Target-Specific Fire Ant Suppression for Preservation of Native Species and Non-Target Organisms such as the Horned Lizard

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The red imported fire ant, *Solenopsis invicta* Buren, has spread through the southeastern United States during the past 80 years, since its accidental introduction into Mobile, Alabama. Because *Solenopsis invicta* was introduced without its natural enemies, and is an aggressive predatory species, it has wrecked havoc with indigenous populations ranging from small invertebrates to man (Porter et al. 1997). This invasion has decimated the indigenous ant fauna primarily by competitive replacement (Porter and Savignano 1990). This then allowed *S. invicta* populations to continue to expand to the point where it is commonly found at levels of higher than 100 mounds per acre, and has been recorded at over 1,000 mounds per acre (Jerry Cook unpublished data). This high density of fire ants is capable of damaging the biodiversity of many ecosystems (Porter and Savignano 1990).

One apparent casualty of the *S. invicta* invasion appears to be the Texas Horned Lizard, *Phrynosoma cornutum*, which is now listed as a threatened species in Texas and Oklahoma. *Phrynosoma cornutum* relies almost exclusively on a diet of harvester ants from the genus *Pogonomyrmex* (Blackshear and Richerson 1999). The harvester ants are being directly impacted by *S. invicta*, along with many other ant species (Porter and Savignano 1990, Mann 1994, Pennisi 2000). There may also be some direct effect on the Texas horned lizard by *S. invicta*, since ingestion of fire ants is toxic to many species due to its alkaloid poisons (Contreras and Labay 1999). However, it is uncertain if *P. cornutum* will feed upon *S. invicta*. The effect of *S. invicta* on *Pogonomyrmex* harvester ants and the Texas horned lizard is just one example of a much greater problem that the red imported fire ant is causing for ecosystems throughout the southeastern United States.

In October 1998 a program sponsored by the Texas Army National Guard was started to determine how to best eliminate fire ants from training facilities (specifically Camp Swift, Camp Bowie, Camp Maxey, and Ft. Wolters) and not further harm the natural ecosystem. The challenge of this project was to eliminate *S. invicta* while not harming native species, including closely related native ants. The common practice of using broadcast baits for fire ant treatment is unsuitable for this type of project because native ants will also feed on these toxic baits and, by eliminating *S. invicta*, native ants could also be removed. A broadcast bait program may not only eliminates native ants that are important to the ecosystem (Folgarait 1998), but this in turn can remove the only real competitors of *S. invicta*. After the elimination of ant competitors, new *S. invicta* colonies usually move back into the empty niche and are then able to exist at much higher population levels than before the chemical treatment. The other drawback to this chemical treatment regime is that it can be expensive and put toxic chemicals into the environment. Therefore, the Texas Army National Guard program had as a goal to find a way to manage *S. invicta* without eliminating other native species. To evaluate the results of the program, *Pogonomyrmex* species populations were monitored.

The concept of this program was to find a technique to use commercially available ant baits and to apply them in a way that would not impact other species. In turn, if this program were a success, it would conserve populations of Texas horned lizards, harvester ants, and other native species. In the first year of this program, a prescription treatment method was identified that

appeared to effectively manage fire ants while not impacting native ants.

This program continued in the Army National Guard fiscal year 2000 with the goal of evaluating the program developed in the previous year and to attempt to conserve harvester ant and Texas horned lizard populations. The four sites being utilized for this program all had harvester ant populations at the start of the study. The harvester ant species found at all of these sites was *Pogonomyrmex barbatus* (F. Smith) and Camp Swift had an additional species, *Pogonomyrmex comanche* Wheeler.

Pogonomyrmex comanche is becoming a rare species and may be more in danger of extinction than even *P. cornutum* (Jerry Cook unpublished data). This ant species was historically found in several sandy regions of central Texas and Oklahoma (Cole 1968, Taber 1998). It has now been eliminated from most of these historical regions and has only been positively identified at two current locations, Lost Pines State Park (near Bastrop, Texas) and Camp Swift. Presumably, the reasons for its decline are habitat loss and, direct competition and predation by *S. invicta*. The status of *P. comanche* was unknown before this project. *Pogonomyrmex barbatus* is also being impacted by the same pressures as *P. comanche*, but it also occurs outside the invasion area of *S. invicta* and has a much larger range. Thus, it is not presently threatened, but its populations are declining, as are most ants in the area invaded by *S. invicta*.

