COST COMPARISON OF Melaleuca Treatment Methods

Introduction

Melaleuca (*Melaleuca quinquenervia*) is an exotic invasive plant species that was introduced to South Florida in the late 19th century. Melaleuca seeds were offered for sale in Florida in 1887 (Serbesoff-King, 2003), and the tree has been distributed throughout South Florida since that time. Around 1937, during the historic rush to drain swamps in the state of Florida, seeds from the native Australian tree were disbursed over the eastern portion of South Florida's Everglades. The tree was believed to be beneficial for drying wetlands for farming and development. In 1941, the United States Army Corps of Engineers planted *M. quinquenervia* on levees south of Lake Okeechobee for erosion control (Bramlage, 2000). Melaleuca was widely planted, and recommended as late as 1970, as "one of Florida's best landscape trees" (Watkins, 1970). Melaleuca grows extremely fast in a variety of conditions. Wetlands, seasonal wetlands, and well-drained uplands offer excellent growing conditions for the tree. Melaleuca is particularly a concern for South Florida because it is highly invasive and has the ability to adapt and flourish in a variety of ecological conditions.

The high production of viable seeds helps this species to establish and disperse and makes control a difficult challenge. Regardless of the method of removal, millions of viable seeds are left behind to re-establish melaleuca populations following any control initiatives. Current methods of control used for melaleuca include integrated strategies of herbicide application, limited mechanical means, and biological controls (Laroche, 1998). Control with herbicides is the most economical and most researched method. The costs and effectiveness of herbicide treatments are well known; however, little information is available on the use and cost of mechanical control options for melaleuca.

The purpose of this project was to determine and compare the cost of various means of mechanical and chemical treatment of melaleuca per amount of standing dry weight biomass treated or removed.

Material and Methods

The project site totaled approximately 400 acres divided into five parcels located in Broward County, Florida. Four parcels were approximately 40 acres each, and the fifth parcel was approximately 240 acres. Each parcel represented the use of a different method of treatment. Parcel No. 3 represented the South Florida Water Management District's (SFWMD) current method of chemical treatment, using ground crews to treat individual trees with the girdle and cut stump application of herbicides, a solution of imazapyr and glyphosate at 25% each. This is the preferred method of treatment for light to moderately infested tracts of land. Parcel 5, the largest parcel, represented aerial spraying, with a combination of 3qts of imazapyr and 3 qts of glyphosate per acre, which is currently the most economical method for controlling large melaleuca monocultures (Laroche, 1998). For Parcels 1, 2 and 4, contractors were selected through a Request for Proposal to treat or remove all exotics while trying to preserve the largest percentage of native vegetation possible within a 90-day period. Future American Corporation was selected for Parcel No. 1, Habitat Restoration Resources for Parcel No. 2, Applied Aquatic Management, Inc. for Parcel No. 3, and Florida Environmental Clearing, Inc. for Parcel No. 4. Helicopter Applicators, Inc. treated Parcel No. 5, which was not included in the estimations of dry weight standing biomass. It was treated by aerial application of herbicides only to illustrate the low cost of this method. All of these parcels were heavily infested, ranging from 90 to 100% coverage of melaleuca with very little incidence of native vegetation.

Tracked Feller Buncher

Future American Corporation proposed to manually cut melaleuca with chainsaws and shearing tools operated by prison inmates. The inmate crews would treat the remaining stumps with herbicide and would move the melaleuca biomass to a staging area where it would be chipped and loaded onto trucks. Lastly, the melaleuca chips would be delivered to prisons for bagging and sold as mulch, or the chips would be delivered to a power plant for bio-fuel.

Habitat Restoration Resources used a tracked Feller Buncher to cut down and windrow trees greater than 1-1/2 inches in diameter. The Feller Buncher cut the trees and also sprayed the stumps with an herbicide solution of 25% imazapyr and 25% glyphosate. Next, a shovel loader moved the tree logs to a staging area, located at the eastern boundary of the parcel, where the debris was chipped with a whole-tree chipper, loaded into trucks and hauled away. Last, a Gyro-Trac forestry mower was used to mow the remaining saplings and a labor crew was mobilized to treat the cut stumps with herbicide.

Applied Aquatic Management, Inc. used laborers with chainsaws and machetes to cut down or girdle melaleuca trees and treat with an herbicide solution of 25% imazapyr and 25% glyphosate. These methods are commonly referred to as "cut/stump" and "frill and girdle." Cut or treated trees were left on site to decay. Florida Environmental Clearing, Inc. used a ClearMore chipper/stumper to knock down melaleuca and grind the trees and stumps into the ground. The melaleuca mulch was mixed into the soil and the ground was left in a level condition upon completion. No herbicide was used with this method. It is proposed that the

ClearMore Tree Chipper/Stumper

melaleuca mulch layer left on the surface will suppress seed germination and the process left no remaining tree stumps for possible regrowth.

