

Eradication of Coral Ardisia (*Ardisia crenata*) in NATL

T. J. Walker, April 2012

This report, or an updated version of it, with live links, is at <http://natl.ifas.ufl.edu/ardisiaplan.pdf>.

Executive summary

Coral Ardisia is an understory shrub that is a major threat to the hardwood hammocks of north Florida. Once established, it rapidly spreads and produces stands so dense that it dominates the understory. The species is native in India and Japan but was introduced to the southeast U.S. as an ornamental shrub for its glossy green foliage and bright-red, persistent berries. When NATL was established in 1994, portions of its hammock were already heavily infested. A concerted effort to eradicate Coral Ardisia from NATL was begun in 2010, and by March 2012, berry production by Coral Ardisia in NATL had almost ceased. Because the species produces no seeds that can survive at typical field temperatures beyond a few months and because the persistent red berries make mature plants easy to find, only minor resources should be required to keep NATL free or nearly free of Coral Ardisia in the future.

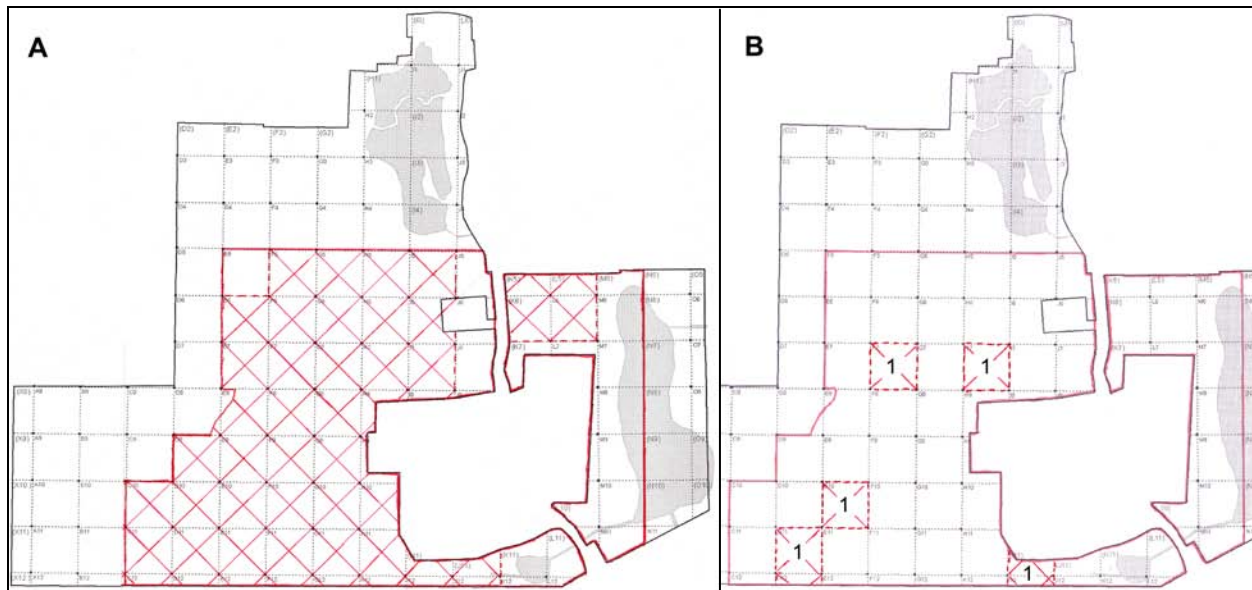


Fig. 1. Maps showing NATL’s 50x50m grid system. A. Areas monitored for Ardisia are within a solid red line and are divided into 57 “Ardisia reporting blocks.” In Feb. 2010, 41 of these blocks were known to have one or more mature Coral Ardisia. In both divisions of NATL, the infested blocks were contiguous and their limits are indicated by two cross-hatched areas—a large one in NATL-west and a much smaller one in NATL-east. B. Limits of monitored areas and infested area are indicated as before. The five reporting blocks with mature Ardisia early in 2012 each had only one berry-bearing plant.

Table 1. Progress toward eradication of *Ardisia crenata* from NATL hammocks: Numbers of plants with red berries in mid or late winter. (This same table, with footnotes added, is repeated later in this report.)

	NATL-west public	NATL-west restricted	NATL-east	Sum	Decline from prev. yr	Decline since 2009
January 2009 ^a	585	>712	No data	>>1297		
February 2010	96	122	98	316	>76%	>76%
January 2011	34	20	27	81	74%	>94%
March 2012	2	3	0	5	94%	>99%

Introduction

In 2009, Gerardo Celis and Corrie Pieterse were awarded a minigrant to study NATL invasives (<http://natl.ifas.ufl.edu/minigrants.htm>). A central feature of their work was mapping and mechanically removing *Ardisia crenata* from the infested areas in NATL-west. In their Final Report (http://natl.ifas.ufl.edu/Celis_Pieterse_finalrept.pdf), they reported

“We removed 1297 adults and 8397 juveniles/seedlings weighing a total of 373 lbs. While we were surveying the hardwood hammock, our initial impression was that the infestation was less severe in previously treated areas. However, the GIS maps (Figures 2 & 3) indicate that in comparison to the 2001 inventory there was no apparent difference in number of individuals present between areas where *Ardisia* had been treated previously and other areas (Figures 4 & 5).”

