INTRODUCED TREES

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Man has always strived to improve his environment, whether it be for safety, comfort, or enjoyment. From their pioneer days in California, residents of the state have imported many plants from other areas of the world to see if they would grow and be of value. Californians have traditionally relied on introductions from areas of similar Mediterranean climate, and the two non-native tree genera of interest in the East Bay Regional Park District, *Eucalyptus* and *Acacia*, were both imported long ago from eastern Australia. The climatic similarities have been great enough that both genera have survived and become established. They were both so well pre-adapted to our climate, in fact, that they have become troublesome and now man, in another attempt to improve his environment, finds it necessary to take measures to control their spread.

With any introduced plant species, there is a chance that even though it may thrive under average weather conditions, extremes may occur which endanger its survival. Such an extreme was reached in December, 1972, when severe prolonged frosts ravaged the eucalypts and acacias in the East Bay hills, killing much of the above-ground foliage. The vast majority of those trees did survive, though, through adaptations not for severe frosts but fires. The repeated bush fires in Australia over the millenia have gifted both genera with the ability to sprout from the roots after the above-ground portion has been killed, a process known as "suckering." This adaptation has shown to be the greatest barrier to effective control of these species.

ACACIA SPECIES

Botanic Descriptions

The genus *Acacia* belongs to the Pea Family (*Leguminoseae*). Acacias, or wattles as they are known in their native Australia, possess nitrogen-fixing *Rhizobium* bacteria living in nodules in their roots, a feature common in legumes. This adaptation allows them to grow in soils poor in nitrogen. The various species of *Acacia* range in size from small shrubs to large trees. The two varieties found on EBRPD land are tree species.

Acacia decurrens, the Green Wattle, is a short-lived tree with a spreading crown growing to a height of 15 meters in Australia, but is usually less than 10 meters high in northern California. The grey-green or silvery compound leaves are 10 to 15 cm. long and are composed of parallel rows of 1/2 cm. leaflets. The mature trees produce golden-yellow flowers in the spring and seed pods in fall. Young trees are characterized by smooth grey-green bark. There are two varieties, the Silver Wattle (*A. decurrens* var. *dealbata*), and the Black Wattle (*A. decurrens* var. *mollis*). The Silver Wattle is slightly more frost-resistant.[10]

Acacia melanoxylon, the Blackwood or Sally Wattle, is native to southeastern coastal Australia. It is commonly 7 to 20 meters in height and may exceed 1 meter in diameter. It has a spreading crown resembling the Green Wattle, but the mature leaves are lanceolate phyllodes, compound leaves being found only in immature growth. The phyllodes range between 8 and 13 cm. in length and are 2 to 3 cm. in width. The foliage is dark green and leathery, and the bark is dark brown. In Australia the Sally Wattle is found at altitudes of up to 1000 meters, where it frosts up to 70 times each year, but it can not tolerate severe prolonged frost. The species is noted for its wide-spreading root system.[10]

History and Distribution in East Bay Regional Park District

The acacias on EBRPD land are thought to have been introduced by Joaquin Miller at the end of the nineteenth century.[3] He and his contemporaries engaged in extensive tree-planting around their homes in an area now contained within Redwood Regional Park, Roberts Regional Recreational Area, and the City of Oakland's Joaquin Miller Park. The buildings have been removed but many of the plantings still remain.[7]

The most notable planting of acacias was at the location of the present Big Trees Camp in Anthony Chabot Regional Park where several specimens of *A. melanoxylon* were introduced. The acacias at that site were killed by the December, 1972 frosts and were subsequently cut down, but in the preceding years they had dropped enough seeds into the creek below that acacias have now become established along the entire downstream length of the creek.[7, 1] There now exists a 5 km. stretch of scattered acacias between Big Trees Camp and Lake Chabot.

