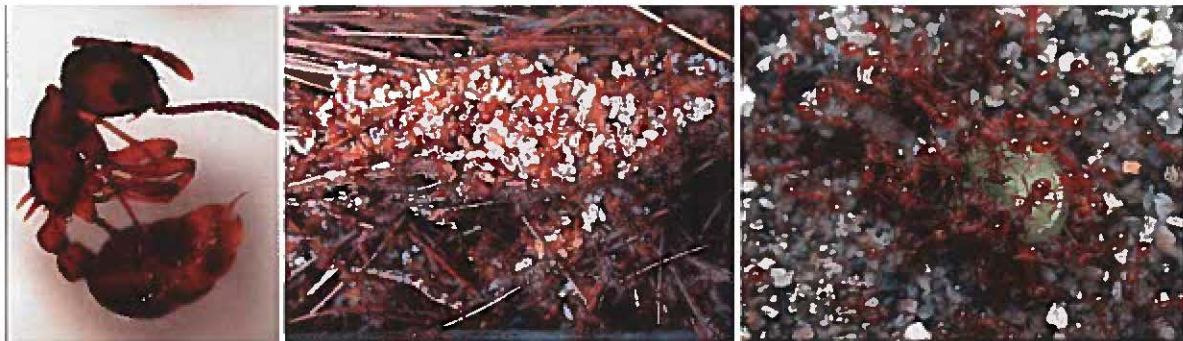


European Fire Ants

Integrated Pest Management Plan for Acadia National Park

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1/1/2015



A site specific treatment plan for the management of invasive European Fire Ants in Acadia National Park.

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EUROPEAN FIRE ANTS

Integrated Pest Management Plan for Acadia National Park

Developed by Elissa Ballman and Dr. Eleanor Groden, University of Maine 2015

EUROPEAN FIRE ANT BIOLOGY

Native range

The native range of European fire ants (*Myrmica rubra*) extends from Great Britain to Siberia and from the Black Sea to the Arctic. Their diverse and cold native habitat makes them well adapted to weather in the Northeastern United States. These ants have lower population densities and are not considered a pest in their native range. It is believed that competition with other native ant species prevents European fire ants from growing to the same numbers seen in North America. Unfortunately, native ants in North America are poor competitors against these invasive ants.

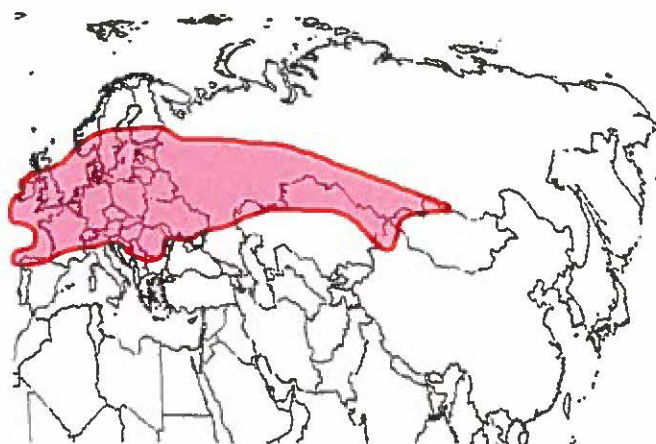


Figure 1. Native range

History in North America

European fire ants were likely introduced to North America on imported plant material. The ants were first recorded from the Arnold Arboretum in Massachusetts in 1908, though

they were not reported as a pest until several decades later. European fire ants were not collected during an intense insect survey on Mount Desert Island (MDI) in the 1940s. They were either absent from the island at this time, or in very low numbers and able to avoid detection. The first European fire ant complaints on Mount Desert Island were recorded in the Town Hill area in the 1960s. Complaints dramatically increased across the island in the early 1990s. In Maine, European fire ants are currently found primarily along coastal communities (including York, Cumberland, Lincoln, Knox, Hancock, and Washington Counties); though some inland populations have become established (Kennebec and Penobscot counties). In North America, they can be found primarily in coastal areas, along water bodies, and moist woodland areas in New England, New York, Western Washington, the Canadian Maritime Provinces, Ontario, and Quebec, Canada.

Impact on native species

European fire ants negatively impact native ants as they are more efficient foragers than Maine's native ants. They recruit to food faster and defend it aggressively from other ant species which ultimately results in reduction of native ant richness. Areas with dense populations of European fire ants have very few native ants compared to areas of similar habitat without these ants. In some heavily infested areas, native ants are completely absent.

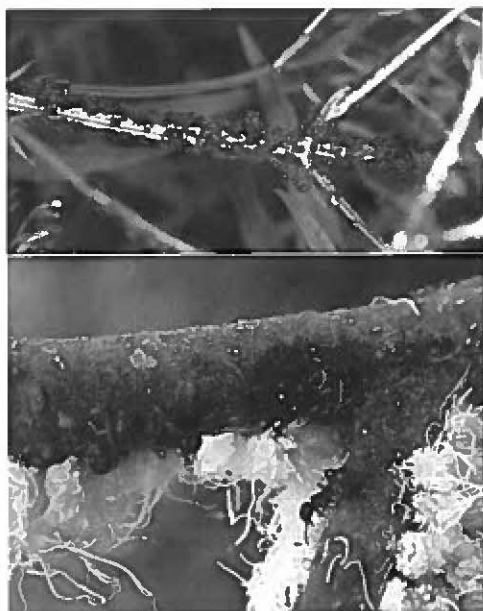


Figure 2. European fire ants tending aphids

European fire ants also impact other native insects, such as plant-sucking insects including aphids and tree hoppers. In exchange for the honeydew produced by these insects, European fire ants tend these plant pests by protecting them from predators and moving them to new plants as needed. This tending results in incredibly large populations of plant sucking insects. These plant pests are capable of harming plants through direct plant feeding and as potential vectors of plant disease.

Impact on humans

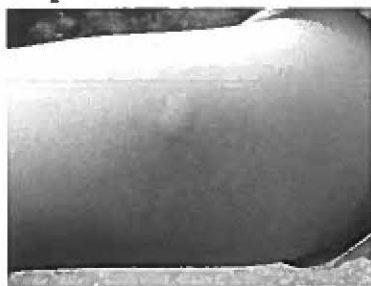


Figure 3.
European fire ant
sting

European fire ants are aggressive stingers and can sting repeatedly. Their sting is accompanied by a temporary, painful, burning sensation. Nests are cryptic and difficult to detect, and

people who unknowingly disturb the nest can quickly be swarmed and stung with ants protecting their nests. Large numbers of workers are usually actively foraging outside the nest in invaded habitats. These foragers are present in dense numbers on the ground and vegetation and crawl onto people or pets as they move through the area.