Materials and Methods

Sites for experimental and control plots were selected at Camp Swift, Fort Wolters, and Camp Bowie. Plots were not selected at Camp Maxey because no harvester ants were found. Each plot contained fire ant mounds and native ants including mounds of harvester ants, *Pogonomyrmex* sp. (in all cases the harvester ant species was *P. barbatus*, but at Camp Swift a site was selected that also included *P. comanche*). Treatment and control plots were comparable in habitat type and relative ant density. The plots were separated by at least 100 feet to provide a buffer zone between treatment and control. The plot size was at least ½ acre and was marked with stakes that remained throughout the test. At each National Guard site, there was a treatment plot and a non-treatment (control) plot.

Prior to any treatments a survey was conducted to establish ant populations. For this survey, pitfall traps and bait traps were used. Nine evenly spaced pitfall traps were used in each plot. These traps consisted of tubes submerged in the soil, so that their opening is at ground level. The tubes were partially filled with a propylene glycol solution that is safe to vertebrates that might get into the traps. The propylene glycol acted as a killing agent and preservative for invertebrates, and will not quickly evaporate. Control and test sites had pit-fall traps utilized for the same period of time. Traps were collected, taken to the laboratory and all ants were identified, counted and recorded. Bait traps consisted of putting a test tube baited with meat (Vienna sausage) onto the ground. Nine of these traps were evenly spaced and put in each of the test plots for about 45 minutes. The vials were capped, taken to the laboratory, frozen, and the ants were then identified, counted and recorded.

Prior to treatments all fire ant mounds within the plot were located and flagged. Mounds were counted and recorded. The *S. invicta* mounds in the treatment plots were then individually treated by sprinkling 1 to 5 tablespoons of bait product around the mound, depending on mound size. Treatments were made using Amdro® (hydramethylnon), a slow acting stomach poison.

Re-treatments were made at a later date to any existing fire ant mounds within the treatment plot. Control plots had mounds identified, counted and recorded.

Surveys were made approximately 3 months later in the same manner as the pre-survey. This time frame is such that control of fire ant should be achieved, if control occurs. The results were compared with the pre-survey populations. A more meaningful comparison will be made one year after treatment, in fall 2000. This survey will be at the same time, seasonally, as the initial survey and will be a more accurate comparison to pre-treatment conditions. However, this will occur in the next year cycle and the earlier analysis was used to complete the final report for this funding year. To get an accurate assessment of this program, it will have to run for more than one year to allow ant populations to adjust to changed conditions, such as relatively fire ant free areas of the treatment plots. Plots will continue to be treated and monitored after the initial survey to allow for this continuance. Any decrease in a native ant species will be evaluated and determined if it is a probable result of the treatment method.

Results

Camp Maxey. At the beginning of this project in 1998 there were only a small number of harvester ants, *Pogonomyrmex barbatus*, present at Camp Maxey (1999 final project report). All of these harvester ants were in regions associated with firing ranges where a program has now been going for the past two years to control fire ants using broadcast bait applications. In the process of these treatments all *P. barbatus* have been eliminated. This year, I extensively surveyed Camp Maxey for additional harvester ants, but none were located.

Camp Swift. Camp Swift has the unique distinction among Texas Army National Guard training facilities of having two harvester ants, *Pogonomyrmex comanche* and *P. barbatus*. These ants are living sympatricly at one site, which was used as the test site for this program. This site is located at N 30° 16.786', W 97° 19.133'. Another population of *P. comanche* is located at N 30° 17.087', W 97° 18.571'. These two sites are 1.06 Km apart, but there are no other harvester ants in between. Because reproductive flights are usually less than this distance, these two populations are most likely isolated. There are several other areas that have *P. barbatus* in small colonies within Camp Swift, including sites near the headquarters building. A treatment for fire ants was made on April 20. There were only 8 *S. invicta* mounds found within the treatment plot. This is a decrease from 35 mounds in spring, 1999 and 22 mounds in fall, 1999. Previous treatments were made after the fall 1999 mound counts. The control site went from 33 *S. invicta* mounds in spring, 1999 to 38 mounds in spring 2000. Only 18 *S. invicta* mounds were observed in fall 2000, but the area was still in a severe drought, and many mounds may have been missed. All harvester ants are now gone from the control site (originally there were 6 *P. comanche* and 4 *P. barbatus* mounds). Harvester ants present in the treatment plot started in spring, 1999 at 12 colonies of *P. comanche* and 4 colonies of *P. barbatus*. By fall, 2000 these numbers had changed to 11 colonies of *P. comanche* and 2 colonies of *P. barbatus*. Mating flights of *P. comanche* were witnessed on June 15 at Camp Swift, but it is too early to know if any new colonies have been successfully started. It is usually the next spring before the incipient colony is large enough to be easily noticed. The first few months of a colony consist of the newly mated queen tending the first batch of brood using reserves from degenerating flight muscles as a nutrition source. There is no

foraging until this first brood becomes adults around three months later. These results of mound counts in these plots are given as part of **Table 5** and **Table 6**.