Other maverick trees and small groves of acacias can be found in other areas of the park. Neil Havlik, Resource Analyst for the EBRPD, noted that these trees are largely restricted to areas of serpentine soil, a soil type which is typically low in nitrogen.[7] He suggested that the acacias' symbiotic nitrogen-fixing bacteria give them a competitive advantage in nitrogen-poor soil which perhaps did not exist in normal soil types, a theory supported by Professor Herbert Baker of the UCB Botany Department.[3]

The Nature of the Acacia Problem

Acacias do not appear to be a great problem in the East Bay Regional Park District at the present time. There seems to be little danger of their rapidly expanding their range beyond those areas in which they are already found. Over a long period of time, however, they could spread enough to upset the natural ecology of the area. A park should be a preserve of natural vegetation, if it exists at present. For that reason, acacias should be prevented from extending their range, and perhaps some areas should be cleared of acacias if economically and practically feasable. In the area of the former homesites in Redwood Regional Park, there is little point in removing the acacias because there are also many other exotic species. In fact, those specimens may have some historical value or should be saved as botanic curiosities.

Methods of Controlling Acacias

In Australia, a large part of the state of Queensland is covered with Brigalow (*Acacia harpophylla*). In their efforts to convert Brigalow range to pasture, the Australians have amassed a great deal of research on eradication of *A. harpophylla*. The following control techniques are in reference to Brigalow, but should apply to the Green and Sally Wattles, too.

Ringbarking, also known as girdling, will kill Brigalow if done under the right conditions.[8] This can be accomplished either with a saw cut or overlapping axe cuts which penetrate through the cambrium around the circumference of the trunk. If done in the summer or autumn under moist soil conditions, no suckering will occur. This technique could be combined with herbicide application, if necessary.

Advantages: Ringbarking can be used on an individual tree without harming any surrounding vegetation. It is safe, requires little skill, and only a saw or axe is needed.

Disadvantages: Girdling is slow and laborious, and is, therefore, impractical for clearing large areas. If the trees are large, they would be unattractive when dead and falling limbs might be a hazard to park users.

Opinion: Ringbarking would appear to be both one of the most ecologically sound and yet most effective control techniques. It would be ideally suited to the small areas in Redwood and Chabot Regional Parks if inexpensive labor could be obtained and suitable soil conditions exist.

Pulling can be used with good success for clearing large areas of Brigalow. This can be done by attaching a cable or chain to the trunk and pulling it with a tractor or bulldozer. For large areas, a ship's anchor chain can be dragged between two bulldozers, tearing up a wide swath. Pulling is often followed by burning to remove dead wood.[8]

Advantages: Re-sprouting is impossible if the root system is pulled from the ground. A drag chain can clear large areas quickly.

Disadvantages: Pulling has a massive ecologically disruptive impact. All woody vegetation is torn up and the soil is greatly disturbed. A large amound of dead wood results which must be dealt with. It requires heavy equipment and persons skilled in its use. It might prove to be impossible to pull the massive root system of *A. melanoxylon*, and seedlings are often too flexible to be pulled.

Opinion: While this clearing technique may have value on Brigalow range in Australia, it is probably useless in the EBRPD. It is simply too aesthetically unpleasing even in areas where native vegetation would not be greatly damaged. Park users would enjoy neither the sight nor the sound of bulldozers pulling trees from the ground.

Grazing can be useful in controlling re-growth.[8] Underfed sheep will eat small soft suckers and seedlings. If grazing is continued for two seasons, re-growth will stop.

Advantages: Very little human labor is required and legumes are nutritious to livestock, being high in protein.

Disadvantages: The restricted diet can be detrimental to sheep unless large numbers graze the area for short periods of time. Sheep prefer other kinds of fodder. Since the softest young shoots are palatable, larger seedlings would be ignored. Grazing can only be used following another technique, such as burning or pulling. Herbicide use would be hazardous to sheep.

Opinion: Grazing would be impractical for acacia control in the District.

Burning is useful only in initial clearing of large areas. It must be followed by control of suckers and seedlings, as fire has been shown actually to stimulate germination of many *Acacia* species.[5, 12] Follow-up measures include re-burning, herbicides and grazing.