Life cycle

European fire ants undergo complete metamorphosis. They start as an egg, progress through three larval stages before pupating and emerging as adults. Similar to other ants, there are three types of adults, including: reproductive queens which lay both fertilized and unfertilized eggs, males, which mate with queens to produce fertilized eggs, and sterile female workers that forage for food, protect the nest, and feed the queen and developing brood. In its native range European fire ants have both a summer brood that develops during the summer and an overwintering brood that overwinter in their immature stages and emerge as adults the following summer. Colonies do overwinter with brood in Maine, and may also have fast developing summer brood. European fire ants are polygynous ants, defined as multiple queens per colony. The number of queens varies with the size of the colony. We have found colonies with 10,000 or more workers and over a hundred queens per nest. Although they do not have a true unicolonial nest structure, studies have shown that nests near one another are less aggressive towards one another. This lack of competition allows nests to focus on foraging and reproduction instead of defense and fighting.

Colony movement

European fire ant colonies in North America appear to be primarily spread by colony

budding and human-assisted movement. Colony budding occurs when a group of workers, brood, and reproductively capable queens bud off from their original nest and start a new nest. Nests are also easily moved by human assistance when infested organic materials such as wood chips, fire wood, wood debris, or plant material is moved out of an infested area into an uninfested site. In their native range, European fire ants also disperse during nuptial flights, where new winged queens and males fly from the nests to mate and queens start new nests. Although winged queens and males are observed in nests in the mid to late summer, nuptial flights have very rarely been observed in North America, suggesting that mating may occur within the nest and queens remain in the vicinity. As a result, the evidence indicates that European fire ants primarily spreads via colony budding instead of nuptial flights and can rapidly proliferate in contiguous areas. However, natural barriers such as roads or streams help to limit the self- spread of these ants.



Figure 4. Typical nesting habitats

Preferred habitat, nesting structure

European fire ants occupy a variety of habitats including gardens, lawns, wetlands, and deciduous forests. They usually avoid dry,

coniferous forests composed of fir and pine. They prefer to nest in areas that are cool, moist, and shaded. Nests are frequently located along tree roots and under or in various substrates including leaf litter, woodchips, woody debris (downed trees and rotting logs), stones, and human materials (pieces of tin, plastic, boards, brick and potted plants).

Why they are difficult to manage

Populations of European fire ants are difficult to manage for a variety of reasons. The polygynous nature of these ants ensures that even if a queen dies, there are several other queens to keep the nest reproducing. These ants form large colonies with multiple nests so if a single nest is destroyed, other nests may remain active. European fire ant colonies do not build large conspicuous soil mounded nests. Nests are camouflaged by their surroundings which greatly delays identifying new infestations until their populations increase enough to interfere with human activities. Because they often nest amongst dense vegetation, reaching the site of infestation can be difficult. Areas that are inaccessible, and therefore untreatable, create a refuge from which ants can reinvade adjacent treated sites. They frequently nest and forage in wet areas, which also makes treatments difficult to apply, and result in rapid degradation of any broadcast baited material. They can also form incredibly large and dense populations. In their invaded range, these ants have an average of 1.4 nests per square meter and up to 4 nests per square meter in heavily infested sites.

National Park Service management policies

The National Park Service has developed policies regarding the management of non-native species (section 4.4.4 in Management

Policies 2006). Section 4.4.4.2 of the policy states that “All exotic plant and animal species...will be managed—up to and including eradication—if (1) control is prudent and feasible...”. Based on our research, we believe that managing European fire ant populations in many parts of the park is both prudent and feasible. The ants significantly impact visitor and employee experiences and negatively impact native insect species. It is feasible to reduce ant populations in the developed areas of the park. We encourage park managers to review NPS Management Policies related to exotic pest management and ensure that all management actions are in accordance with current policy guidelines.

IDENTIFICATION OF EUROPEAN FIRE ANTS

European fire ants are reddish-brown in color and approximately 5 mm in length. Closer inspection reveals two backward-projecting spines in front of their “waist” and two segmented nodes known as the petiole and post petiole. European fire ants captured during sampling with baited vials and subsequently frozen often have their stinger projected from the tip of their abdomen in a defensive posture. Again, these ants are often seen in large numbers and are aggressive stingers. Their nests are usually in very dense aggregations, but are cryptic and often hidden under logs or similar debris which may make detection difficult. Several native ants have similar coloring or body shape, so care should be taken to differentiate between these and the invasive European fire ants.

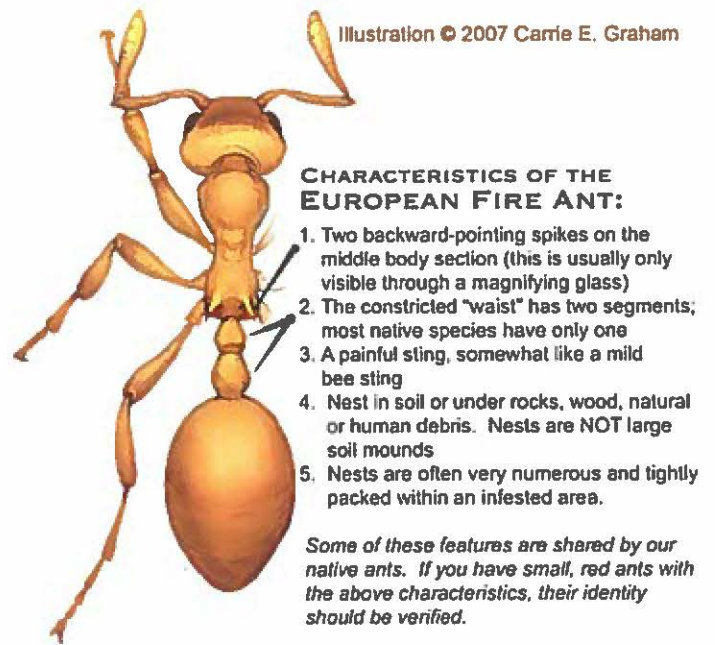


Figure 5. Key identifying features of European fire ants

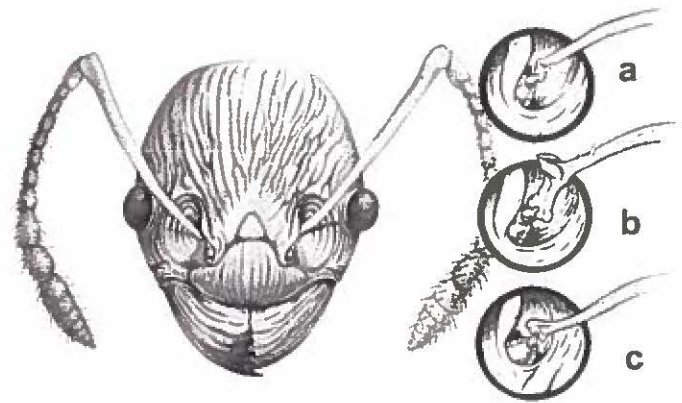


Figure 6. *M. rubra* has a narrowed antennal base and meets the head in a straight line (a), whereas native *Myrmica* can have toothed projections coming off of the antenna (b), an enlarged antennal base (c), or antenna that meet the head at a 90° angle (not pictured).