Pitfall traps collected more species than bait traps. When fire ants were present, they tended to exclude other ants from the bait traps, so bait traps can be utilized best to evaluate relative numbers of fire ants present. Pitfall traps give a better picture of the diversity, because they are a more random collecting method, collecting anything that falls into them. Results at Camp Swift are given in **Table 1**. The spring collection was a time when ants were very active and probably represents a more realistic picture of the ant diversity. The fall samples were collected after a severe drought and record temperature period had occurred, probably yielding unrealistically low levels of ant activity.

Table 1. Ant totals collected in traps at the treatment and control sites at Camp Swift. The numbers provided are totals from 9 pitfall traps and 9 bait traps. Note that conditions were very dry in the fall 2000 collection and comparisons are not realistic between spring and fall.

Species	Spring pitfall Treat	Spring pitfall Control	Fall pitfall Treat	Fall pitfall Control	Spring bait Treat	Spring bait Control	Fall bait Treat	Fall bait Control
Solenopsis invicta	96	832	0	74	412	1658	0	0
Pogonomyrmexbarbatus	42	0	29	0	0	0	0	0
Pogonomyrmex comanche	37	0	41	0	0	0	0	0
Dorymyrmex flavopectus	68	12	40	0	64	0	24	0
Monomorium minimum	67	51	4	0	0	0	0	0
Linepithema pruinosus	42	0	18	9	0	0	0	0
Paratrechina vividula	30	0	0	0	0	0	0	0
Labidus coecus	12	0	0	0	0	0	0	0
Atta texana	18	0	0	0	0	0	0	0
Solenopsis krockowi	4	0	0	0	0	0.	0	

Camp Bowie. Camp Bowie has many *Pogonomyrmex barbatus* sites throughout the base and *P. cornutum* sightings are rare, but not unusual. There was no effort made to evaluate numbers of *P. cornutum*, but personnel at the base reported sightings. Camp Bowie is unique among the four facilities used for these tests because fire ants are not prevalent throughout the base. In fact, fire ants were found in only three regions, around the headquarters, buildings and firing ranges; around a pond and wooded area centered at N 31°38.494', W 98° 56.299'; and one *S. invicta* mound was sited at on open field, N31° 38.596', W 98° 56.438'. The rest of the base had no *S. invicta* activity observed. The second site (around the pond) had no native ants observed.

Pogonomyrmex barbatus colonies were surveyed at several sites in May 2000. The site at N31° 38.596', W 98° 56.438' had about 3 colonies per hectare of *P. barbatus* and many mounds of *Linepithema* sp. and *Forelius* sp. The site on the firing range had numerous harvester ants and will be reported upon below, as it was the test site for this program. A site at N 31° 36.895', W 98° 55.472' had about 10 colonies of *P. barbatus* per hectare and several other native ant mounds, but no *S. invicta* mounds. This concentration of *P. barbatus* is quite high for a harvester ant with large colonies. Harvester ants were also observed at several other areas throughout the base.

Harvester ant populations at the treatment site have remained stable throughout the test. In fall 1998, there were 3 *P. barbatus* colonies within the treatment site and those colonies have remained throughout the test. The control site had one *P. barbatus* colony, which is also still present in 2000. *Solenopsis invicta* colonies fluctuated as reported in **Table 6**.

The survey of ant species at Camp Bowie is given in **Table 2**. The site used for this project has had relatively high densities of fire ants for many years (Jim Hillegus personal communication). This site did not have a large biodiversity of ant species collected in the traps.

Table 2. Ant totals collected in traps at the treatment and control sites at Camp Bowie. The numbers provided are totals from 9 pitfall traps and 9 bait traps. Note that conditions were very dry in the fall 2000 collection and comparisons are not realistic between spring and fall.