Advantages: The initial burn is inexpensive and allows complete conversion to another type of vegetation.

Disadvantages: The re-growth problem is greater than with any other technique due to the increased seed germination. Fires destroy all the vegetation, not just acacias, and involve many other problems which are discussed in the next report.

Opinion: Under the existing conditions in the EBRPD, burning would increase the problems with acacias, rather than reduce them.

Herbicides have been used mainly for re-growth control Brigalow. However, Anderson and Beeston showed 2,4,5-T ester in diesel oil to be effective in aerial spraying.[1] it should, therefore, also be effective with foliar application from ground level or perhaps by injection.

Advantages: Herbicide use might require less labor or be less expensive than other techniques.

Disadvantages: Assuming the chemical itself is safe, complete foliar application might not be possible from ground level on large specimens and injection techniques might have to be experimented with.

Opinion: Herbicides have not been shown to be necessary in Brigalow, and, therefore, the EBRPD should avoid them in acacia control, especially next to a creek flowing into Lake Chabot.

Biological control has been neglected in the available literature. Cunningham described two fungus species, *Uromycladium notabile* and *U. Tepperianum* which produce fatal gall infections in several species of *Acacia* in New Zealand. If these fungi attack only acacias, they might be of use in their control.

Opinion: Biological control can be risky and is not warranted for such a small-scale control program. A fungus could spread to non-District property, creating a control problem of its own.

Conclusion

Acacias do not appear to be a severe problem on District parklands. I observed a few frost-damaged specimens of *A. melanoxylon* in Chabot Park just south of the Big Trees Campground which exhibited moderate suckering, but these could be killed with little effort. Most of the acacias farther downstream are obscured by dense stands of *Baccharis*, and efforts to remove them could reasonably be delayed until manpower and finances permit.

EUCALYPTUS SPECIES

Botanic Descriptions

The genus *Eucalyptus* is a member of the Myrtle Family (*Myrtaceae*). *Eucalyptus* groves are noted for a lack of undergrowth, a fact which has created a great deal of debate as to whether or not eucalypts produce allelopathic chemicals to retard growth of competitors. Eucalypts sucker profusely when burned or cut, with as many as eight suckers sprouting from one stump. The most common eucalypt in California is *E. globulus*, the Blue Gum, which represents about 80% of eucalypts planted here.[14] The other common species on EBRPD land is the Red Gum, *E. camaldulensis*.

Eucalyptus globulus is a native of Tasmania. Mature trees will reach heights of 70 meters, with the smooth tan and green unbranched trunks shedding long strips of bark. The leaves are sickle-shaped, about 15 cm. long and deep green in color. In coastal areas, ground moisture is increased in Blue Gum groves because of water condensing upon the leaves and falling to the ground as fog drip. Blue Gums are intolerant of long exposure to temperatures below -5 degrees Celsius.[10]

E. camaldulensis is similar in form to the Blue Gum, but the leaves are shorter, narrower, and less curved. The Red Gum's frost resistance is slightly higher than the Blue Gum's.[10]

History and Distribution in EBRPD

The eucalypts in the East Bay hills were originally planted for lumber. At the beginning of this century a great deal of propaganda was published by seed companies promising great profits for *Eucalyptus* growers, most of which was found to be untrue, but not until Frank C. Havens and other promoters had planted eight million trees over 1,200 hectares of the Berkeley and Oakland hills.[14]

The Nature of the *Eucalyptus* Problem

The freeze of December 1972 devastated the eucalypts in the East Bay hills. Original estimates put the fraction of dead trees at 80 to 90%.[14] Since the huge volume of dead leaves and branches would pose a severe fire hazard the following summer, a crash program of *Eucalyptus* removal was initiated. A fuel break was created to control the spread of any fire through extensive cutting, with the lumber offered to the public as free firewood. At Chabot Regional Park, a number of logging companies were contracted to clear *Eucalyptus* groves, but the project was too disorganized to be of success.[7]