Table 1. Ants commonly mistaken for European fire ants

Ant Species	Picture	Distinguishing features	Notes
European fire ant (<i>Myrmica rubra</i>)	 April Nobile antweb.org	Reddish brown color Two large propodeal spines and post petiole node The scape (antennal base) gently tapers to where it meets the head, stinger often protruded	
Native <i>Myrmica</i> sp.	 April Nobile antweb.org	Looks very similar to European fire ants Typically a darker color than European fire ants with deeper ridges and pitting on the head and thorax and often have an altered antennal base (scape) where it meets the head (see figure 6)	These ants can be difficult to distinguish from European fire ant
<i>Aphaenogaster</i> sp.	 April Nobile antweb.org	Similar in size to European fire ants Two spines and double petiole but legs and antenna are much longer, and overall a thinner looking ant	
<i>Leptothorax</i> sp.	 April Nobile antweb.org	About half the size of European fire ants, smaller propodeal spines Only has 11 antennal segments, while European fire ants have 12	

Ant Species	Picture	Distinguishing features	Notes
Allegheny mound ants (<i>Formica exsectoides</i>)	 April Nobile antweb.org	Larger than European fire ants Bi-colored ant, light colored head and thorax and dark gaster No spines on the thorax Single petiole	A common stinging ant in Maine, forms prominent large mounds
<i>Lasius sp.</i>	 April Nobile antweb.org	Small yellow to brown ants Smaller than European fire ants No spines on the thorax Single petiole	Very common in a variety of habitats
<i>Formica sp.</i>	 April Nobile antweb.org	Usually larger than European fire ants No spines on the thorax Single petiole Usually darkly colored, or bicolored	A very large and diverse group of ants, common in Acadia National Park

EUROPEAN FIRE ANT MANAGEMENT

Managing European fire ants is a three step process composed of monitoring, treatment and follow-up sampling /monitoring of treated areas. See appendix I for site specific management recommendations.

Ant Monitoring

Before developing a treatment plan, the area of concern should be sampled to determine the size and magnitude of the European fire ant population. European fire ants are sugar loving ants and can be easily sampled using small vials baited with a sugar solution. Make a 20% sugar solution (three tablespoons of sugar to one cup of water). Cut a double layer of gauze into 1 inch squares and dip these lightly in the sugar solution. Place the lightly saturated gauze squares in the bottom of a vial. Plastic scintillation vials (1 ounce) work well, but any similar sized vial is adequate. Cap vials and store in the freezer to prevent mold and/or drying if they are not used immediately.

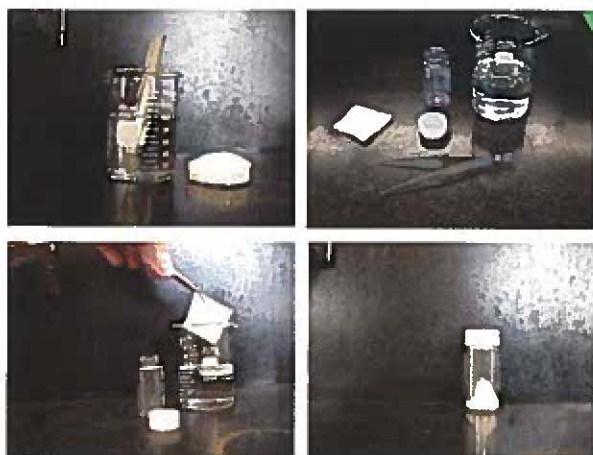


Figure 7. Steps for making ant sampling vials

The best way to sample an area for ants is to partition the area of concern into a grid, with flagged stakes placed every 10 meters. The flags should be labeled and, if necessary, the flag locations can be recorded via GPS. At the base of each flag, place an uncapped, plastic vial labeled with the flag number and baited with gauze soaked in 20% sugar water. The vials should not be placed in direct sunlight, or if they are, they should be covered with a leaf or other material to keep the vials cool enough to encourage ant foraging.

Ants can recruit to bait in as little as 15 minutes, but waiting longer gives a more accurate reflection of ant densities. However, if the baited vial is left out for too long, ants can remove all the sugar solution and stop foraging in that vial. We suggest leaving the vials in place for approximately two hours. When retrieved, vials should be quickly capped to trap any ants inside. Freeze the vials to make ant identification and counting easier.



Figure 8. Laying the vials out by the flags

Sampling can begin when air temperatures consistently reach approximately 65°F (typically early June). Because the ground stays cool into late spring, monitoring too early may not accurately reflect the severity of European fire ant infestations. Sampling during late summer (August) can reveal population growth and

spread that occurred during the summer season. We recommend sampling on clear days above 65°F. Foraging ants are less likely to leave the nest on days that are too cold or rainy.

Ant Treatment Methods

Habitat modification

Fire ants prefer moist, shaded areas with complex structures such as a variety of vegetation and downed trees, woodchips, and stones to nest under. Limiting these types of preferred habitats in campsites and picnic areas can help discourage ants in the immediate vicinity. Because ants particularly prefer nesting in downed, woody debris, removing these types of potential nesting structures may help limit ant densities. If debris is moved from an infested area, it is crucial to not move it to a non-infested site. This tactic is not feasible for large or natural areas, but keeping downed logs away from picnic and camp sites may help reduce ants in the immediate area. Mowing and keeping vegetation trimmed around picnic tables and campsites can also help deter ants from those areas.

Biological control methods

European fire ants in their native range are not controlled by any one pathogen or parasitoid, but instead are controlled by a variety of factors including complex interactions with other native ant species they encounter. In North America, they are released from their native competitors and are superior competitors compared to our native ants. Even with these difficulties, a number of biological control agents have been investigated for use against the European fire ant.

Several entomopathogenic fungi have been tested and proven to kill fire ants including *Beauveria bassiana*, *Metarhizium anisopliae*,

and *Hirsutella* sp. In lab assays, *Beauveria* and *Metarhizium* killed exposed ants, but field treatments did not result in measurable reductions or infection. Multiple species of *Hirsutella* were discovered attacking European fire ants in their native range in England. In 2009, a previously undescribed species of *Hirsutella* was found on a small number of ant cadavers collected on Mount Desert Island. The following year, several more ant cadavers were collected that also had the same species of *Hirsutella*. Since that time, the fungus has spread across the island becoming much more ubiquitous.

