# Aerial Glyphosate Application to Control Privet in Mature Hardwood Stands

By: James Johnson (GFC)[1], Scott Griffin (GFC)[2], & John Taylor (USFS)[3]

## BACKGROUND:

Chinese Privet (*Ligustrum sinense*) is one of the most widespread non-native invasive plants within hardwood and pine forests throughout all ecoregions of Georgia (Harper 2009). It aggressively invades, spreads and eventually dominates many forested understories, completely displacing native flora. This field trial evaluated one technique (previously untested) for removing a privet-choked understory in a hardwood bottom within the piedmont region.

Dormant season applications of glyphosate herbicide applied as foliar treatments to Chinese privet have been shown to be an effective control option which may limit damage to non-target dormant plants (Evans 2008). Privet infestations beneath hardwood canopies are common along field borders, drains and streams. Often, treatment is difficult in stands growing beneath hardwood canopies because of access obstacles and minimal application methods that insure ample privet canopy coverage while limiting damage to the desirable overstory. In this project, glyphosate herbicide was applied aerially in an effort to control Chinese privet beneath dormant hardwood forests and to provide a basis for measuring both efficacy to privet and damage to the dormant hardwood stand.

## METHODS:

On February 6-7, 2009, Glyphosate (Accord Concentrate®@ 54% active ingredient) was applied at two rates (3% and 6%), using a helicopter calibrated to deliver a spray volume of 15 gallons per acre (GPA). (Equipment used: Bell Jet Ranger helicopter equipped with Accu Flow 028® forestry nozzles coupled to an AutoCal® application calibration system.) These rates equate to (of Accord Concentrate® applied) 0.45 GPA and 0.9 GPA for the 3% and 6% treatment areas, respectively. Entry II® surfactant was used at 0.5% (0.075 GPA). Sites were selected at two state parks in the piedmont of Georgia for this trial (Hard Labor Creek and Fort Yargo State Parks -Figure 1 at left). "High" and "low" rates were applied to two areas at each park, creating four treatments areas. Treatment sites were separated by adequate buffers to insure plot integrity and minimize the potential for cross-treatment contamination.

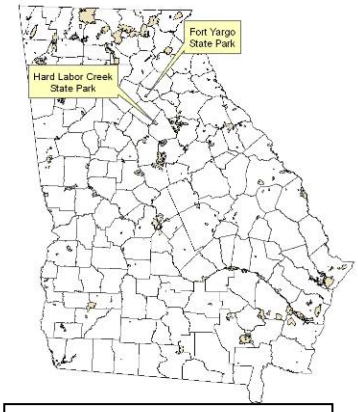



**Figure 1**. Location of State Parks

Within each of the four treatment areas (which totaled 50 acres), three one-tenth acre (circular) plots were established for pre- and post-

**1**-Georgia Forestry Commission, Athens, GA (jjohnson@gfc.state.ga.us); **2**-Georgia Forestry Commission, Gainesville, GA (sgrifffin@gfc.state.ga.us); **3** US Forest Service, Atlanta, GA (jwtaylor@fs.fed.us)

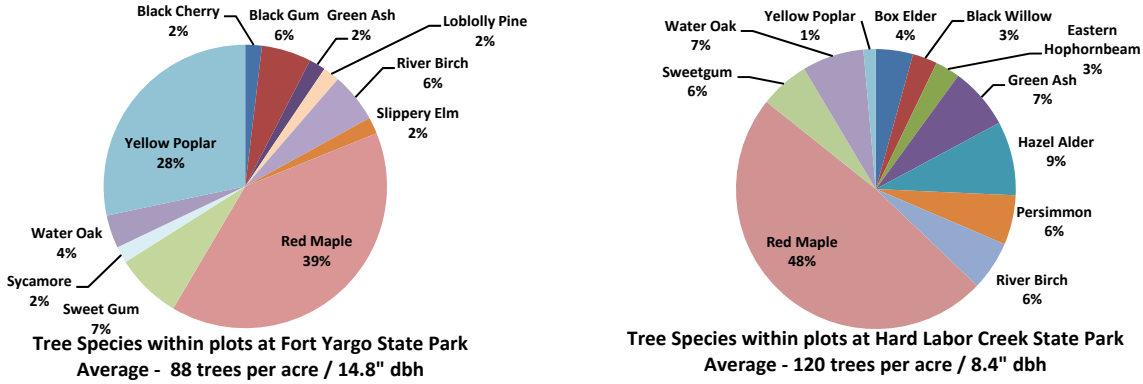
treatment measurements of overstory trees and privet. Individual species, diameter, health condition, and privet density / regeneration were recorded. These vegetation sample plots were marked with one-half inch metal stakes at plot center and geo-referenced for re-measurement following treatment. Each tree was identified by species and dbh (diameter at breast height), and estimates of overall health condition were made. Within each plot, six or more one-inch (dbh) and greater privet were tagged and measured for plant health estimations following treatment. Both the trees and each privet stem were measured again in late May, following the dormant-season treatment.

