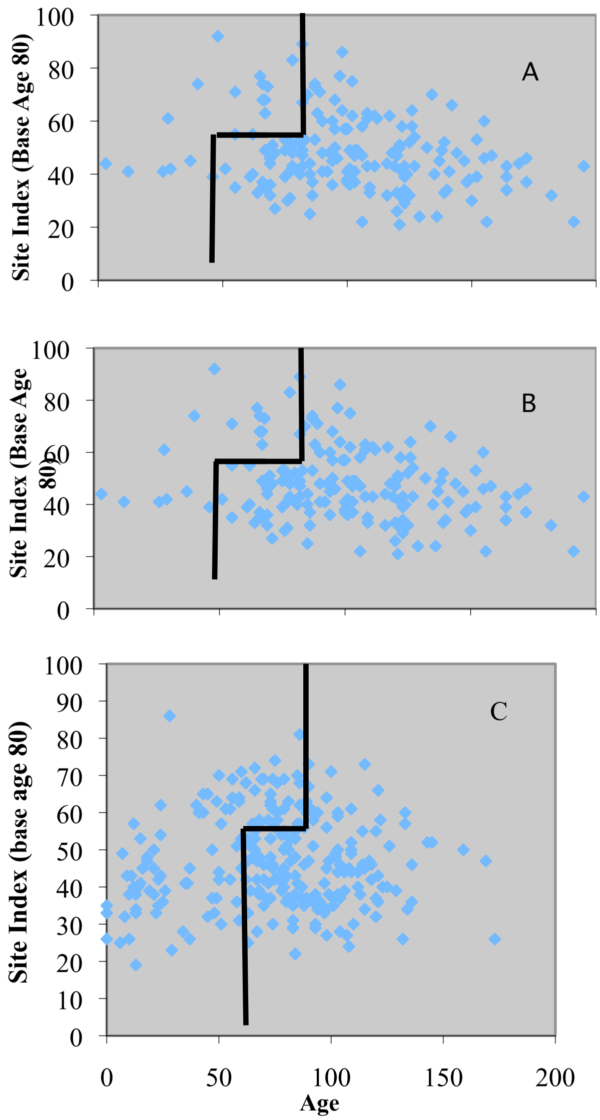
with stand longevity suggest that aspen prefer cool, moist environments. If we consider weather in the Intermountain West during the past ten years, it has been much warmer and drier than normal, factors which should increase aspen mortality rates.



Figures 1—Age of aspen by site index in Arizona (A), Colorado (B), and Utah (C). Data taken from USDA Forest Service Forest Inventory and Analysis. Data are from aspen plot conditions. Some stands from Arizona and Colorado were omitted for consistency among graphs. Lines represent the rotation ages recommended by Baker (1925) for different site categories. Points below and to the right of the lines are overmature for their site quality.

Daniel (1980) attributes better aspen growth in the southwestern Rocky Mountains to a longer growing season and more reliable summer rain. Thus, there is at least some indication that these variables may be important in the western US.

At some point in time, perhaps driven by increased temperatures, decreased precipitation, or other factors, trees surrounding gaps caused by aspen mortality are no longer able to fill the gap. Stands in this stage are considered to be "deteriorating" (Fralish 1972; Shields and Bockheim 1981; Mueggler 1989),"breaking up" (Baker 1925; Fralish 1972), "senile" (Krebill 1972), rapidly seral (Harniss and Harper 1982), defective (Meineke 1929), declining (Pothier et al. 2004) or "decadent" (Weigle and Frothingham 1911; Baker 1925; Mueggler 1989). Unfortunately, all of these terms are subjective and difficult to quantify; i.e., we know it when we see it. Pothier et al. (2004) indicate that age alone is not a sufficient predictor of stand condition. They proposed using the ratio of dead to live basal area to identify the point at which a stand has a periodic annual increment equal to 0, and using this time as the onset of stand decline. This measure is good only for short term assessments. Perhaps it would be more useful to discuss stands as being overmature, which really is the cause of their decline. If we add their age and site index to the discussion, we can often gain an understanding of what is happening in a stand.

Variable	Correlation coefficient
ln mean annual temp C	-0.85
Latitude	0.78
ln mean August temp C	-0.77
ln mean September temp C	-0.77
ln mean July temp C	-0.65
Frost-free period (days)	-0.65
Ln mean June temp C	-0.62
Annual precipitation – potential evapotranspiration	0.36

Table 1—Variables correlated with aspen longevity index. From Shields and Bockheim, 1981.

The age at which aspen breakup occurs and the rate of mortality once the process begins have been attributed to many causes. Moisture stress may be the most important determinant of aspen longevity (Shields and Bockheim 1981). Given the recent drought in the Intermountain West, it seems logical to expect increasing mortality, especially in a population of stands older than optimal. Several authors note that