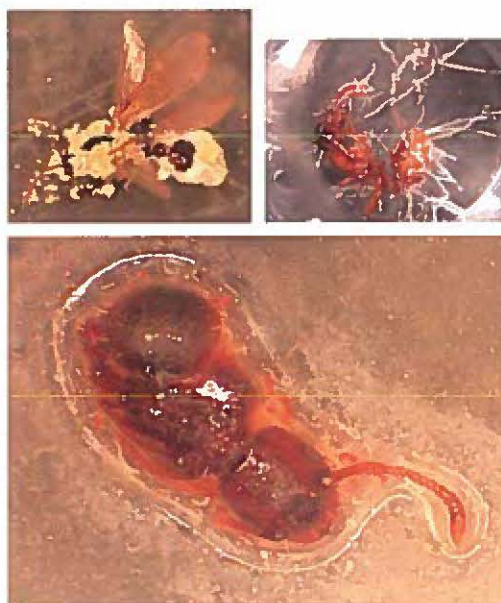


Figure 9. Ant pathogens and parasites, from top left: *Metarhizium*, *Hirsutella*, and *P. entomophagus* nematodes

In 2008, several populations of European fire ants in Maine were found parasitized by *Pristionchus entomophagus*, a facultative nematode. European fire ants exposed to these nematodes in early laboratory assays had between 2 to 30 percent mortality. Currently, this species of nematode is found associated

with European fire ants at nearly every infested location on MDI. Different populations of nematodes have varying levels of virulence, probably due to the different types of bacteria they carry with them. Research into using these nematodes as biological control agents of European fire ants is ongoing.

Chemical management

Currently, baited insecticides are the most effective management strategy for European fire ants. Baited insecticides consist of an ant toxin or insect growth regulator mixed with an attractive food source, commonly sugar, oil, and/or protein. Baited materials are designed to have delayed toxicity so that foraging ants bring the materials back to the nest and feed it to their nestmates, including developing brood and queens, before succumbing to the poison. As such, baits may work more slowly than contact sprays, taking days to weeks for full results, but have a much greater impact on ant populations. In addition to having a greater impact, they are also safer for environmentally sensitive areas. A large percentage of bait is consumed as opposed to contact sprays, which remain in the environment and are more likely to be washed into water sources. **Contact or mound treatments are not recommended for European fire ants because they do not result in long term ant reductions, and have a higher rate of runoff into water supplies.**

Our research has shown that bait stations are not as effective as bait granules that are spread (broadcast) directly onto the ground. Fewer ants enter and recruit to bait stations compared to those that forage on broadcasted granules. However, broadcasted baits cannot be applied in certain ecologically sensitive areas, such as near water bodies. If management is needed in these areas, bait stations can be employed.

The time of year and weather conditions when an ant treatment is applied can impact its success. Baited materials should be broadcast when conditions are optimal for ant foraging. Treatments can begin when days are consistently above 65°F and preferably sunny. Treating before, or immediately after rain storms will result in product runoff and reduced efficacy. Product labels should be read thoroughly and all instructions, including application rates and safety recommendations, followed closely. See appendix II for treatment results on European fire ant populations across all treated sites on MDI.

Although boric acid is a popular ant control product, our results have not shown any measurable reductions in European fire ants with commercial or homemade products we have tested in field trials. When using any pesticide, be sure to follow all label instructions including personal protective equipment and application rates.



Figure 10. Applying a broadcast granular product along a transect using a broadcast spreader



Examples of ant bait stations, clockwise from top: Bayer® Maxforce Outdoor Refillable Bait Station, homemade bait station made from PVC pipe, and KM Ant Pro® liquid bait station

Characteristics of ideal pesticide

The ideal pesticide product will be a baited material made with a preferred food source (such as sugar or protein), non-repellent, and a slow acting toxicant. This last characteristic is especially important because it allows the foraging worker ants to bring the baited material back to the nest and feed it to their nestmates. Products that kill ants too quickly will prevent foragers from bringing the product back into the nest, which makes it less effective.

Refer to table 2 for a list of products successful in reducing ant populations at the time of this publication, keeping in mind that regulations and registrations may have changed. For the most up to date information on product registrations in Maine, refer to the Maine Board of Pesticides Control.

Table 2. List of successful pesticides used against European fire ants as of 2015

Product Name	Active Ingredient	EPA Registration Number	Availability as of 2015	Population Reduction Response Rate	Notes
Advion Fire Ant Bait	Indoxacarb	100-1481	Registered in Maine	Moderate	Most effective in field trials
*Conserve Fire Ant Bait	Spinosad	62719-304	Not currently registered in Maine	Moderate	Organic product, almost as effective as Advion
Maxforce Complete Granular Insect Bait	Hydramethylnon	432-1255	Registered in Maine	Fast	Works quickly, but ant populations rebound quickly after application
Amdro Fire Ant Bait	Hydramethylnon	73342-1	Registered in Maine	Moderate	Bait has a short shelf life, older material is less effective. Shelf life can be impacted by storage conditions. We recommend using the product during the season it was purchased in.
Distance Insect growth regulator	Pyriproxyfen	59639-96	Registered in Maine	Slow	Insect growth regulator
Maxforce Quantum Ant Bait	Imidacloprid	432-1506	Registered in Maine	Moderate	Imidacloprid is toxic to bees. Containing the material within a bait station designed for ants should limit the potential impact on non-target pollinators.

*This product was called Green Light Fire Ant Control during our trials. Conserve has the same EPA registration number as the former Green Light product, but we never used the product when it was called Conserve.

Table 3. Below is a list of Maine registered products that are designed for managing pestiferous ants, but have not been tested against the European fire ants. These products may be successful at managing European fire ants, but details regarding efficacy and reduction speed are unknown.

Product Name	Active Ingredient**	EPA Registration Number	Availability as of 2015
Combat Fire Ant Killer Granules	Hydramethylnon	64240-1	Registered in Maine
Ascend Ant Granular Bait	Abamectin	499-370	Registered in Maine

**Additional products, (some with the same active ingredients), are marketed and available for ant control. Several are sold as sprayable or contact formulations (including non-baited water soluble granules). We generally do not recommend these contact formulations. Baited formulations, because of their delayed toxicity, are distributed throughout the colony by the ants, which results in more effective management of European fire ant populations.

Thresholds for treatment

Different areas within ANP will have different treatment thresholds depending on their use. Campgrounds and picnic sites will have a very low threshold for European fire ants and should be treated when these ants disrupt park visitors or employees. Natural areas may have a higher treatment threshold so long as they do not disrupt park visitors or are not adjacent to areas of significance in the park, such as Jordan Pond House and popular hiking trails. Park managers should base any management action on visitor use or ecological treatment thresholds. For visitor use facilities, managers might consider a treatment threshold based on the number of visitor or employee complaints. This would be dependent on providing visitor education about the threat and establishing an easy way for visitors to lodge complaints. Before treating, any ant complaints must be verified as European fire ants. There are native ants that can sting and interfere with park visitors, but are usually in much lower densities compared to European fire ants.

Minimum treatment area

Sampling can be a very useful tool to determine the location and density of European fire ants. However, these ants may still persist in an area but at low enough numbers to avoid detection with sampling. These undetected and therefore untreated nests have the potential to expand and spread through an area thought to be otherwise uninfested.

