The loss of biodiversity caused by invasive species and how it changes USA's environment

Invasive species are an enormous problem in the United States. From the wooly adelgid to the snakehead fish, many invasive species cause a great deal of damage each year. In fact, it is estimated that the environmental damages and other losses from invasive species add up to $120 billion in damages per year! (Pimental, Zuniga and Morrison) Additionally, invasive species can either out-compete or out reproduce similar indigenous species, causing a huge change to the environment and other factors such as the loss of biodiversity. In her paper “Invasive Species and Evolution”, Stigall states, “Modern invasive species have been documented to cause ecosystem restructuring, both in terms of simplifying food webs and altering resource utilization processes” (Stigall). So arguably, it is the loss of biodiversity that is the most important factor that branches from the introduction of an invasive species, as the loss of one or more species and the redistributing resources can drastically alter the equilibrium of the environment.

The loss of biodiversity is of deep concern. “Biodiversity boosts ecosystem productivity where each species, no matter how small, all have an important role to play” (Shah). Additionally, some species need one another to survive. For example, if a keystone species goes extinct, all of the species that rely on it for survival or reproduction etc. will go extinct as well. Sometimes this can cause a chain event, as the loss of the second species can influence a third species. Therefore, if an invasive species invades and can outcome or out reproduce the native species, they native species can possibly become extinct and potentially ruin an environment. However, not all invasive species are detrimental to an ecosystem.

White and Schwarz state, “The worst exotic pest species have been the result of intercontinental introductions, presumably because of release from natural control factors (White and Schwarz). However, not all “invasive species” are “invasive”. The United States Department of Agriculture defines an invasive species as “plants, animals, or pathogens that are non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause harm.” (United States Department of Agriculture). Additionally, many of the invasive plant species were introduced for food, fiber and/or ornamental purposes. While some of these got out hand, the majority of invasive species do not pose a threat (Pimental, Zuniga and Morrison). However, the invasive species we will be studying causes great harm to many things, including our economy, our land, us humans, and many others. This paper will investigate the both the causes and threats of the red imported fire ant, and several plans to take to eradicate them from our ecosystem and to evaluate the pros and cons of each.

Here is what we know about the problem

The red imported fire ant was accidently introduced in Alabama from South America in the 1930’s, since then it has spread around largely around southeastern USA, including, but not limited to: Florida, Georgia, Mississippi, Arkansas, South Carolina, North Carolina, Texas, Louisiana, Tennessee, New Mexico, Oklahoma, and California (Arizona-Sonora Desert Museum). This problem has become so bad, that the United States contained approximately five times the amount of red imported fire ants than in South America. (Fader). These ants have

easily eliminated competing insects and rapidly overwhelmed the south (Texas Imported Fire Ant Research and Management Project). Additionally, the red imported fire ant has no natural predator which results in population booms in the areas that they invade, thereby increasing both their number and the rate at which they invade other areas (Arizona-Sonora Desert Museum). Luckily, the red imported fire ant dislikes colder temperature (Arizona-Sonora Desert Museum) so it seems like the northern part of the United States is immune to infestation-at least for now. With rising global temperatures, the red important fire ants may begin to travel further north and ultimately infest the entire United States.

Red imported fire ants cause significant damage every year. It is estimated that red imported fire ants bite 5 million people each year, with around 25,000 of these bites requiring medical attention (Arizona-Sonora Desert Museum). The red imported fire ant also attacks the eggs and young of many bird and reptile species; specifically the Southern Hognose Snake (Heterodon simus). World-renowned amateur photographer and herpetologist Ali Iyoob states, “The Heterodon simus hatchings are vulnerable to attack. Along with the introduction of the red imported fire ant, the population of Heterodon simus has been declining dramatically and is currently being considered for the endangered species list” (Kirby) (Iyoob). Additionally, “the red imported fire ant kills poultry chicks, lizards, snakes, and ground-nesting birds” (Pimental, Zuniga and Morrison), causing significant loss to the biodiversity to all parts of the southeastern United States.

The red imported fire ant’s main threat is the competition and displacement of native ants (Rabitsch). Many native ants can be a keystone seed disperser, and their removal can have drastic effects (Lubertazzi, Lubertazzi and McCoy).Without such an imported seed disperser, plants may not be able to effectively spread their seeds, and lower their reproduction. With a lower reproduction rate for the plants, herbivorous animals may suffer from lack of food etc. This is a chain reaction, which needs to be stopped as soon as possible in order to maintain biodiversity.

However, some argue that ants are not the cause of biodiversity loss (Hill, Rosengaus and Gilbert), but rather that they are the ““passenger” of human habitat alteration, rather than the “drivers” of biodiversity loss” (King and Tschinkel, Fire ants are not drivers of biodiversity change: a response to Stuble et al. (2013)). Additionally, King and Tschinkel concluded that the addition or removal of fire ants had little effect on an ecosystem in northern Florida (King and Tschinkel, Experimental evidence for weak effects of ?re ants in a naturally invaded pine-savanna ecosystem in north Florida). However, we must note that “there were no plots without fire ants, and therefore no baseline data on the structure of the native ant assemblage in the absence of fire ants” (Stuble, Chick and Rodriguez-Cabal).

Even if fire ants turn out to not be the cause of the loss of biodiversity, their economic effects are still present. On an economical scale, the estimated damages due to the red imported fire ants alone throughout the entire south is nearly $1 billion. This includes damage to livestock, wildlife, and public health. Additionally, almost $200 million is spent every year in pest control per year (Pimental, Zuniga and Morrison). $1 billion may not seem like a lot compared to the $120 billion in damages from all combined invasive species (Pimental, Zuniga and Morrison). But with the increase of global temperature, the fire ants may spread across the entire landscape of the United States which could in turn become an even costlier endeavor for us to have to deal with.