Species	Spring pitfall Treat	Spring pitfall Control	Fall pitfall Treat	Fall pitfall Control	Spring bait Treat	Spring bait Control	Fall bait Treat	Fall bait Control
Solenopsis invicta	1121	851	78	132	1621	2117	23	44
Pogonomyrmex barbatus	16	8	11	31	0	0	0	0
Dorymyrmex flavopectus	38	18	44	31	52	0	27	0
Monomorium minimum	6	24	0	0	0	0	0	0
Linepithema pruinosus	16	2	6	0	0	0	0	0

Ft. Wolters. Harvester ants at Ft. Wolters are all *Pogonomyrmex barbatus* and are found in densities less than occur at Camp Bowie or Camp Swift. Throughout the base the highest *P. barbatus* densities were about 5 per hectare (which is still considered a high density for this species). *Pogonomyrmex barbatus* was found in five distinct regions of Ft. Wolters. One of the locations does not have a recorded GPS location, but was found near the firing ranges. Other locations of *P. barbatus* were N 32° 50.964', W 98° 02.525' (2 colonies or *P. barbatus* and about 20 colonies of *S. invicta* per hectare; N 32° 51.019', W 98° 02.652' (1 colony of *P. barbatus* and about 40 colonies of *S. invicta* per hectare); N 32° 52.122'm W 98° 02.479' (5 colonies of *P. barbatus* and about 10 colonies of *S. invicta* per hectare; and N 32° 51.405', W 98° 01.874' (1 colony of *P. barbatus* and about 40 colonies of *S. invicta* per hectare). These numbers will support *P. cornutum* populations and there have been several sightings at Ft. Wolters (Sgt. York personal communication).

The bait test at Ft. Wolters showed a decrease in fire ant colonies from 54 colonies to 12 colonies in the first year of the project. In spring 2000, *S. invicta* colonies had increased to 26 colonies and again reduced to 6 in late summer 2000 (however this last figure may be an underestimate due to extreme weather conditions). The control site ranged around 40 colonies, except for the final summer survey of 14 mounds. The number of *P. barbatus* colonies in the treatment plot has remained at two throughout the test. In the control plot, *P. barbatus* started with one colony, which was lost in the summer of 2000. Results of the prescription bait treatment program are given in **Tables 5** and **6.** Ant surveys collected at baits and in pitfall traps are shown in **Table 3.**

Overall summary

The prescription bait treatment program has the cumulative results listed in **Table 4.** These results are provided to survey the effectiveness of the protocol. *Solenopsis invicta* was reduced by prescription treatments by an average of 92 percent from spring, 1999 to fall, 2000; although this result may partially be a result of weather. A more accurate approximation of the reduction would be somewhere between a 58 and 92 percent reduction. In these same treatment plots about 6 percent of the harvester ant mounds were lost. In untreated control plots fire ant levels changed in concentration somewhere between declining by 58% to increasing by 9 percent. In control plots, about 67 percent (an average of the sites) of harvester ant colonies were lost when insecticide treatment was not provided. Since many more harvester ants were found at one site (Camp Swift) in control plots the actual percent lost was about 88 percent of all *Pogonomyrmex* species in the non-treated plots.

Table 3. Ant totals collected in traps at the treatment and control sites at Ft. Wolters.

Species	Spring pitfall Treat	Spring pitfall Control	Fall pitfall Treat	Fall pitfall Control	Spring bait Treat	Spring bait Control	Fall bait Treat	Fall bait Control
Solenopsis invicta	222	673	19	81	489	1264	26	60
Pogonomyrmex barbatus	18	2	32	0	0	0	0	0
Brachymyrmex depilis	8	0	0	0	0	0	0	0
Dorymyrmex flavopectus	16	31	28	6	12	0	58	0
Monomorium minimum	16	8	0	0				
Linepithema pruinosus	0	4	22	0	0	0	0	0
Forelius mccooki	4	0	13	0	0	0	0	0
Prenolepis imparis	5	0	0	0	0	0	0	0
Hypoponera sp.	1	0	0	0	0	0	0	0
Pheidole dentata	16	0	0	0	0	0	0	0
Solenopsis molesta	0	0	3	0	0	0	0	0

Table 4. Percent change in mound densities between treatment and untreated control plots. *Solenopsis invicta* and combined *Pogonomyrmex* species were evaluated from spring 1999 to fall, 2000. Results for *S. invicta* may be skewed downward because of dry conditions making it difficult to identify mounds. Therefore, columns with "*" are determined from spring 1999 to spring 2000, just prior to the spring treatment. Results for the *Pogonomyrmex* sp. should be accurate because even in the extreme weather conditions, these ants were active and colonies could be accurately identified.