Our research has shown that small spot treatments within large infested areas are usually ineffective. This is particularly true for sites that have had a history of severe infestations. Even when European fire ants are only observed in a small portion of a known

larger infested site, treating less than 20% of the site typically resulted in a rebound of the ant population. For example, the Fabbri picnic site is infested with European fire ants, but after a widespread initial treatment the population was reduced and subsequent sampling revealed only small pockets of persistent ant activity. When we then treated less than 20% of the site, targeting only those small areas where ants were observed, European fire ants populations quickly rebounded throughout the site. When infestations within this site were more widespread, and an area greater than 20% was treated, greater long term reductions were evident.

Changes in ant densities are also related to the size of the pre-treatment ant population. The proportion of ant reductions is larger with larger initial populations. Smaller initial ant populations often result in a much smaller proportion decline compared to larger starting ant populations. Because of the limited success of spot treatments, we recommend spot treatments only in camp sites as a temporary way to allow campsites to remain open.

Follow-up recommendations

It may take several weeks for baited insecticide treatments to significantly reduce ant populations. To measure reductions in ant populations, resample a treated area three to four weeks after application. Insect growth regulators (IGRs) take even longer to have measureable impacts, in most cases they may take a month or longer. Because of the slow action of IGRs, we do not recommend these materials in high use areas such as campsites. The more traditional baited insecticides should be used for these areas where the goal is to keep ant populations low enough to keep sites open.

In previously treated infested sites, follow-up treatments in the same year are generally not effective. A single widespread application early in the summer is more effective than several smaller treatments spaced throughout the summer. However, in newly discovered dense infestations, multiple treatments may be needed in the first year with a single follow-up application in subsequent years. Also, individual picnic and camp sites may need multiple treatments to reduce ants at individual sites. In those instances, additional treatments should be based on employee and visitor complaints.

In many sites, treatments can be made on an every other year basis. Fire ant populations take about two years before they start to rebound. The year after treatments show very small growth compared to the original population level. Areas with widespread European fire ant infestations can probably best be managed by a single every other year widespread application after the initial treatment year.

Park employee and public education

In order to minimize the spread of European fire ants and discover new infestations while they are fairly contained, it is important to

educate and communicate with park employees and visitors about these ants. Two million visitors a year travel through many parts of the park and have the potential to help detect European fire ant activity. Placing signs or handing out factsheets can alert people of the ants and inform them of how to report their own sightings. These signs are especially important near sensitive areas or places that border infestations, such as the Bear Brook Picnic Area. Treatment thresholds can be based on European fire ants complaints if people are given an easy way to report ant activity. It is important to keep both park employees and visitors educated about this ant as they can alert the park of new or problem infestations.

Set realistic management goals

The European fire ant cannot be eradicated from Mount Desert Island. Ant populations are too large, widespread, and inaccessible for this to be possible. Treatments should focus on managing ant populations at an acceptable level that allows employees and visitors to continue to enjoy the park. Priority should be given to infestations in high visitor or employee use areas.

Appendix I. Site specific treatment recommendations

Before using any pesticide product, read the label carefully for personal protective equipment and application rate specifications. Granular insecticide applications can best be made with a hand-held broadcast spreader, such as Earthway® Ev-N-Spred (figure 12) or other similar types of seed/fertilizer spreaders. For very small areas, a small homemade shaker can be made using a plastic container with holes punched in the lid. In order to comply with application rate restrictions, determine how much product is dispensed from any bait dispenser before using.



Figure 12. Broadcast spreader

The treatment strategy for managing European fire ants will vary with the size of the infestation, the density of the ants, and the park and visitor use of the area. See the following site types to determine the best course of action.

Site type: Ants uniformly distributed across the site, heavily used by visitors and park employees.

Including: Seawall Maintenance Area, Fabbri Picnic site

Recommendations: Monitor on a yearly basis to determine size and density of fire ants across the site. Treat the entire area, including

wooded area surrounding picnic tables, with a baited broadcast material on an every other year basis. The products should be applied to down woody debris and around old foundations as these are favored nesting sites for the ants. Care should be taken to avoid applying products too close to picnic tables to prevent any material from landing on the tables and benches. Baits will break down rapidly in wet areas, and so treatments of these areas with broadcast baits should be avoided. See below for treatments around wet areas.

Site type: Spotty distribution of ants in a heavily used public area.

Including: Seawall Campgrounds, Blackwoods Campgrounds, Jordan Pond House

Recommendations: Treating in these areas should depend upon ant monitoring conducted annually and/or as a follow-up to complaints from employees and visitors. Areas with confirmed European fire ant infestations can be spot treated with broadcast baits. For example, if complaints are made at a particular site, the site should first be sampled to confirm the ant species and the extent of the infestation. The site plus a 10m buffer around the infested area should be treated. Baited material should be broadcast into any bordering wooded or vegetative areas of the campsite. Spot treatments will not eliminate ants from the site, but will reduce ant densities allowing these sites to remain open and usable for the public.

Site type: Heavy uniform distribution of ants in a natural area with little to no visitor presence.

Including: Otter Cliff Road site, Old Park Maintenance staging ground along route 233, the parking lot area across Hull's Cove Visitor Center and surrounding park housing

Recommendations: No treatment recommendations can be made that will

successfully manage ants in areas that are part of a much larger, dense infestation of fire ants. Treating these natural areas is expensive, time consuming, and will not result in long term fire ant reductions. Instead, we recommend placing signs that alert people in these areas to the hazards of the ants. We also strongly recommend placing signs where park employees work or store material that alert them to the presence of these ants and inform them not to move organic materials from these sites. Organic materials such as wood chips, or fire wood, should never be stored then moved from these heavily infested sites. Moving organic materials from these sites will result in the movement and spread of these invasive ants to other uninfested portions of the park. Storing and moving non-organic materials can also pose a risk of transporting ants so all materials should be closely and carefully inspected for signs of ants.

Although we do not recommend treating these larger areas for effective long term reductions, we do suggest treating the open lawn area surrounding park housing at the Hull's Cove Visitor Center as needed. Treating this subset of the total area can prevent park employees from being stung and allow the area immediately around the house to be used. Keeping the grass cut short around the house can also help to prevent the re-infestation of ants from the wooded portion of this area.

Site type: Heavy uniform distribution of ants adjacent to a public use area.

Including: Bear Brook Picnic site

Recommendations: Treat the infested area along the edge of the uninfested site to keep

ants in this area from increasing and invading the uninfested site. To have an impact on these heavily infested adjacent areas the treatment swatch should be large (roughly 40 meters wide). Treatments can be made on an every other year basis, but monitoring should be conducted yearly to verify ants have not invaded the public use areas. In areas such as these, thorough monitoring and public education is essential for preventing the spread of ants into these areas of concern. Signs should alert picnickers to watch for the ants and to limit the movement of downed woody debris including collecting firewood and provide information on how to report possible ant sightings.

Site type: Spotty ant distribution near ecologically sensitive areas.