This was disappointing because substantial efforts to reduce *Ardisia* in NATL had been made during the two years prior to the minigrant work. However, re-reading the report of Fox and Kitajima (2001, <http://natl.ifas.ufl.edu/Fox&Kitajima2001.pdf>) on their studies of *Ardisia* life history made it seem logical to change the goal of *Ardisia* treatment in NATL from reduction to eradication.

Premises of eradication plan

These four considerations are critical to the success of the current *Ardisia* eradication plan:

1. *Ardisia* has no seed dormancy
Fox and Kitajima (2001, p. 2) found “no evidence of internal seed dormancy mechanisms or soil seed banks” in *Ardisia*. Seeds that mature on the plants in NATL either germinate or die within their first year.
2. Nearly all *Ardisia* seeds in NATL come from mature plants in NATL.
Fox&Kitajima (2001, p.26-28) found that most mature seeds stayed on *Ardisia* plants for months. In one study 50% of mature berries were still on the plants in mid April and 10% remained at the end of June. Most of the fruit that disappeared from plants simply dropped to the ground and could be recovered in trays placed on the ground beneath. They observed damaged fruit but had no information as to what species accounted for the damage and possible removal of fruit from the immediate vicinity of the plant. Except for a few small sites just beyond NATL’s south boundary and already tended to, no *Ardisia*-infested area is known from which flightless wildlife could conceivably transport seeds to NATL. Although transport of *Ardisia* seeds into NATL by birds or man may occur, it must be exceedingly rare.
3. Mature individuals are unusually easy to spot once their berries turn red in late December.
Fox&Kitajima (2001, p.26) found that *Ardisia* plants flower in May, green fruit are generally present by early September, and most fruit do not “ripen to their mature red coloration until late December.” They did not study the relationship between fruit coloration and competence to germinate, but plants stripped of their green fruit prior to December will not be counted as potential contributors to the seedling cohort of the following year.
4. A 2% aqueous foliar spray of triclopyr kills *Ardisia* plants.
Erick Smith (2009 and 2010, personal communications) emailed that 2% Garlon 4 in water with Dye-Amic surfactant is effective against all stages of *Ardisia* and at all times of year; although in winter, plants may take 3 to 4 months to die.

Development of the eradication plan

In early February, 2010, when resources for *Ardisia* control became available, the initial plan was to study the possibility of *Ardisia* eradication in NATL-east by mechanical removal of root crowns and above ground parts of all berry-bearing plants. This plan quickly morphed into a plan to remove only the berries, mark the plant with a fluorescent pink flag, and kill it later with a foliar application of triclopyr. Berry removal in NATL-east was completed by mid February, and it was decided to extend the procedure to the rest of NATL. In NATL-west, areas that had been treated by Celis and Pieterse in 2009 proved to have much lower numbers of berry-

bearing plants than similar areas that they had failed to treat. At that point, the plan switched from a pilot study in NATL-east to an attempt to eradicate *Ardisia* in all of NATL. By Feb. 26, all of NATL-west's hammocks had been searched, 218 mature plants had been found, and their berries had been removed.

During the February 2010 search for berry-bearing *Ardisia*, plants were recorded and mapped on maps that showed the 50x50m blocks of NATL's grid system and, to make searching more systematic, each grid block was divided into four 25x25m "census blocks." The grid blocks were already permanently marked with 1-inch-dia PVC stakes. To delineate the census blocks, 3/4-inch-dia PVC stakes were installed at the census-block corners that were not grid-block corners. Some grid blocks were not a full 50x50m, which required ad hoc decisions as to divisions into census blocks. For convenience in finding and mapping *Ardisia* plants, maps of *Ardisia* census blocks were drafted (Appendix A), and, for convenience in reporting the results of the *Ardisia* eradication program, a map of *Ardisia* "reporting blocks" (each named after a NATL grid block) was drafted (see Appendix B).

For the remainder of 2010 and early 2011, the following procedures were planned:

- (1) In April, spray triclopyr on the flagged, de-berried plants and all other *Ardisia* plants that could be located.
- (2) In July, spray any surviving *Ardisia* that could be found.
- (3) In October, once more spray any surviving *Ardisia* that could be found and, in addition, remove the berries from any plant which has them.
- (4) In early January use as many volunteers as can be enlisted to search all of NATL for berry-bearing *Ardisia* plants, remove the berries from any such plants that are found, and flag and map the plants for future spraying.

The results of these procedures were to be evaluated early in 2011, and the four procedures continued unchanged unless previous results suggested that modifications would improve the chances of achieving and maintaining a count of zero *Ardisia* with mature berries in every reporting block.

Methods (subsequent to January 2011 census)

See Appendix G, H, I.

Results

February 2010

See Table. 1. In the portion of NATL-west where Celis and Pieteron removed 1297 adult plants, only 166 adult *Ardisia* were found. In portions of NATL where Celis and Pieteron did not remove plants, 150 were found--52 in NATL-west and 98 in NATL-east.