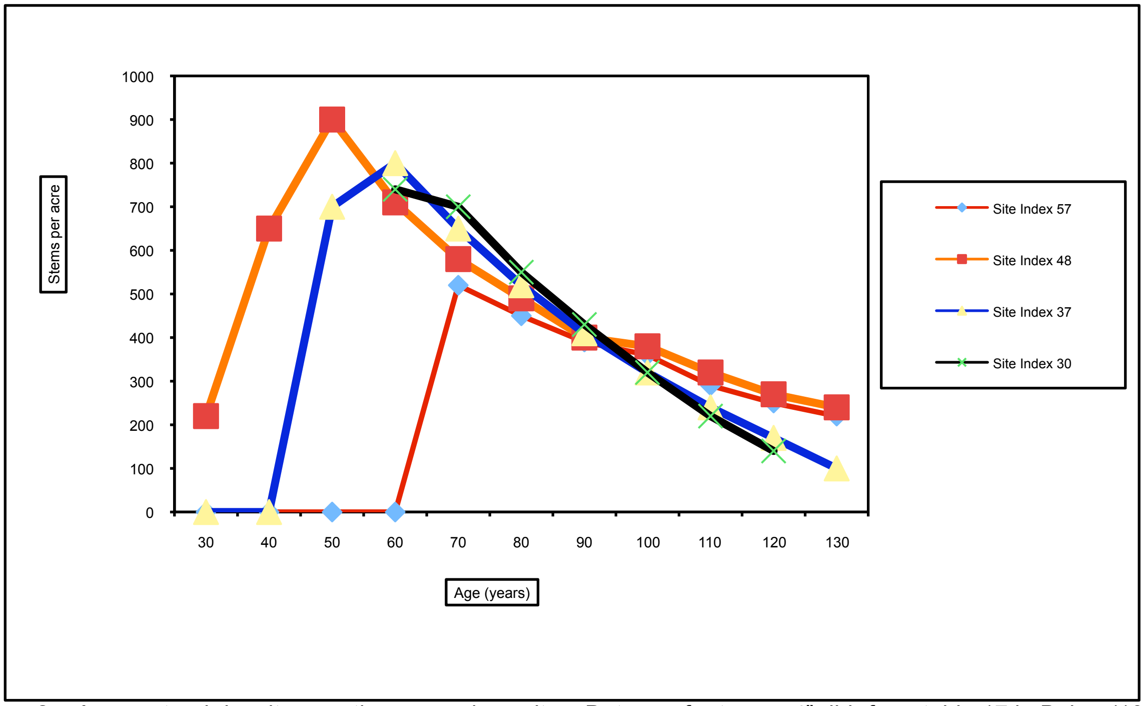


Figure 2—Aspen stand density over time on various sites. Data are fro trees >4" dbh from table 17 in Baker (1925). Site class converted to site index after Jones (1967).

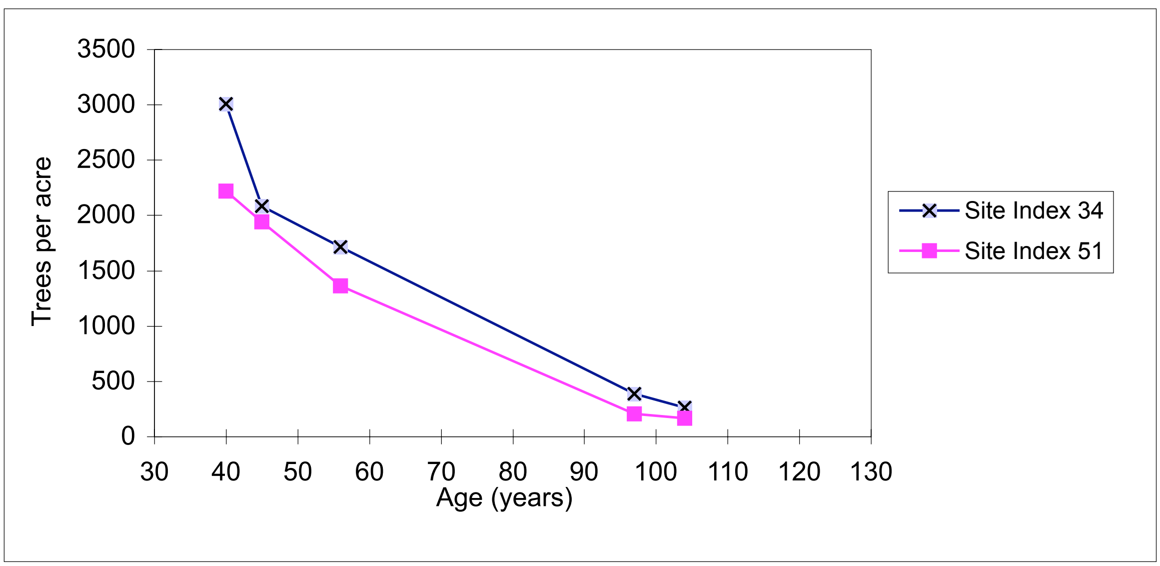


Figure 3—Decline in aspen density with age. From Mueggler, 1989.

once mortality starts, in an aspen stand, it proceeds quickly. Graham et al. 1963 noted that deterioration following the opening of aspen crown canopies can sometimes render. . "within a 5- or 10-year period a valuable stand . . to a worthless condition." Shields and Bockheim (1981) illustrate "a well -stocked stand" that was " reduced to a few diseased trees in as short a time as 6 years." Presumably, increased exposure to sunlight and associated sunscald results from opening the canopy, and increases the susceptibility of remaining trees to harmful insects and diseases (Krebill 1972.) Decay caused by *Phellinus tremulae* (= *Fomes igniarius*) is a common feature of old aspen stands, and can also contribute to rapid stand deterioration (Weigle and Frothingham1911.) Aspens with trunks weakened by decay often snap when exposed to wind. In addition to these primary causes of mortality, several additional factors may have increased aspen mortality.

Defoliation by *Marsonnina* is quite common some years in the Intermountain West. Spring frosts have occurred in some areas as well; at least two spring frosts have damaged aspen in northern Utah in the past ten years. The effects of these events can be manifest for many years. For example, after forest tent caterpillar defoliation, Perala (1978) stated, "8-18 years following defoliation, [basal area mortality] was still elevated, peaking at 13 years." He goes on to state "This 13-year delay in peak mortality also seems reasonable, because defoliation exerts a stress on the tree that is not immediately fatal, but that subtly tips the balance of survival, perhaps much like the stress induced by hot, dry, Julys." Thus, we should expect to see aspen mortality continue for some years after precipitation returns to normal.

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