Red maple is normally the first species to break bud each spring, usually in mid to late March. All trees were in full leaf by the time our plots were re-measured in late May for post-treatment effects Aerial views of the treatment areas and plot locations are displayed in the appendix of this document. Post-treatment measurements of the overstory tree and privet component included plant health and mortality, and privet regeneration at plot center.

Previous (glyphosate) ground applications using 3-5% (of 41% active ingredient products) have shown that dormant season foliar glyphosate applications on privet are very effective, yet will leave nearby (non-foliated) plants unharmed (Evans 2008). For this reason, a treatment window when hardwoods are dormant and defoliated was chosen (mid December until mid February), with treatments occurring on February 6-7, 2009. Temperatures on the afternoon of the 6th were in the upper 50°s F (treatment at Yargo occurred within one hour of dark), and on the 7th the low was in the upper 20°s F at daybreak. Treatment at Hard Labor occurred around 9:30 am and temperatures had risen to mid 30°s F by that time. Costs for the treatment were $130/acre for the application and chemical and surfactant costs are about $40/acre for the 6% rate, and $20/acre for the 3% rate.

## RESULTS AND DISCUSSION:

**Trees:** Seventeen tree species were measured in the plots on both parks. The dominant species at both locations is red maple (*Acer rubrum*). Hard Labor averaged more trees per acre than Yargo, and average diameter was lower (Figures 2 & 3). All plots were within a "closed" canopy containing privet as the dominant understory component. Table 2 lists all tree species.




**Figures 2 & 3**. Tree species composition within treatment areas at Fort Yargo (left) and Hard Labor Creek (right)

Our initial theory predicted that several tree species could sustain damage: red maple (a noteworthy early season flowering/seeding species), some water oak (several trees with green leaves still in place

were measured in December), and loblolly and longleaf pine. None of these species, however, showed any damage, and new growth could be seen on all trees measured.

Collateral damage on all tree species was negligible, with the exception of the persimmon (*Diospyros virginiana*) measured on the 6% treatment area of Hard Labor Creek (no other persimmon were measured on the other three treatment areas). There was noticable dieback on all four stems in this plot. The initial health score average of 3.75, and post treatment average score of 2.0, and the damage was typical of glyphosate (tip and shoot dieback, "feathery", malformed and stunted leaf production along the main stem). These results indicate that this species is likely prone to damage from dormant season treatments of glyphosate (and possibly the surfactant used may play a role in this damage).

The remnant pines (loblolly at Yargo, and loblolly and longleaf at Hard Labor) within these low-lying areas are large mature specimens, and none showed any signs of herbicide damage. Growing season applications with low concentrations of glyphosate over pines following final bud-set in late summer (1 quart per acre of 41% active ingredient products) has been an option for controlling or suppressing competing vegetation in pine stands. However, this trial showed no collateral damage on loblolly or longleaf with this winter-season treatment using much higher rates.

| | *Condition 12-08* | | *Condition 5-09* | |
|---|---|---|---|---|
| | *3%* | *6%* | *3%* | *6%* |
| ***All Trees*** | | | | |
| Fort Yargo | 3.94 | 4 | 3.94 | 3.95 |
| Hard Labor | 3.87 | 3.83 | 3.86 | 3.54***** |
| ***Privet ( greater than 1" dbh)*** | | | | |
| Fort Yargo | 4 | 4 | 1.42 | 1.12 |
| Hard Labor | 4 | 4 | 1.91 | 1.05 |

| ***Privet (regeneration/acre)*** | Stems Per Acre | |
|---|---|---|
| Fort Yargo | 52,086 | 8,938 |
| Hard Labor | 14,331 | 3,852 |

**Table 1**. Summary of pre-treatment, and post-treatment measurements of privet and trees.

Condition Scores:

| | |
|---|---|
| **1** | dead |
| **2** | more than 50% canopy dieback |
| **3** | less than 50% canopy dieback |
| **4** | healthy |