Rest of 2010

The April “find-and-spray” procedure went as planned. Robert Guggenheim found the 316 *Ardisia* locations flagged in February and sprayed every *Ardisia* he could find. Unflagged patches of *Ardisia* he found and sprayed, he marked and with a fluorescent pink flag.

In July, Robert began the second such procedure, but became unable to continue. A suitable replacement *Ardisia* find-and-spray person was not found and funded until mid October, 2010, when Ethan Carter was hired. By 24 November, Ethan had nearly completed for NATL-west what should have been done in July for all of NATL. In addition he removed berries from the 289 berry-bearing plants he found. Tom Walker and Lary Reeves did similar work in NATL-east, and in November found only 12 berry-bearing plants to strip of their fruit.

January 2011, NATL-west.

On 15 Jan 2011, 20 volunteers, directed by Lary Reeves, Tom Walker, and Dan Fitzpatrick, searched all of NATL-west for *Ardisia* plants with red berries, removed the berries, and marked the plants with fire-orange flags. About 30 of the 54 plants found were already flagged, showed herbicidal effects, and had relatively few berries. This was clear evidence that these 30 were among the 289 mature plants found and sprayed in Oct/Nov but that some of their green berries had been missed during the attempt to remove all.

January 2011, NATL-east.

On 14 and 18 Jan 2011, Lary Reeves and Tom Walker searched NATL-east for red-berried *Ardisia* and found 25. They removed the berries from these and flagged them for future spraying. More than half of the 25 had been found the previous November but imperfectly stripped of their berries. On 24 January, Ethan Carter found and sprayed these 25 plus 2 new ones.

Feb 2011

Summary map prepared to show the results of the eradication project through January 2011 (Fig. 2 on page 6.)

2 May 2011

Ethan Carter completes spring spraying of all the living coral ardisia he can find and removes the pink flags from sites where ardisia no longer can be found.

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March 2012	2	3	0	5	94%	>99%

^a During January to August 2009, in NATL-west, Gerardo Celis and Corrie Pieterse (2009) removed 1297 “adult” *Ardisia* (those more than 20cm in height). For areas where they worked, the numbers removed are here considered to estimate the number of red-berried plants on 1 Jan 2009. In any case, the 1297 plants removed would otherwise have been of major consequence to the February 2010 census.

^b Celis and Pieterse (2009) did not census or remove adult *Ardisia* in a few areas of hammock in NATL-west’s restricted area. These areas yielded 49 of the 122 red-berried *Ardisia* found in the restricted area in February 2010.

^c If <24 of 100 plants survived the first year, a 74% decline in those plants would mean that <6 would survive into 2011.

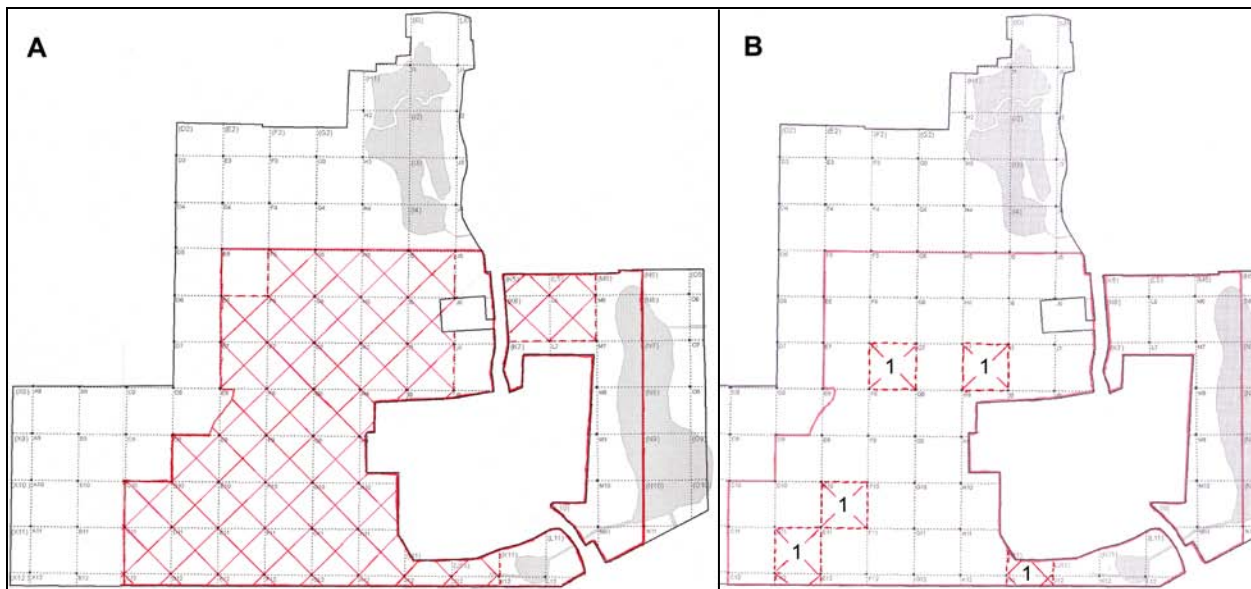


Fig. 1. Maps showing NATL’s 50x50m grid system. Areas monitored for *Ardisia* are within a solid blue line. The monitored areas were divided into 57 “*Ardisia* reporting blocks,” most of which corresponded to 50x50m grid blocks. In both A and B, Infested blocks are marked with a red X. A. In Feb. 2010, 41 of these blocks were known to have one or more mature Coral *Ardisia*. In both divisions of NATL, these infested blocks were contiguous. B. By March 2012, mature *Ardisia* could be found in only five reporting blocks and each had only one berry-bearing plant.