Location	% change *S. invicta* treatment	% change *S. invicta* control	% change *S. invicta* treatment*	% change *S. invicta* control*	% change *Pogo.* sp. treatment	% change *Pogo.* sp. control
Swift	-100	-45	-45	+15	-19	-100
Bowie	-88	-69	-58	-10	0	0
Wolters	-89	-61	-70	+22	0	-100
Average	-92	-58	-58	+9	-6	-67

Table 5. Number of harvester ants in plots at three Texas National Guard facilities. Camp Swift results include both *Pogonomyrmex barbatus* and *P. comanche*. Camp Maxey is not included because there are no remaining harvester ants.

Site	Treatment	Spring 1999	Fall 1999	Spring 2000	Fall 2000
Swift	Treated	16	14	13	13
Swift	Control	6	4	1	0
Bowie	Treated	3	3	3	3
Bowie	Control	1	1	1	1
Wolters	Treated	2	2	2	2
Wolters	Control	1	1	1	0

Table 6.Number of *Solenopsis invicta* mounds in plots at three Texas National Guard facilities. Camp Maxey is not included because there are no remaining harvester ants for continuation of the project.

Site	Treatment	Spring 1999	Fall 1999	Spring 2000	Fall 2000*
Swift	Treated	35	22	8	0
Swift	Control	33	37	38	18
Bowie	Treated	66	51	28	8
Bowie	Control	71	67	64	22
Wolters	Treated	54	12	26	6
Wolters	Control	36	39	44	14

* Fall 2000 results were collected in September, when it was still extremely dry, making it possible that *S. invicta* mounds may have been missed.

Discussion

Some of the results for 2000 are rather misleading because of the severe drought and high temperatures of late summer and early fall. It is unfortunate that the timing of this report was such that it is hard to make sense of the fire ant numbers. However, it is clear that there has been a decline in *S. invicta* numbers from spring 1999 to fall 1999, and even though there was naturally some rebound in colony number before the spring 2000 treatment, these numbers were lower than spring 1999. Actual numbers of *S. invicta* colonies will likely be even much different between treatment and untreated control sites, when the weather conditions make it easier to count colonies. The observed fall 2000 numbers are almost certainly more than are reported, but mounds were simply not apparent on the surface. This is also demonstrated in the numbers of *S. invicta* colonies appearing to reduce by over 50 percent in the untreated control colonies. In reality, these numbers are probably very close to the spring mound counts

The results that are encouraging are those of harvester ant conservation. There has been a loss of three *Pogonomyrmex* barbatus colonies at Camp Swift during the treatment time, but 94 percent of all *Pogonomyrmex* colonies have been conserved. This loss may be a natural fluctuation, or it could be a result of the remaining fire ants within the plot. However, mating flights were observed this year and if any of these were successful, they should be apparent by later this fall, or certainly by spring 2001. If some of these are able to establish it may be because predation and competition by fire ants are becoming less in the treatment plots.

One outcome of this project that has already been demonstrated is that broadcast bait treatments are detrimental to harvester ants, and probably to other native ants also. At Camp Maxey, the only harvester ants were associated with disturbed areas on the firing ranges. These areas were part of another program to treat fire ants along these ranges using less labor intensive broadcast baiting. The harvester ants at these areas were eliminated, along with many fire ants. However, the results are that fire ants return (although at lower numbers if the bait application is regularly applied), but harvester ants do not. Other native ant species are probably not found in these treatment areas after the two years of broadcast baitings. The result is that these treatments must be continued or fire ants will soon be found in numbers even larger than before the start of the program because there is no longer competition from other ant species.

Surveys of other ants in both the prescription bait treatment plots and their associated control plots do not really mean much at this time. They do show that the treatment program does not appear to be affecting large numbers of native ants, but even this is hard to say at this time. These results were gathered to provide a good starting point for the evaluation of this program in regards to affects of the entire ant population. Because the fall results were skewed by weather conditions, comparisons are really meaningless. The biodiversity in these small plots is ample for good evaluations of this treatment program and its effects on native ants and will provide numbers needed for a good statistical analysis in next years program.

National Guard management policies do not have to be changed to maintain the work on this project and preservation of harvester ants and horned lizards. Harvester ants and horned lizards prefer disturbed habitats. Training exercises should not greatly affect the maintenance of these populations. However, other native species may be more adversely affected. Thus far, there is little information on the effects on other native ant species, but this information may be forthcoming in next years project. An important concern is the use of pesticides in these areas. Many native ants, such as harvester ants, are much more susceptible to insecticides than the red

imported fire ant. Treatment strategies other than prescription bait treatments will almost certainly impact harvester ants and in turn, impact populations of the Texas horned lizard. As stated earlier, elimination of all ant species in an area makes it easier for re-establishment by red imported fire ants. To maintain native ants, the only insecticide use should be such that it is limited to the target population.

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