***** Persimmon impact

**Privet:** Impact on privet was widespread, and visually and measurably noticeable (Table 1). The higher concentration (6%) areas did produce slightly better privet mortality, but even the lower concentration areas (3%) showed good impacts. There was some variability of herbicide impact in the low area at Hard Labor Creek and some privet showed almost no impact. This variability was not observed on the other three areas. Since all treatment areas had almost complete canopy closure (and consequent spray intercept potential), it would be logical to assume that most of these healthy privet stems did receive some spray and a "shadow" effect (interception of spray from trees overhead) can not explain this situation. Previous ground applications targeting privet by the GFC have indicated that below freezing temperatures at the time of application can affect herbicide efficacy and this may have played a role in this variability. Overall, this area with variablity did show significant privet mortality and would be considered successful.

**Privet Regeneration:** A significant impact on the privet regeneration was not anticipated because it was assumed that spray droplets would be intercepted long before they reached the last few feet above the ground where privet seedlings are found. We were impressed with the reduction of this regeneration, since it would be of great concern to land managers attempting to eradicate privet from these stands. If this initial treatment merely killed the larger stems and allowed this regeneration a free-to-grow environment, another broadcast treatment would likely be prescribed. Our test plots indicate that overall regeneration was noticably reduced, but with thousands of seedlings per acre, another broadcast treatment might be indicated. Privet seeds remain vialible for one growing season, so it is anticipated that some additional seedlings will emerge throughout the first season following treatment.

One observation about privet regeneration is that there was significant and widespread browse impacts at Hard Labor Creek from deer. This was not occuring at Fort Yargo. This browse pressure undoubtedly had an overall impact on the number of stems measured per acre, since similar mid-story privet was found at both parks (and presumably similar seed production).

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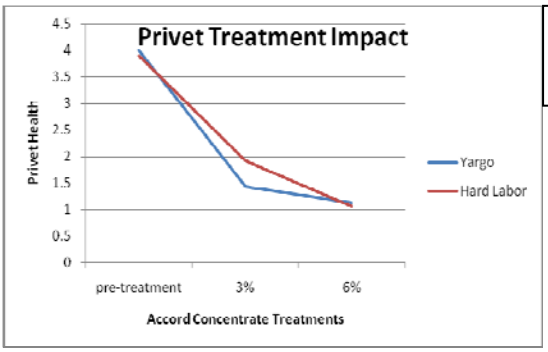


**Figure 4**. Impact of glyphosate treatments (3% & 6% Accord Concentrate @ 15 gallons of solution per acre). Includes both State Parks

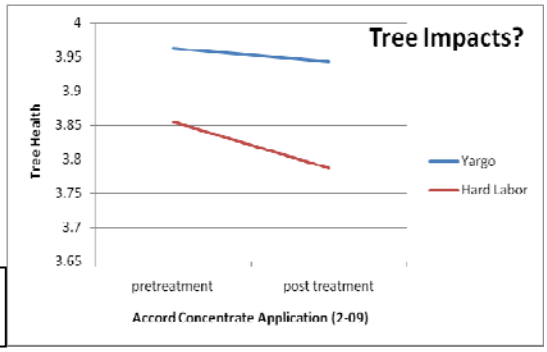


**Figure 5**. Impact of glyphosate treatments on 16 tree species within treatment areas. Includes both State Parks.

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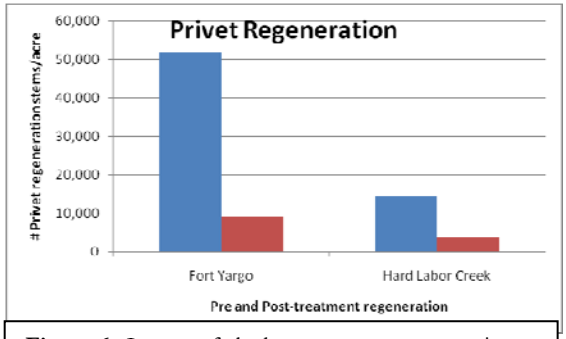