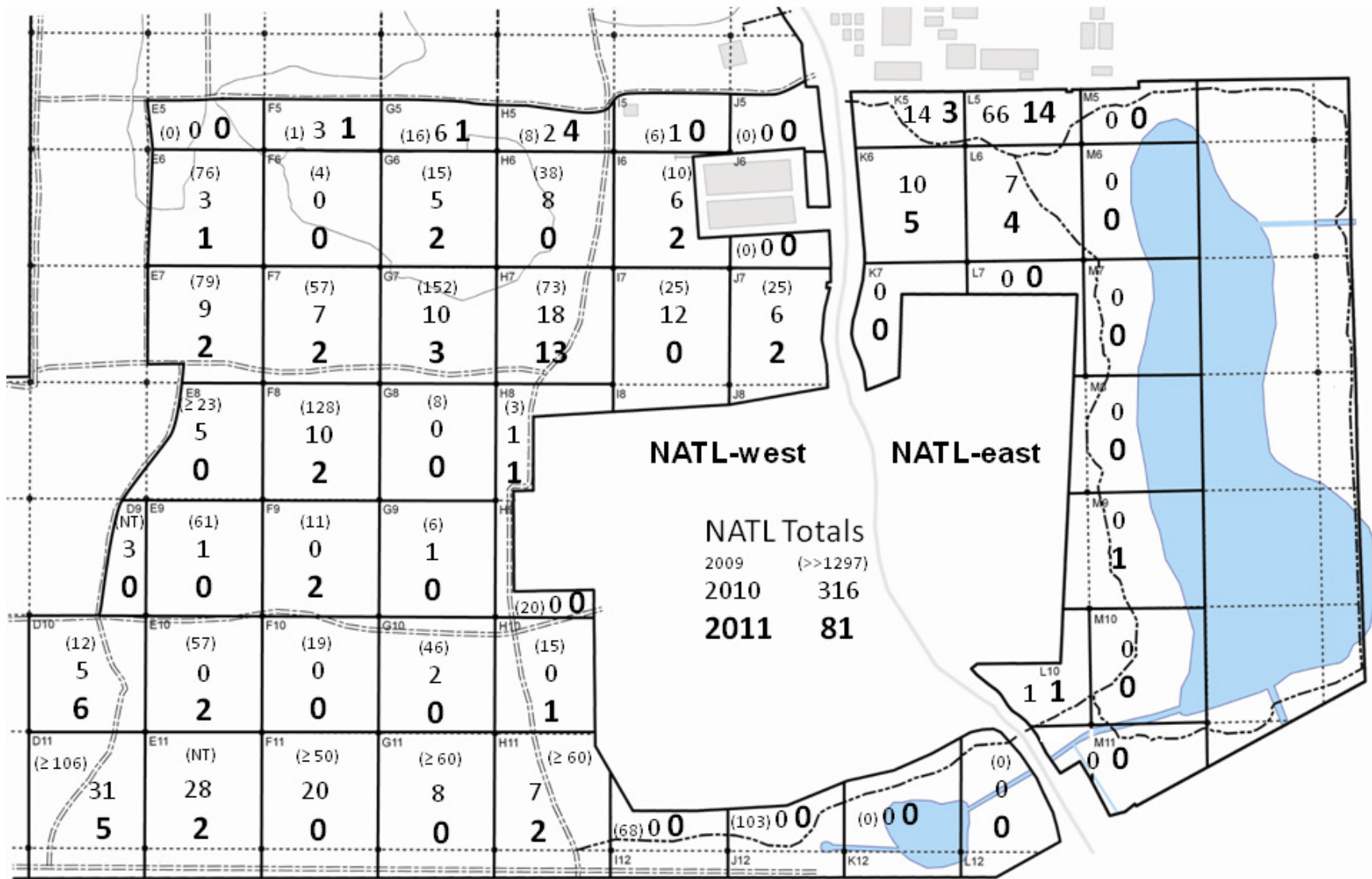
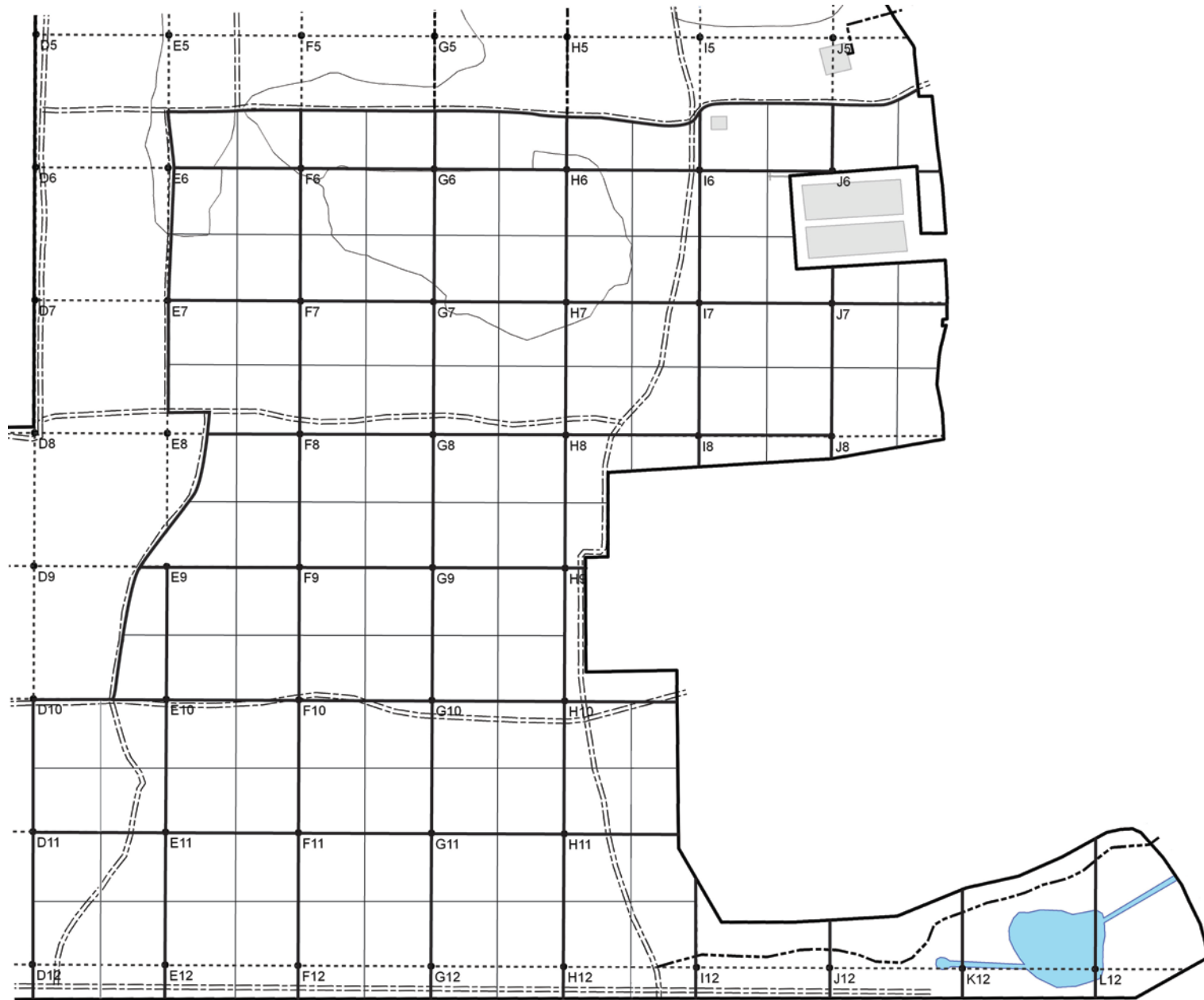