Helicopter Applicators, Inc. treated melaleuca by aerially broadcasting herbicide over the treatment area. Parcel No. 5 is approximately 240 acres, however only 188 acres were treated.

To determine total biomass, three experimental plots were measured within each of Parcels 1 thru 4. Within each plot, the diameter of each melaleuca trunk was measured in millimeters at breast height (diameter at breast height, dbh) with a digital micrometer. The circumference for large trees was measured with a metric measuring tape, and was later converted to diameter using the formula Diameter=Circumference/3.14. The measurement was recorded for all trees taller than breast height (approximately 1.5m). Trees shorter than breast height were counted as seedlings. Due to their minimal amount of standing biomass, seedlings have no significance in the analysis of biomass results. Therefore, seedlings were only counted for determining the population density of melaleuca in each parcel. Non-melaleuca species data were not collected. However, the common name of native species present was recorded and the presence of sawgrass (*Cladium jamaicense*) was recorded as sparse, scattered, or dense depending on the observed distribution throughout the plot. The dbh data was used to determine standing dry weight biomass. This was accomplished by using a known combined regression equation, developed by USGS scientists, for estimating standing dry weight biomass of melaleuca (Van, et al., 2000).

$$\mathrm{Log}_e(W) = -1.83+2.01*\ \mathrm{Log}_e(DBH)$$
$$R^2=0.956,\ MSE=0.191$$

This equation was used to convert the raw dbh data to standing dry weight biomass in metric tons/acre. The average of the plot results was used to determine the estimated biomass for the parcel.

The population density for each plot was calculated by taking the total number of trees counted for each plot (including seedlings) as the number of trees per square feet to determine density per acre in each parcel. Tree dbh measurements were divided into three categories to differentiate between trees sizes: small (dbh less than 10cm), medium (dbh greater than 10cm and less than 20cm), and large (dbh greater than 20cm).

The cost information, from actual completion of work and the proposed contract cost, was used to analyze the cost of each method of removal. A comparison was prepared to show the dollar cost per acre and the dollar cost per metric ton of biomass removed or treated. Acres treated were obtained by GPS measurements of the treated area in each parcel. The possible return from the sale of removed biomass was calculated for each contractor. Although not all contractors proposed to seek revenue from the biomass, this is a good indicator of the value of the melaleuca contained within each parcel. The possible biomass revenue was calculated by multiplying the total biomass contained in each parcel by an estimated market value of $3 per metric ton.

Results and Discussion

Melaleuca biomass, density, and size distribution varied among parcels, as summarized in Table 1.

Future American Corporation proposed a total contract cost of $58,000. The cost per acre for Parcel No. 1 would have been $1,620 based on 35.8 acres. The cost per metric ton of biomass for Parcel No.1 would have been $66 (Table 2). The total possible revenue from the biomass removed would be $2,628.67.

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Table 1. **Melaleuca biomass data**	Future American Co. (prison labor)*	Habitat Restoration Resources (Feller Buncher)	Applied Aquatic Mgmt. (manual herbicide)	Florida Environmental Clearing (ClearMore chipper)	Helicopter Applicators (aerial herbicide)
Acres	35.8	37.5	38.5	20	180
# Trees/acre	14,273	16,848	9,152	25,159	N/A
Size distribution: Small Medium Large	 93.92% 5.60% 0.49%	 91.93% 7.22% 0.85%	 96.71% 3.18% 0.11%	 96.15% 2.38% 1.25%	N/A
Total Biomass (metric ton)	876	2082	1741	1120	N/A
Metric ton/acre	24.49	55.54	45.24	56.03	N/A

Table 2. **Melaleuca control cost by various methods of treatment**	Future American Co. (prison labor)*	Habitat Restoration Resources (Feller Buncher)	Applied Aquatic Mgmt. (manual herbicide)	Florida Environmental Clearing (ClearMore chipper)	Helicopter Applicators (aerial herbicide)
Total Cost	$58,000	$99,400	$70,199.53	$75,190	$51411.70
Cost/Acre	$1,620	$2,651	$1,823	$3,760	$286
Cost/metric ton Biomass	$66	$48	$40	$67	N/A
Cost/Plant	$0.18	$0.19	$0.08	$0.22	N/A
Labor/equipment cost/acre	N/A	N/A	$1068	N/A	$60
Herbicide cost/acre	N/A	N/A	$755	N/A	$226
Time to complete	N/A	120 days	21 days	160 days	2 days