Including: Areas adjacent to bodies of water where runoff is a concern such as near streams, ponds, and the ocean

Recommendations: Use a commercial product that contains an insecticide in a liquid sugar solution, such as Maxforce Quantum in a liquid bait dispenser. Although granular bait dispensers are available, we have found that sugar-based liquid baits are more attractive to the ants. The bait dispenser will keep the bait from dissolving and entering the waterway. Broadcast baits cannot be applied in areas where it will run off into waterways, but bait dispensers will keep the product secure. Bait stations have limited success and should not be used in place of broadcast applications when possible. Bait stations will need to be checked and refilled one to two times per season.

Appendix II. European fire ant density and proportion trends by site

For each site we managed, we graphed the changes in European fire ant densities from 2011 to 2013. Because the campgrounds were very large and infestations were not contiguous, separate ant density graphs were developed for separate infested areas within these sites. We report here the average number of European fire ants across each location and the average number of vials that sampled positive for these ants. The type of treatment (spot or broadcast), pesticide product used, and time of application is indicated on the graphs with symbols corresponding to the key provided below. We chose not to depict on the graphs the bait station treatments deployed at the sites in order to keep the graphs simpler and because the bait station treatments had very limited success.

As we previously stated, larger starting populations had the most dramatic decreases of European fire ants after initial treatments. In some cases, multiple treatments in the first year were necessary for measureable ant reductions. Sites with small spotty ant distributions had much smaller proportions of the population reduced compared to treatments in areas with denser ant infestations. This is especially evident in campsites that had low densities of the ants. Treated areas that were part of a larger contiguous ant infestation, such as the park maintenance area, Hull's Cove visitor center, and Otter Cliff Road, had less successful long term reductions.

Symbol shapes represent types of treatments



Large area broadcast (> 20% of area treated)



Spot treatment (< 20% of area treated)

Fill of shapes represent type of product used during that treatment



Maxforce Complete Granular Insect Bait



Advion Fire Ant Bait



Distance Insect growth regulator



Amdro Fire Ant Bait



Green Light Fire Ant Control

Line types represent proportion of vials with European fire ants and average numbers of European fire ants per vial

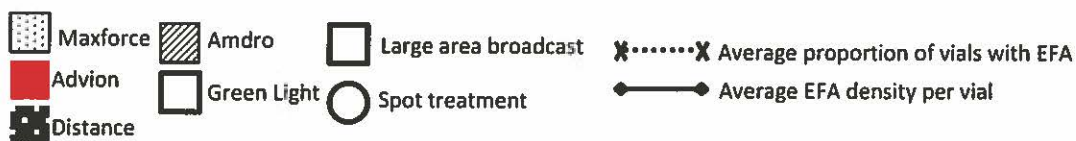
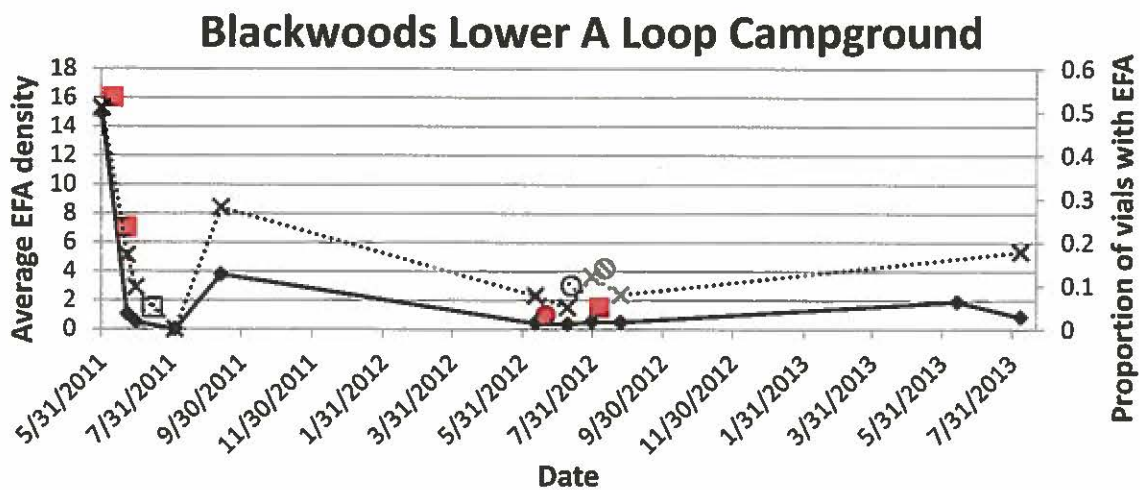
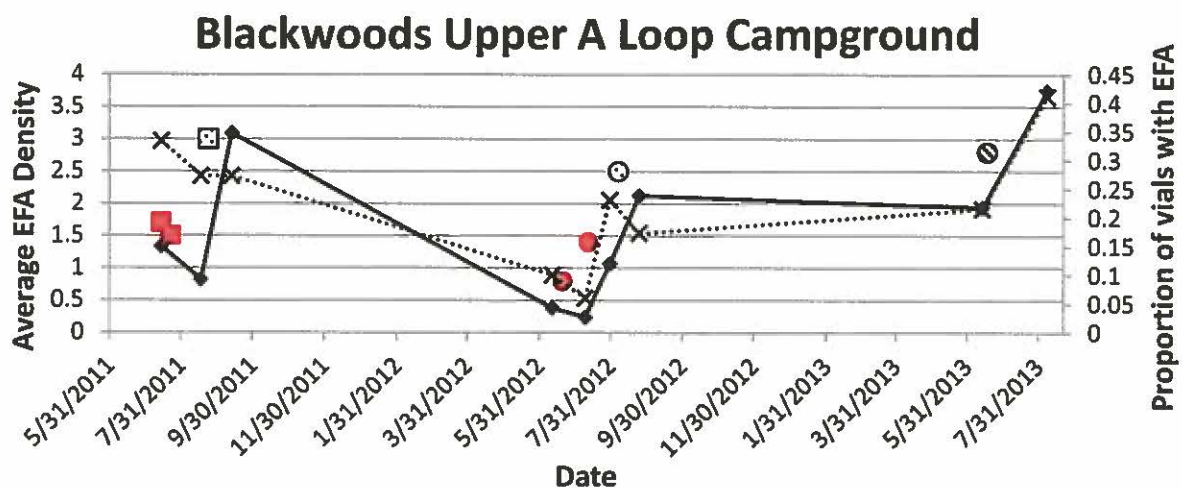
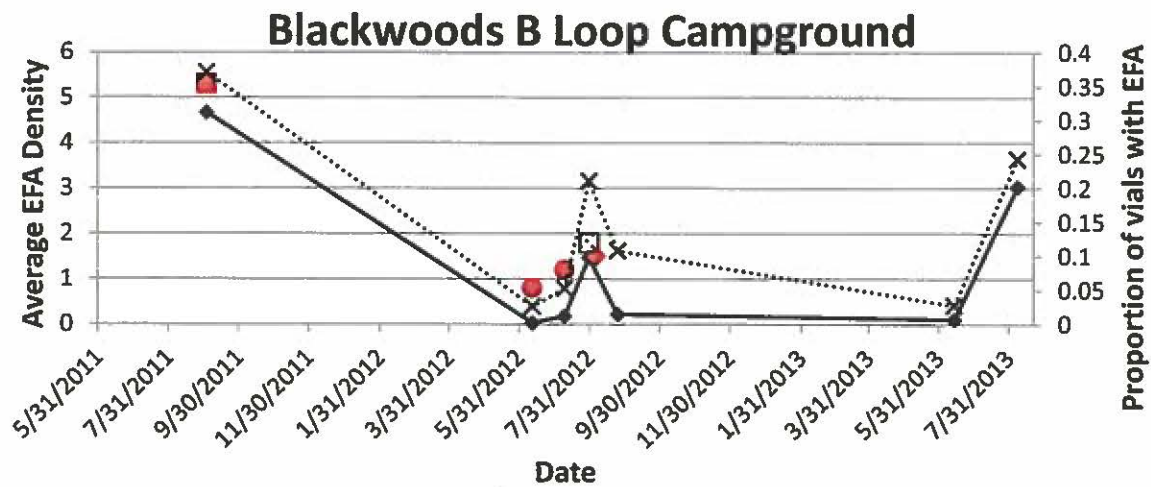