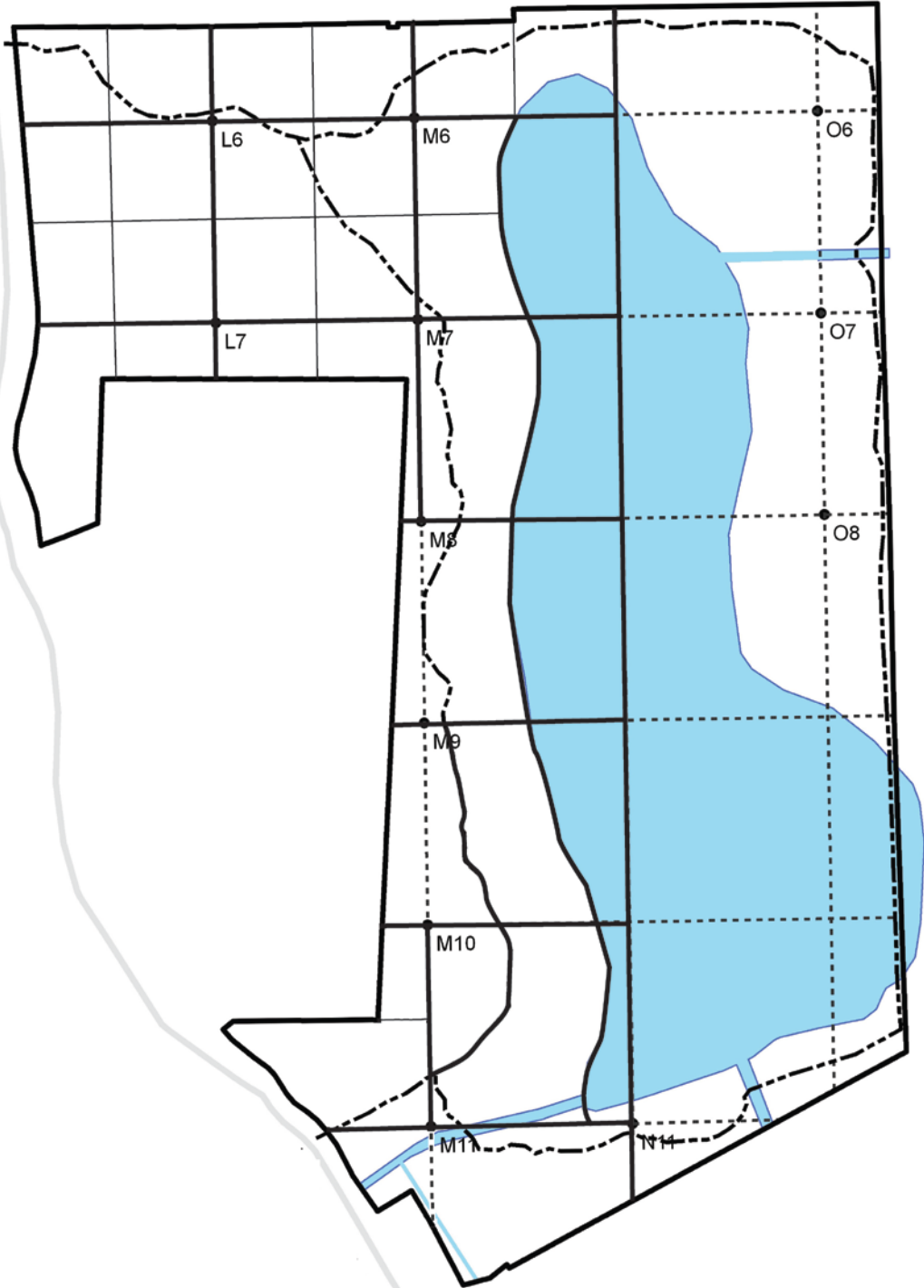