Eucalyptus stumps must be treated to prevent suckering. According to Havlick, only 5 to 10% of the fuelbreak stumps were treated with herbicides in 1973, and massive suckering has occurred. Presently, Youth Forest Protection workers (an Oakland City group) are cutting suckers, but are not licensed for herbicide use, so that must be done by EBRPD or CETA employees. The official park policy is to treat the stump of any tree cut, to prevent re-growth, but many EBRPD employees are reluctant to handle herbicides.[7]

Since the eucalypts have still not recovered from the frost, this is an appropriate time to consider the complete conversion of *Eucalyptus* groves back to native vegetation. The native plant species have proven themselves capable of re-colonizing their natural range in the area above the golf course in Tilden Park, which was cleared of eucalypts in 1974. Re-growth of eucalypts is occurring, though, and the District is planning to inhibit that suckering.[7]

The original vegetation of areas now dominated by *Eucalyptus* varies. On north-facing slopes the hills were dominated by shrubs, and on west-facing slopes grasses and wildflowers prevailed. Havlick would favor complete restoration of the shrubs but feels the the eucalypts would be more attractive to the public on the western slopes than grassland,[7] even though official District policy would seem to indicate the desirability of that vegetation type.[11] Roof is strongly in favor of the return of wildflowers and grasses.[6, 13] Baker would also like to see the eucalypts removed, with the exception of certain groves preserved for their educational value.[3] The District is presently considering two urban forestry programs where 240 to 400 hectares of Chabot Regional Park would be clear-cut in segments, and about 40 hectares of *Eucalyptus* and Monterey Pine in Redwood Regional Park would be converted to redwood, to be logged at 40-year intervals.[2]

Methods of Controlling *Eucalyptus*

Control of eucalypts has been studied a great deal in Australia. Many of those control techniques should be of use in California as well. The applicable control techniques begin with felling the tree, followed by sucker control.

Repeated cutting of suckers will eventually cause the roots to exhaust their supply of stored nutrients and cause death.

Advantages: Cutting has little effect on the environment.

Disadvantages: The suckers must be cut yearly to prevent the rootstock from building up a supply of nutrients. Cutting requires a great deal of manpower and a long-term program which must be completed, over a duration of about five years. Since each stump can produce many suckers, without continued cutting the result would be a cluster of several trees where there was once only one.

Opinion: Cutting would be the only possible alternative to herbicide use.

Herbicides are very effective in preventing re-growth. The EBRPD has had good success with 2,4-D amine + water applied both to newly-cut stumps and to a girdled basal frill.[11] Other effective herbicides are 2,4,5-T butyl ester in diesel oil in a basal frill[15] and "Tordon 105," a mixture of picloram and 2,4,5-T amine in water injected anywhere in the trunk.[9] Young also found diesel oil alone in a basal frill to be 58% effective.[15]

Advantages: If used properly, an herbicide will give a nearly 100% kill with a single treatment.

Disadvantages: Herbicide use has been widely criticized recently, and public opinion is strongly against use.[14] Many park employees are reluctant to handle them. Since some herbicides are undoubtably environmentally unsafe, the choice of chemical should be wisely considered.

Opinion: The District has clearly found 2,4-D to be simple and effective,[7, 11] but in light of recent indictments against dioxin-containing compounds the advisability of its use should be questioned. Diesel oil alone would probably be used by employees, and accepted by the public more willingly, but may be shown to be dangerous as well. The suitability of other chemicals should be tested.

Conclusion

With many of the District's eucalypts, the question is not whether to cut or leave them, but how to control suckering in those areas which have already been cleared. If vigorous re-growth control measures are not undertaken, the resulting *Eucalyptus* groves could well be much denser than those presently existing, because of the *Eucalyptus'* propensity for multiple suckering. The choice of control method and the issue of attacking uncut stands is dependent upon the labor and monetary constraints of the District, and within the guidelines listed in the Vegetation Management Plan, but any delay in sucker control will only intensify the problem in the future.

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