Treating Cost *continued*

However, this contractor did not perform the work; cost estimates were determined on the proposed cost for the purpose of this study. It should be noted that unforeseen complications, such as the inability to use prison laborers, could have caused the actual cost to be higher than expected. Habitat Restoration Resources' total contract cost was $99,400. The cost per acre for Parcel No. 2 was $2,651 based on 37.5 acres treated and a cost of $48 per metric ton of biomass. The total possible revenue from the biomass removed was $6,245.44. This contractor was the only one who actually removed the biomass from the site. The work was completed in approximately 120 days. Equipment breakdown and the use of several different types of machines increased the project completion time. Applied Aquatic Management, Inc. completed their contract for a total cost of $70,199.53. The cost per acre for Parcel No. 3 was $1,823 based on 38.5 acres treated and the cost per metric ton was $40. The total possible revenue from the biomass if removed would have been $3,482.66. The work was completed in 21 days with no complications. The actual cost for Florida Environmental Clearing was $75,190. The cost per acre for Parcel No. 4 was $3,760 based on 20 treated acres and a cost per metric ton of biomass of $56. The total possible revenue from the biomass if removed would be $6,720.37. This contractor had major complications and did not complete the whole parcel. Approximately half the parcel was treated (20 acres) over a period of 160 days. This equipment was never tested on melaleuca trees and the contractor needed to do some adjustments to account for the high density of the trees. Helicopter Applicators completed aerial treatment on Parcel No. 5 in two days. Information on this parcel was included to illustrate the low cost per acre of aerial treatment of dense melaleuca monocultures. The total cost for this method was $286.

Cost per acre of the four similarly sized parcels indicates that Future American Corporation would have had the lowest cost per acre of land treated at $1,620/acre. However, as stated earlier, this contractor did not perform the work. Therefore, the possibility exists that this method could be more costly than proposed. Consequently, the commonly used method of frill/girdle and cut/stump used in parcel 3 was the lowest, $1,823 per acre. The prison labor method would have been $200 lower, suggesting that Future American Corporation's method is not significantly less expensive. Many companies could perform similar work within a reasonable price range.

Statistical analysis of the data revealed that the variability between plots within each parcel was not significant. Parcel 1 and 3 yielded significantly lower average dry weight standing biomass than parcel 2 and 4, 25 and 45 metric tons per acre, respectively (Table 1). Parcel 2 and 4 yielded similar average dry weight standing biomass results, 54 and 56 metric tons per acre, respectively. The variation of average dry weight standing biomass between parcels 1 and 3 and parcels 2 and 4 can be explained by further analysis of the distribution of tree sizes. Parcels 2 and 4 had a greater amount of large trees present in the size distribution. The large trees contributed much more substantially to the amount of biomass in these parcels. Parcels 1 and 3 contained the highest percentages of small trees in the distribution, accounting for the lower average dry weight standing biomass. This can also account for the significant increase in time of completion in parcels 2 and 4. However, population density of melaleuca was relatively similar in parcels 2 thru 4. The contractors in these parcels dealt with similar numbers of trees. Tree density in parcel 1 was significantly lower.

Total dollar cost per metric ton of biomass contained within each parcel may represent a fairer comparison than dollar cost per land area since the amount of biomass contained within each parcel varies greatly between parcels of the same area. Greater effort and cost must be expended to treat parcels with higher metric tonnage of biomass. Based on cost per metric ton of biomass, the commonly used method of frill/girdle and cut/stump used in parcel 3 was the least expensive ($40 per metric ton of biomass treated). Florida Environmental Clearing (using the ClearMore chipper) and Future American Corporation (using prison labor) were the most expensive methods of treatment at $67 and $66 per metric ton biomass respectively.

Results from this study indicate that the widely used methods of frill/girdle and cut/stump treatment are more economical than mechanical methods of melaleuca treatment. However this method is not recommended for large areas of dense monoculture of melaleuca. Aerial application of herbicides remains the most economical and the most feasible choice of treatment ($286/acre) for large parcels of heavily infested lands. This method of treatment is not selective to target vegetation, however, and should only be used for monospecific stands of melaleuca.

For more information, contact Francois Laroche, Senior Environmental Scientist, Vegetation Management Department at the SFWMD, (561) 682-6193, flaroche@sfwmd.gov

Acknowledgments

Appreciation is expressed to the Florida DEP, Bureau of Invasive Plant Management, Mr. Greg Jubinsky, and the SFWMD mitigation section, Mrs. Marjorie Moore, for providing funding for this project, and Dr. Thai Van (USDA/APHIS), for running the data through SAS and for his help with the data analysis. Special thanks to Gordon Baker, Linda Yarrish and Kris Serbesoff-King for their assistance with field data collection.

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