Fig. 2. *Ardisia* eradication results through January 2011. For each reporting block in NATL-west, the number in parentheses is the number of mature plants removed in January to August, 2009; the middle number is the number of berry-bearing plants removed or de-berried in February 2010; the final, bold-faced number is the number of berry-bearing plants found and de-berried in January 2011. In NATL-east, the first data taken were in February 2010. NT=not treated.

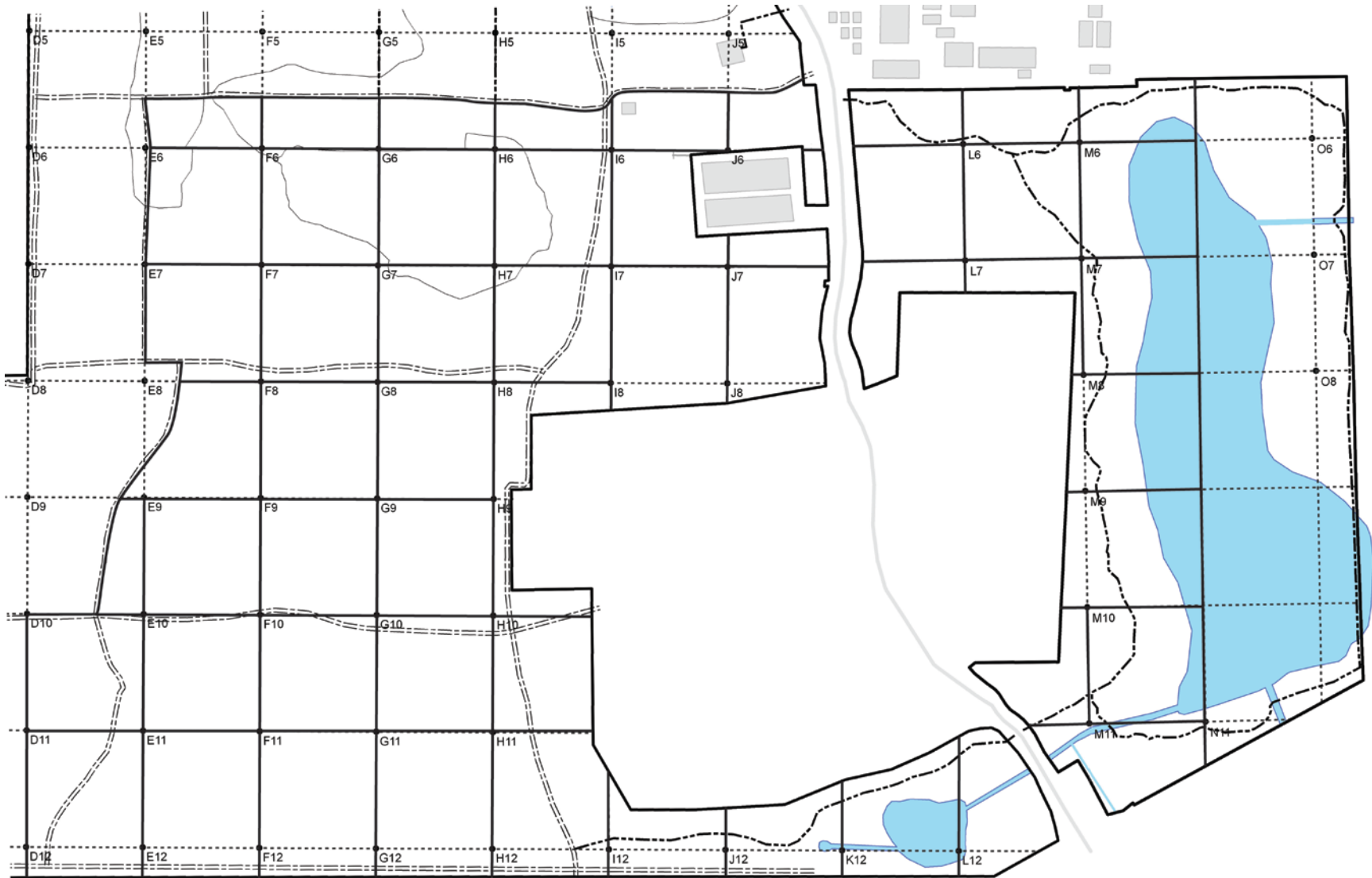
Appendix A: *Ardisia* census-block map for NATL-west.