Average proportion of vials with European fire ants

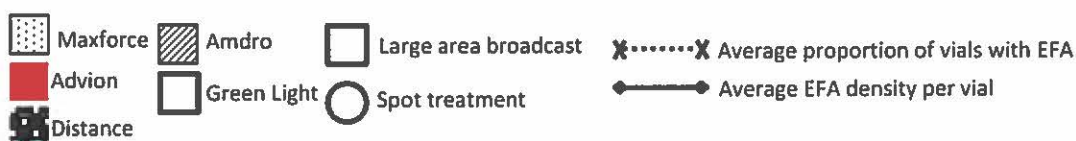
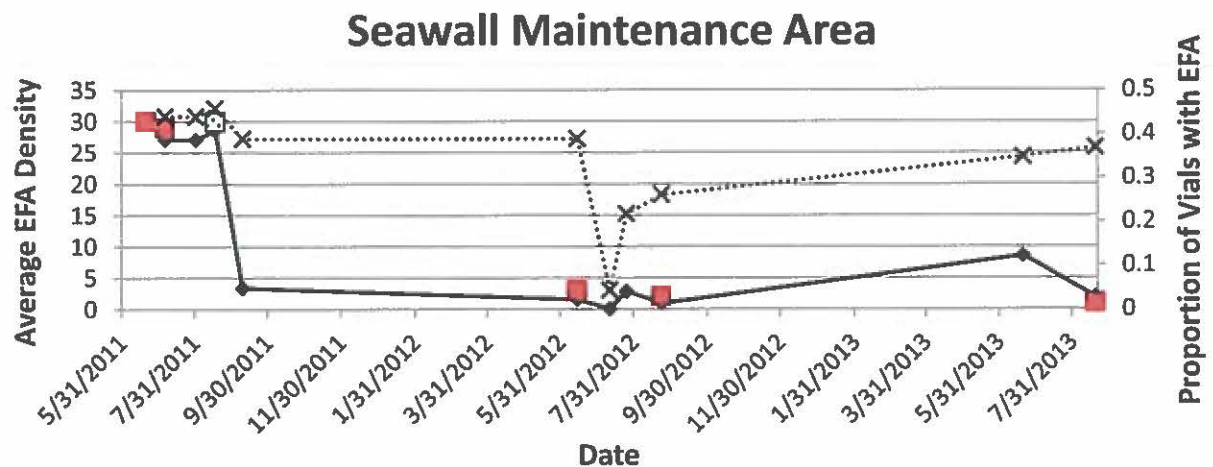
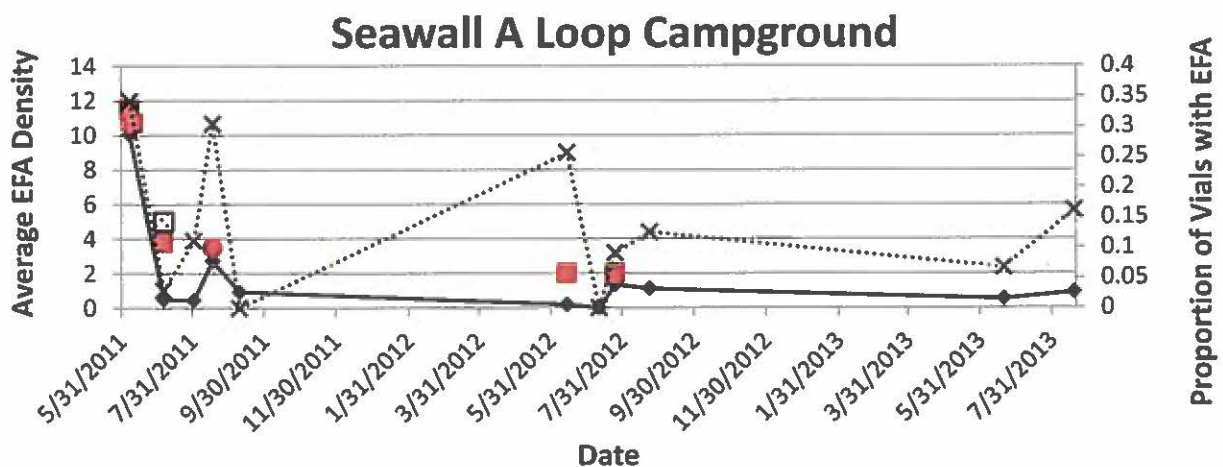
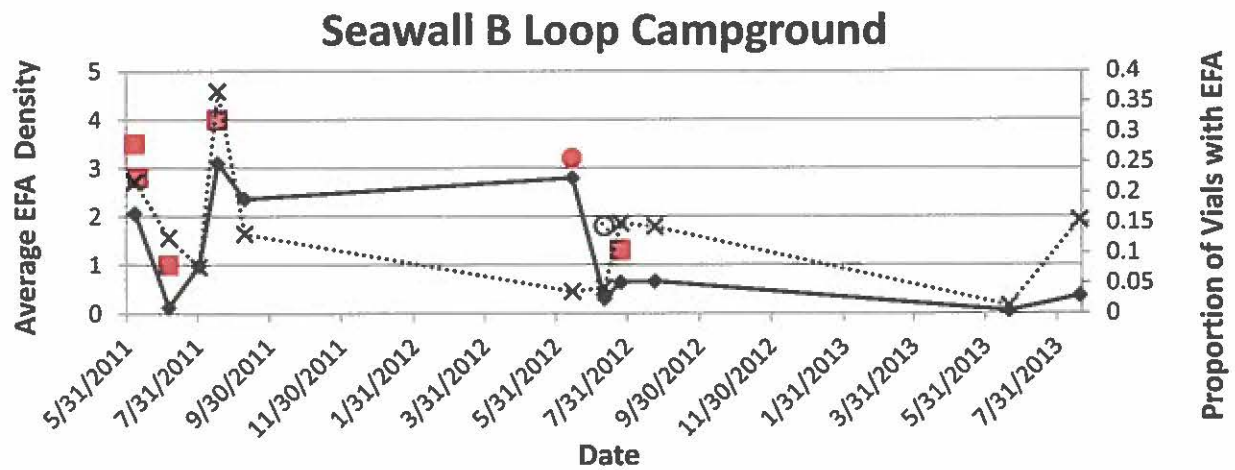


Average European fire ant density per vial

Trends in European fire ants relative densities at Blackwoods Campsites. Data presented is average number of European fire ants per vial across a site and the average number of vials containing European fire ants.

