Forest Health Protection

Pacific Southwest Region

Date: August 15th, 2007
File Code: 3420

The following is a report on a Field Visit I made on July 5th, 2007. Mark Smith of the Sierra National Forest invited me to visit with a private landowner who was concerned that the Blue Oaks on his property (on the outskirts of Clovis CA) were declining.

Observations of the Problem.

In the company of the local Cal Fire specialist (Bill Solinsky, Forest Practice, Cal Fire), Mark Smith (Silviculturist, Sierra NF) and I met up with the owner at his property. Upon approaching the Blue Oaks (***Quercus douglasii*** Hook & Arn) I was struck by their thin crowns (figure 1) and once within the crown drip line I noticed the ground to be littered with shed leaves (figure 2). Both the land owner and Mark Smith assured me that a few weeks prior to my visit Blue Oaks in the Clovis area had the appearance of fall coloration and yet it was still summer! The owner wanted to know if something untoward was happening to his oaks.

Figure 1. Typical examples of the blue oaks we visited

Figure 2. Inside the drip line of the tree in figure 1 showing the layer of shed leaves.

SOUTHERN SIERRA SHARED SERVICE AREA
19777 Greenley
Sonora Ca 95370

Beverly Bulaon
Entomologist
bbulaon@fs.fed.us

Martin MacKenzie
Plant Pathologist
mmackenzie@fs.fed.us

While standing inside the tree crown drip line and looking up and through the tree crowns (figure 3) it was immediately obvious the tree had shed all but the last 3 or 4 leaves on almost every shoot tip. An examination of several terminal buds indicated that they were alive and the tree would flush next spring. While I was supplied with a background on the local drought history we examined several other trees and found them to be exhibiting the same combination of symptoms.

I made examinations of both fallen and living leaves and found no evidence of leaf chewing or mining. Several boles were carefully examined for any evidence of bark or ambrosial beetles and again I found no evidence of insect activity. Despite a careful search I saw no evidence of any *Tarry Spots* or bleeding cankers. Although the property was being grazed by cattle, there was no evidence of cattle caused root damage or of soil compaction within the drip line. Obviously the owner has his live stock density at a level that is causing minimal impact upon the trees. Cattle dung might in fact be fertilizing the trees.

Mark Smith made the comment that he thought that the California Buckeye had turned about a month early this year. At this time I had not seen a California Buckeye (***Aesculus californica*** (Spach) Nutt.), so I decided to research it (figure 4). It was my impression from the conversations with the locals that last winter had been mild and that they thought that the trees would have gone into the 2007 spring with about normal soil moisture levels.

Figure 3. The view looking up and out through the edge of the tree crown, showing that the tree has retained only the last 3 to 4 leaves on each twig. The drought deciduous leaves have been shed.

Figure 4. California Buckeye exhibiting the extreme case of species with drought deciduous leaves.

Field Assessment of the Problem

Finding no evidence of any damaging pathogen or insect I concluded that the discoloration or deciduous event was probably abiotically driven. It was our consensus that the Blue Oaks were at no risk of dying and that the “Fall Coloration” that had recently been observed was probably drought induced.

As the landowner (or at least his wife) had expressed an interest in planting blue oaks around the house they are planning to build on the property I agreed to research blue oak regeneration.

Additional Review of Blue Oak Literature.

The Blue Oak Paradox.

Blue Oak (***Quercus douglasii*** Hook & Arn) is a drought resistant deciduous oak endemic to the Sierra Nevada foothills and costal ranges of California and, depending upon your information source, it covers 2 or 3 million acres. The paradox of this, the most widely distributed of California's hardwoods, is that it is apparently not regenerating. At least, it is not regenerating as well as it did in the first 50 -- 80 years after the gold rush. One of the best documentations of these observations is in Swiecki & Bernhardt (1998) (also at http://phylosphere.com/publications/Blueoakf.htm). However, as the blue oaks can live to be 200 -500 years old not having had a good year of regeneration for 70+ years may not be that significant. Or is it? Given the recent attention given to the writings of van Mantgem and Stephenson (2007) and the general public's interest in Global Warming there should be a focus on Blue Oak. Van Mantgem and Stephenson (2007) have suggested that climate change has increased the mortality of old growth forests in the Sierra Nevada Mountains and at the same time there has been no increase in the rate of recruitment of seedlings. In Blue Oak we have a species that is ideally adapted to take advantage of a changing climate.

The Drought Adaptations of Blue Oak.