Appendix A (continued): *Ardisia* census-block map for NATL-east.



Appendix B: *Ardisia* reporting-block map for NATL.



Appendix C: Unanswered questions of potential importance to success of the plan

1. Are there circumstances in which a foliar application of Erick's mixture fails to kill the *Ardisia* plant?

Erick's mixture, when made in a Solo sprayer is 3.5 gal water to which have been added 9oz Garlon4 or Element4 and 2tbsp Dyne-Amic surfactant.

An off-site pilot study in the winter of 2009-10 indicated that the death of mature *Ardisia* plants sprayed with this mixture took several months but approached 100%. Mortality of mature plants sprayed in NATL during late fall and winter of 2010-11 has been less certain or slower (or both), and four samples of 10 plants each that were sprayed on different dates are now being monitored.

2. How quickly do newly germinated *Ardisia* seedlings in NATL grow large enough to produce berries?

Fox&Kitajima (2001, p.15) found that *Ardisia* seedlings grown in greenhouses could reach 20cm in height and produce fruit within 2 or 3 years of germination. On the other hand, they estimated that in their natural habitat seedlings might require 10 years to reach the size of first fruit production (20cm tall).

Appendix D: Earlier control efforts

In 2000 and 2001, Alison M. Fox and Kaoru Kitajima studied *Ardisia* in the Gainesville area. These studies, funded by the Florida Department of Environmental Protection, included detailed mapping of the *Ardisia* plants in a heavily infested area in NATL-west, south of Main Trail and between gridlines E and I. In the 100x325m area between gridlines E and G, they mapped all *Ardisia* plants once and in the similar-sized area between gridlines G and I they mapped the plants at least twice. Over the entire area they removed many plants, including, at minimum, all those ≥ 20 cm at least once. (Links to their 2001 final report are at <http://natl.ifas.ufl.edu/invasiveCtrl.htm>.)

In 2008, as recorded in a spreadsheet at <http://natl.ifas.ufl.edu/invasiveCtrl.htm#spreadsheets>, NATL Teaching Assistants and volunteers attempted to mechanically remove all mature plants and seedlings of *Ardisia* from substantial blocks of NATL, including the areas previously treated by Fox and Kitajima and all of NATL-east.

Appendix E: Methods (thus far)

February 2010

Between 3 and 24 Feb 2010, Robert Guggenheim, Adam Casavant, and Tom Walker systematically searched NATL for berry-bearing *Ardisia* and either mechanically removed the plants or stripped them of their berries. To facilitate further treatments they marked the locations with yellow or fluorescent-pink flags and recorded the number of locations at the level of 25x25m blocks.

Initially, the root crowns and berries of berry-bearing plants were removed and each removal site was marked with a pink flag. When time became short, only the berries were removed and the site was marked with a yellow flag.

April 2010

Using the grid maps and aided by the pink and yellow flags, locate and spray *Ardisia* plants of all sizes. Mark all previously marked berry-bearing sites with a tall pink flag. Mark with a short pink flag other infested sites that are sprayed. .

July 2010

Robert Guggenheim began the process of checking all flagged locations for *Ardisia* (of any size) and of flagging any new *Ardisia* sites that he discovered. He sprayed all *Ardisia* that he found and recorded flagged locations that no longer had *Ardisia* (but did not remove the flags). When he had checked nearly all of the public area and the northwest corner of the restricted area, he developed a knee problem that required him to discontinue his *Ardisia* work.

Fall 2010

In October 2010, Ethan Carter was hired to do resume and complete the summer/fall search and spray effort. His instructions are Appendices F, G, and H of this report.