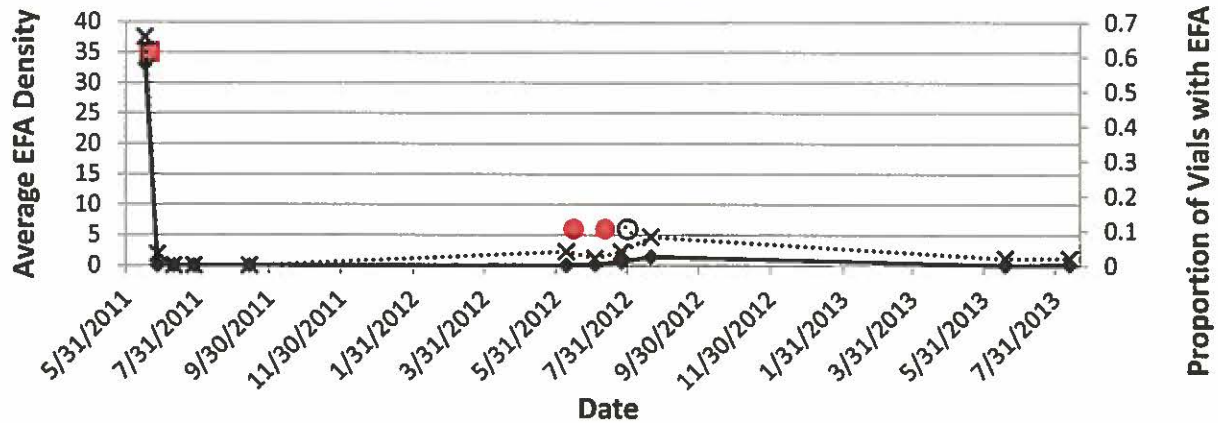


Trends in European fire ants relative densities at Seawall Campsites. Data presented is average number of European fire ants per vial across a site and the average number of vials containing European fire ants.

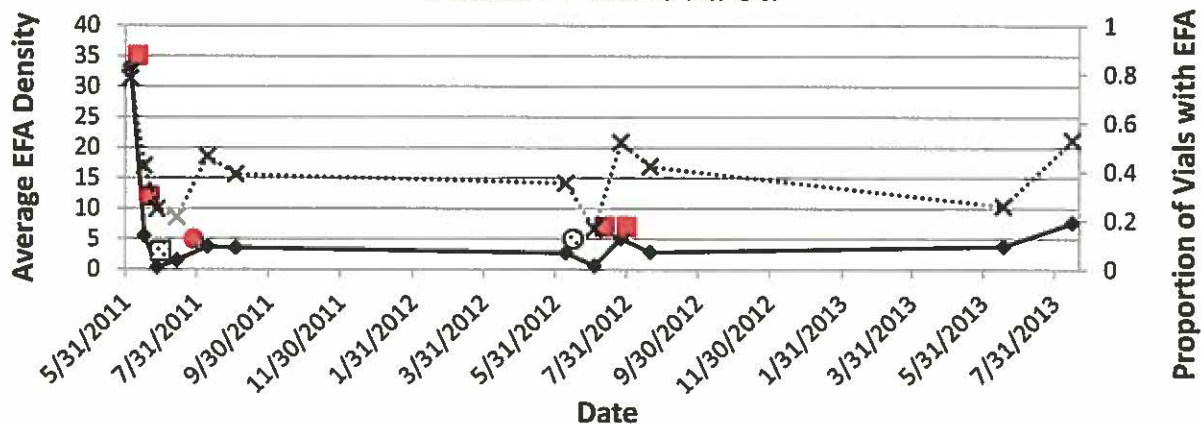


Trends in European fire ants relative densities at picnic and high use sites. Data presented is average number of European fire ants per vial across a site and the average number of vials containing European fire ants.

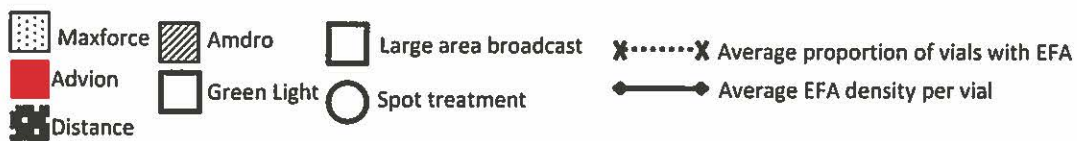
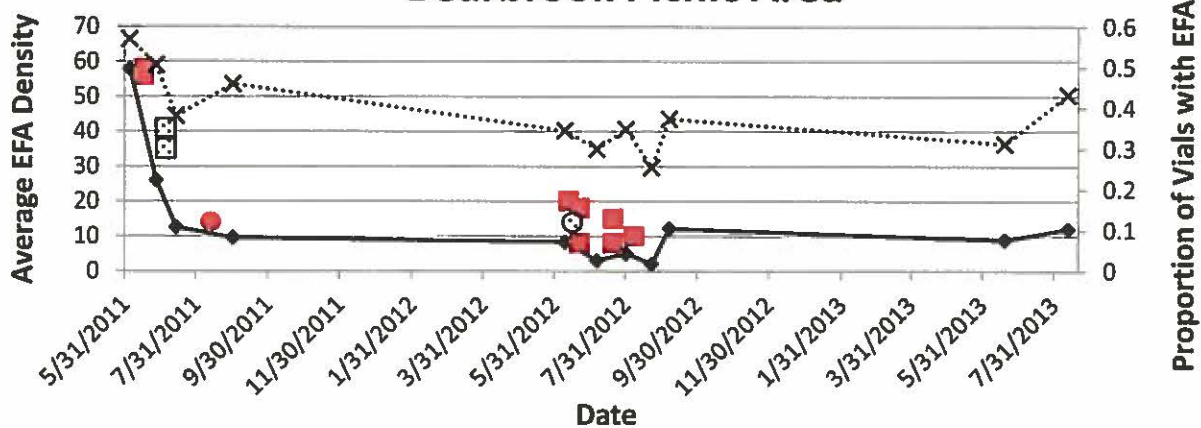
Jordon Pond House



Fabbri Picnic Area



Bearbrook Picnic Area



Trends in European fire ants relative densities in low use, natural areas of the park. Data presented is average number of European fire ants per vial across a site and the average number of vials containing European fire ants.