Despite the suggestion of a problem with the regeneration, Pavlik *et al* (1991) maintains that the acorns do not require a cold period of stratification. They germinate rapidly, and unlike the acorns of other oaks the blue oak's acorns germinate in the fall. The cool rains of October are adequate to start the process. The root growth is more rapid than that of other arboreal oaks. This mechanism evolved to get root down beneath the competing roots of the grasses. Root growth continues into the cool winter months. Thus root to shoot to root ratio is higher than in other arboreal oaks. This high ratio of root to shoot is maintained in all growth stages the tree, through sapling and into adult tree. Through out its life the canopy of leaves remains proportionally smaller than in other less drought resistant species. Thus the observation shown in figure 3 may well be no more than a reflection of the oak maintaining the high root to shoot ratio. A high root to shoot ratio ensures that the tree is never carrying a crown larger than its roots are able to supply with water. I wonder if the sparse crowns of the Grey pine (Pinus sabiniana Doug.) reflect another species having evolved a similar strategy.

Water conserving mechanisms are not restricted to the roots, for the upper epidermal waxes that give the leaves their characteristic bluish cast (and their common name) is an adaptation to reducing moisture loss. As water stress accumulates upon the oak leaves they do two unusual things, they reinforce their leaf cells both mechanically and osmotically. First the cell walls of the oak leaves are strengthened with deposits of cellulose and lignin to reduce the tendency of cells to wilt under progressive dehydration. Secondly, to keep the photosynthesizing cells from collapsing under water loss the cells adjust their internal salt content to such an extent that despite loosing as much as 30% of their water content the leaves do not wilt. In this respect they exceed the ability of true desert plants such as mesquite and ironwood to withstand water loss.

Another Blue Oak adaptation, and the one most pertinent to this field visit, is having ***drought deciduous leaves***. Both Pavlik et al (1991) and McDonald (1990), report that under extreme water stress the oak sheds its leaves and becomes dormant. Drought deciduous leaves are a common occurrence in desert and chaparral plants but rare amongst the oaks. However blue oak is a notable exception.

> "Water conservation mechanisms have evolved in blue oak that are similar to those observed in chaparral and desert communities." Pavlik et al (1991)

Subsequent to my visit to Clovis I got an opportunity to observe the California Buckeye (figure 4) displaying drought deciduous leaves. The example pictured here is the extreme case of a plant avoiding water stress by simply going dormant in the summer. Presumably this is what a blue oak would have looked like under the "*prohibitive water stress*" described by McDonald (1990).

Conclusions

After doing some research into the ecology of the Blue Oak, I have not changed the conclusions we came to in the field. I believe that the "fall colors" that the locals observed and the "premature leaf fall" that I observed were a reflection of the blue oak's ability to shed leaves under water stress. It is possible that in the past year of adequate water the trees to build up their crowns and when the drought conditions returned they adjusted the number of leaves to match their roots' ability to supply water. We had observed drought deciduous leaves.

When considering the literature on the regeneration of this species; I recognize that there may be a current problem with natural regeneration. However, this is with a species that can live for 200-500 years and most of the current 2 million acres of blue oaks are not much more than 100 years old. There is little chance this species will become threatened in the near future. Failure to see regeneration may simply reflect, seedlings being browsed by deer and cattle, or that they are being shaded out by the maturing trees that dominate the foothills and driest slopes of the Sierras. There is no reason to believe that 70% + of acorns gathered in the fall will not germinate in a greenhouse setting.

References.

McDonald P. M., **(1990).** Quercus douglasii Hook & Arn. Blue Oak in Silvics of North America vol 2. 877 pp USDA Ag HandBk # 654 ed by Burns & Honkala (http;//www.na.fed.us/spfo/pubs/silvics_manual/volume-2/quercus/douglasii.htm)

Pavlik B. M., **P. C. Muick, S. G. Johnson & M. Popper**, (**1991).** Oaks of California. Catchuma Press 184 pp.

Swiecki T. J. and E. Bernhardt, (1998). Understanding Blue Oak Regeneration. Fremontia 26 (1): 19-26. (http://phylosphere.com/publications/Blueoakf.htm

Van Mantgem P. and N. L. Stephenson, (2007). Ecology Letters, 2007 10: 1-8

If you have any questions regarding this report or need additional information please contact Martin MacKenzie at (209) 3671 ext 242

/s/Martin MacKenzie

cc: Mark Smith Silviculturist Sierra National Forest
Bill Solinsky, Cal Fire.