Appendix F: Protocol for treating *Ardisia* in NATL, Oct & Nov 2010

1. Make walkable all gridlines relevant to assigned block(s) [gridlines are the straight N-S and E-W paths established by grid stakes]. [Have flags in a backpack to temporarily mark any *Ardisia* you notice as you work?]
2. Insure that a pink-flagged PVC stake marks the midpoint along each 50 m gridline segment between grid stakes (i.e., pace off or measure 25 meters from either grid stake and set a new stake or verify that an earlier one is still there). [Use 40-inch pieces of 3/4-inch-dia PVC for these stakes.]
3. Where needed to define census blocks, set a 40" pink-flagged stake at the center of each 50x50 m grid block—that is, where N-S and E-W lines that connect opposite midpoint stakes cross at the center of the grid block.]
4. Find all *Ardisia* plants in each census block. Spray each with Erick's mix and mark each plant or small patch of plants with a pink-flag. For plants with berries (hopefully green) add a yellow flag to the pink one. Remove all berries from berry-bearing plants.
5. On a master map of *Ardisia* census blocks indicate the location of each berry-bearing plant sprayed and flagged with a dot surrounded by a circle: ⊙.
6. On the same master map of *Ardisia* census blocks indicate in each census block the number of patches of berry-bearing plants sprayed and the number of new flags placed for non-berry-bearing plants. [Counting pink flags on hand before starting and after finishing each census block will be the easiest means of determining the total number of pink flags used. [Total pink flags used – no. of berry bearing plants = no. of patches of non-berry bearing plants flagged.]
7. Census block C11 proved to be a special case because it had not been treated or censused in 2009 and had been wrongly reported as having no *Ardisia* in 2010. Thus C11 formed an unintended control for the eradication efforts of the those two years and a chance to see how quickly *Ardisia* could have been eradicated had the program been started in fall 2010. On Nov. 8 and 10, n green-berry-bearing plants were found,

sprayed after the berries had been removed, and marked with a pink flag (but no yellow). Patches of plants without berries were sprayed but not flagged.]

Appendix G: Protocol for follow-up of Ardisia volunteer event of Jan. 15

1. Using the report sheets provided, find plants mapped by volunteers and marked with fire-orange flags.
2. For each plant found--
 - a. Remove any berries that were missed by volunteers.
 - b. Note whether the plant appears to have been affected by spraying . If not, to aid locating it for spraying, map its position on a fresh report sheet.
3. While locating volunteer-mapped plants, keep an eye out for red-berried plants that the volunteers missed. For each such plant found—
 - a. Mark with a tall fire-orange flag and a short yellow flag.
 - b. Remove the berries and bag them.
 - c. To aid locating the plant for spraying, record its position on the fresh report-sheet.
4. On next work day spray with Erick's mix all plants that were mapped on the fresh report sheet. Use a Sharpie to write date of spraying on orange flag (11B=last ½ of Jan; 11C=first ½ of Feb, 11D=last ½ of Feb, etc.).

Appendix H: Protocol for April 2011

- 0 Using the map and report sheets provided, find the 40 plants checked for herbicidal effects on 21 Jan 2011.
 - a. On the report sheet indicate for each plant whether it is 100% dead or has surviving parts.
 - b. Spray Erick's mix on any of the 40 plants that have surviving parts.
1. In each reporting block entered for 0. above--
 - a. Spray Erick's mix on all living Ardisia found by systematic searching of the census blocks.
 - b. For areas that are flagged but have no living Ardisia remove the flags.
 - c. For patches that are sprayed but are not already flagged, plant a tall pink flag.
2. Starting in the south, systematically search for Ardisia in each census block of each remaining reporting block and take the three actions listed for #1 above.

Appendix I: Protocol for October 2011

1. Go to assigned census blocks and make their boundaries and limits well-marked and walkable. Each census block should have a pink-flagged, white PVC stake at each corner. When there are four census blocks in a 50x50m NATL Gridblock, each of those census blocks should have a 1-inch-dia, NATL Gridstake (has, at top, a green-band with a code letter and number and marks the intersection of the Gridlines that delineate NATL Gridblocks) at one corner and smaller diameter stakes at the other three corners. You should label, with a Sharpie pen, stakes that mark census block corners and are on NATL Gridlines but are not NATL Gridstakes either "NS" (for north-south) or "EW" (for east-west) to indicate whether they are on a north-south Gridline or an east-west one. The stake that is in the center of the Gridblock and marks the corners of four census blocks should be labeled "CTR" (center of Gridblock). At top, all Gridblock stakes should have a fresh pink ribbon and, at bottom, a fire-orange ribbon.

[This will enable the volunteers in January to keep better track of where they are as they search for red-berried *Ardisia* plants.]

2. As you work to renew the census blocks, have pink flags with coded dates available (in a back pack) to mark any unmarked live *Ardisia* you notice.

3. Find all *Ardisia* plants in each census block. Be sure to look carefully in vicinity of any pink flag that was left after the April 2011 inspection and spraying. Spray each living *Ardisia* plant or small patch found with Erick's mix and mark the site with a tall pink-flag that has had the half-month of spraying written on it with a Sharpie using this system: 11R=first ½ of Oct; 11S=last ½ Oct; 11T=first ½ of Nov; etc.

4. If a sprayed site already had a pink flag, remove it when you plant the dated flag. Do not remove any pink flags that are marking where you could find no living plants unless such flags are more than needed to keep volunteers interested in looking for *Ardisia*. If plants you spray have berries do not remove them, because the census blocks will be visited again in late November or early December to determine the effects of spraying, and, if deemed necessary, the berries can be removed then.

4. On a master map of *Ardisia* census blocks, for each assigned block, indicate the number of sites sprayed (and left with dated tall pink flags) followed by the number of sites that had no living *Ardisia* but were left with undated tall pink flags. Examples: 0-0, 0-2, 2-0, 2-2. [No need to do any mapping, because volunteers will know how many pink flags to look for in each census block.] [This would not prevent you from using circled dots and dots on your map indicating the approximate positions of all sprayed and not-sprayed sites.]