**Figure 6**. Impact of glyphosate treatments on privet regeneration (less than 1 inch diameter at ground).

**Table 2**. Tree species and common names in plots.

| Tree common names | Scientific Names |
|---|---|
| Black Cherry | *Prunus serotina* |
| Black Gum | *Nyssa sylvatica* |
| Black Willow | *Salix nigra* |
| Box Elder | *Acer negundo* |
| Eastern Hophornbean | *Ostyra virginiana* |
| Green Ash | *Fraxinus pennsylvanica* |
| Hazel Alder | *Alnus serrulata* |
| Loblolly Pine | *Pinus Taeda* |
| Persimmon | *Diospyros virginiana* |
| Red Maple | *Acer rubrum* |
| River Birch | *Betula nigra* |
| Slippery Elm | *Ulmus rubra* |
| Sweetgum | *Liquidambar styraciflua* |
| Sycamore | *Platanus occidentalis* |
| Water Oak | *Quercus nigra* |
| Winged Elm | *Ulmus alata* |
| Yellow Poplar | *Liriodendron tulipifera* |

**SUMMARY:**
Implications from this procedure indicate that a dormant aerial treatment of glyphosate (3-6% of 54% active ingredient product) is a viable option for land managers attempting to control privet in the piedmont region of Georgia. If the tree species' composition is similar to those in Figures 2 and 3, little to no damage to the overstory (with the exception of Persimmon) can be expected. It should be noted, however, that weather varies each year, and resource managers should time applications to when trees are fully dormant.

Our selection of these sites was meant to give resource managers an option for an initial treatment of the worst privet-choked sites. It appears this type of treatment is a viable option for similar sites within the piedmont region of Georgia (and perhaps other states with similar vegetation). Note that most glyphosate products are not labeled for treatment within areas that may have standing water, so resource managers should carefully read and follow label instructions when selecting a product and calculating rates. Although Accord Concentrate®and Entry II® surfactant were used in this trial, an endorsement of these products is not implied. Moreover, there are similarly-labeled glyphosate products on the market which may offer similar results. The Entry II® surfactant (cationic tallow amine) was difficult to locate and procure for this trial, and other "pine release"-type surfactants may offer similar results. Other options include Entrée® (Aqumix), and TA-35® (Brewer International). The authors believe that careful selection of the glyphosate products, rates, and the appropriate surfactant are necessary to expect good efficacy on the privet and minimal non-target damage of other plants within the treatment areas. For more information on surfactant chemistry relating to "release"-type treatments, see: http://www.dof.virginia.gov/research/fact-surfactant-chemistry.shtml.

While showing good effects on the targeted privet these initial treatment results in no way imply this invasive plant has been eradicated. Further (ground applied) follow-up treatments must occur to eliminate the plants from these sites. Once the mid-story privet is removed, resource managers will also confront a tremendous amount of dead material that may make the site difficult or impossible to access for several years following the initial treatment. Depending upon the site, heavy equipment might be an option for mulching, pushing and piling, or simply running over this material to gain access for successive treatments. These disturbances may, however, destroy the initial seedlings that emerge from nearby parent trees, or herbaceous growth that will quickly reclaim these fertile bottomland sites.

Based upon previous field trials with privet eradication by the Georgia Forestry Commission, we recommend privet stems be at least 24" in height before attempting another treatment to eliminate it from these sites. This generally equates to one to two growing seasons for root resprouts, or even a third season for seed origin privet that emerges after the initial privet. Smaller stems may not translocate adequate amounts of herbicide into the root stock to provide effective control. Privet seed remains viable for one year, so most of the seedlings will appear during the first growing season following the initial treatment.

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- ✓ Georgia State Parks and Historic Sites for allowing their lands to be used in this trial
  - o Chuck Gregory, Natural Resource Manager
  - o Daniel Hill, Park Manager at Hard Labor Creek State Park
  - o Eric Bentley, Park Manager at Fort Yargo State Park
- ✓ University of Georgia – (Dr. David J. Moorhead) proposal development and insight

## APPENDIX:

References:

*Georgia's Forests, 2004*. Richard A. Harper et al, 2009. Page 49.
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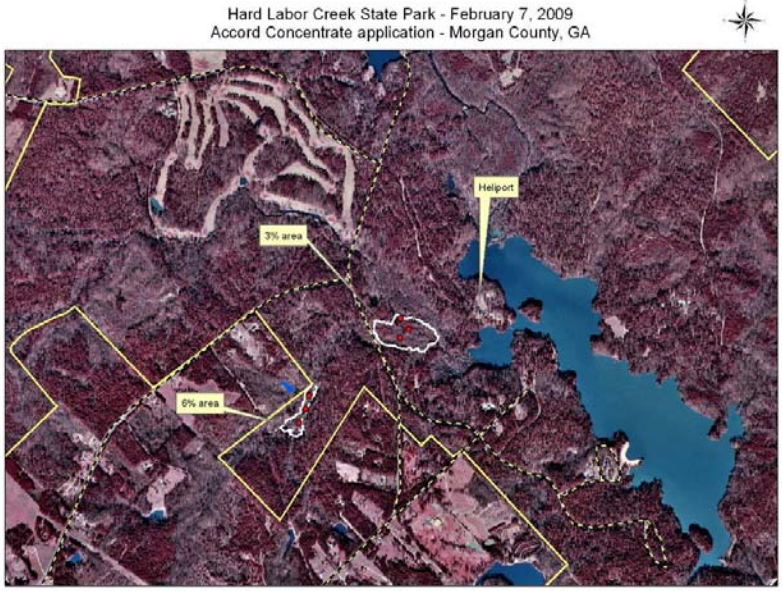


Left: Aerial image of treatment areas on Hard Labor Creek State Park.


Right: Aerial image of treatment areas on Fort Yargo State Park.

**Addendum 1** – *Year 2 application trials for aerial glyphosate applications targeting privet*

In 2010, nine additional tracts containing privet were sprayed aerially with glyphosate. Through this process several things were learned and will help make this type treatment more successful.

**Spray timing:** Tracts can be sprayed from just after hardwood leaf drop to the time red maple seed is developing, but not yet released. It is recommended to time your spraying as early in this range as possible. In 2010, Georgia experienced an extremely cold winter. It is believed that this caused above-normal privet leaf drop by the winter's end. This could reduce the effectiveness of an aerial application, where every drop counts. Tracts suitable for ground equipment might best be treated in November and December for this reason. Aerial spray applied late in this range, especially at higher concentrations, could result in some damage to trees that break dormancy early such as yellow poplar and red maple. One tract sprayed with 7.5 quarts of Accord Concentrate per acre in mid-February resulted in some herbicide damage to yellow poplars and red maples, but at the time of this report most had recovered.

**Herbicide prescription:** A glyphosate product, labeled for forested sites which contain surface waters (Accord Concentrate®, Aquaneat®, Aquamaster®), must be used when spraying over water and should be applied at the maximum labeled rate for aquatic areas of 7.5 pints per acre. These or other glyphosate products can be used at higher rates when not sprayed over water. One should be aware of the percent active ingredient in the product to be sure they are applying at an appropriate rate. Products with 54% active ingredient have a maximum application rate of 7.5 quarts per acre; and products with 41% active ingredient have a maximum application rate of 10 quarts per acre when not applying to water. An equal amount of active ingredient goes out in either application. More research needs to be done to determine if there is a point between the lower and upper limit of product applied per acre where you can achieve maximum control. A minimum spray volume of 15 gallons per acre should be used in all applications.

| | **Herbicide** | **Rate** |
|---|---|---|
| **Spray site with surface water** | Glyphosate (54%) with aquatic label + .5% surfactant | 7.5 pints per acre delivered in 15 gallons of spray volume per acre |
| **Spray Site without surface water** | Glyphosate (41%) + .5% surfactant if not included | 9.75 pints to 10 quarts per acre delivered in 15 gallons of spray volume per acre |
| **Spray Site without surface water** | Glyphosate (54%) + .5% surfactant if not included | 7.5 pints to 7.5 quarts per acre delivered in 15 gallons of spray volume per acre |

In Summary:

- ✓ Choose the product based upon whether surface waters are present on the application site.
- ✓ If no water is present, use higher rates and any product labeled for aerial application.
- ✓ Some damage may be expected to evergreens, such as sweetbay (smaller stems) and switchcane, when applied at higher labeled rates. Southern Magnolia appears to be resistant.
- ✓ Note the differences in active ingredients between some of these products (54% vs. 41%).
    - o Tank mix accordingly.
    - o The 54% products labeled for aquatic use do not contain surfactant, and several have been used with no difference in efficacy.
- ✓ For upland sites without surface waters present that are accessible for ground applications, consider using ground treatment earlier in the fall (November or December).
- ✓ For aerial applications, treat as soon as possible after overstory has dropped all leaves.
    - o Note that privet does loose leaves later in the winter, and this will impact chemical delivery to the plant. Cold winters can cause more leaf drop than milder winter and reduce efficacy of the treatment.