Back in the late 1960's and early 1970's people tried several insecticides such as heptachlor and mirex to deal with the red imported fire ants. However, the red imported fire ants persisted and returned to areas that were previously treated with the insecticides. Additionally, in 1981 and 1983 Amdro and Pro-Drone were used to try to combat the red imported fire ants, but again, failed. (Texas Imported Fire Ant Research and Management Project). Because the red imported fire ants have such a high reproductive rate and a high rate of dispersal a single treatment would take an extremely long time and insurmountable amounts of money. (Texas Imported Fire Ant Research and Management Project) So how do we fix this problem in an economical and environmentally friendly way?

There are several ways of disposing of red imported fire ants. Three of the most common are surface treatment, individual mound treatment, and bait treatment. (Texas Imported Fire Ant Research and Management Project). The surface treatment uses a residual contact poison to spread around the entire ground, killing any red imported fire ants that come into contact with it. This method may not be the most effective as some of the ants may survive by going deep underground. The surface treatment also is the "the least environmentally sound because long residual poisons must be used and the surface remains toxic for long periods" (Texas Imported Fire Ant Research and Management Project). Individual mound treatment is when a large amount of pesticide is applied to an individual mound in order to kill the queen. However, this treatment contains many drawbacks, as it requires a large amount of pesticide per mound. Not only does the amount of pesticide add up to a large sum of money, the transportation of the pesticide adds an additional cost to the application. Additionally, "Colonies not eliminated may move or split into several colonies" (Texas Imported Fire Ant Research and Management Project). So even if you are were successful in eradicating most of the red imported fire ants, they can potentially repopulate the area again-a complete waste of manpower and money. The bait treatment uses "some sort of attractive substance the ants like to eat" (Texas Imported Fire Ant Research and Management Project), however, the baits are not always consumed and therefore, ineffective. So with all of these ineffective treatments, how will we eradicate the red imported fire ant?

Thank God for Me!

I propose that we take several approaches to eradicate the red imported fire ants. Specifically, we will ask, "Which method of extermination and type of pesticide is the most effective in killing the red imported fire ants, and what environmental effects, if any, does the treatment have?" We will look at the surface treatment, individual mound treatment, and bait treatment, and potentially, other small scale ways of treating the red imported fire ants. We will also look at how each treatment works on both a small and large scale.

The variables will we be considering are: cost, effectiveness, effects of native ant populations, effects of any other native flora or fauna, and differences between small and large scale applications.

In order to test each of the treatment methods, we will have to acquire two plots of land, one considered "small" and another considered "large". Luckily, Aunt Maggie is allowing us to purchase her small farm from her (Dylan), which is completely infested with both native and red imported fire ants. Also, the United States is willing to let us experiment in one of their national parks that is also infested with both native and red imported fire ants. Both plots of land have

the exact same climate, the same native ant: red imported fire ant ratio, the same soil, etc. Additionally, because of the perfect nature of both Maggie's Farm (Dylan) and the National Park, the native ants and red imported fire ants are evenly distributed throughout the land. All other factors are exactly the same other than the size. Prior to any experimentation, we will survey the area and count the number of both the red imported fire ant hills and native ant hills-but since they are evenly distributed, they should be the same for each plot, this is just being done to get a count of the original number of hills.

Each plot of land will then be divided into three chunks of equal size-one for each method. These chunks will also be subdivided in order to test various alterations of the three different methods. For example, we will use various pesticides with each one in order to find the one that most effectively kills the red imported fire ant, but has the least detrimental effect on the native ants.

According to the University of California Agriculture & Natural Resources, there are 7 "Active Ingredients", each pertaining to a particular pesticide (Greenburg and Kabashima). These 7 active ingredients are hydramethylnon, abamectin, fipronil, pyriproxyfen, spinosad, methoprene, and indoxacarb. Hydramethylnon and indoxacarb are the only ones available to homeowners, so we can assume that they are the least effective and can be thrown out. Leaving 5 active ingredients that we can test.

In order to test the most effective pesticide and way of treatment, the three divisions in both Maggie's Farm (Dylan) and the national park will be divided into 25 equal area subdivisions, allowing for 5 separate tests of all 5 of the pesticides, amounting to a total of 150 plots. The plots will be oriented in a way in which neighboring plots will not share the same pesticide-in order to minimize the edge effects of the plots.

The first section of each plot will be treated with the surface treatment. With this treatment, a team of undergraduate minions will only apply the recommended dosage of pesticides throughout the landscape of the designated areas on Maggie's Farm (Dylan) and the National Park. Because we will be using undergraduate labor, the pesticide will be manually sprayed on the land. However, these undergraduate minions are perfect in applying the pesticides and will apply a perfectly even coat across the landscape. I estimate that this will be a very effective treatment for all 5 pesticides, however, because we will be treating the entire landscape, it will be the most expensive of the three methods, however, if it effectively kills all the red imported fire ants, it may be the only viable option. In addition, the pesticides used may also kill the native ants, so we would have to select the pesticide that had the least detrimental effects on the native ants.

The second section of each plot will be treated with the individual mound treatment. The undergraduate minions will scout the area in advance and count the number of mounds on each section. We will then acquire enough of each pesticide to treat each mound. We will treat each mount with three times the recommended amount of pesticide to ensure that the mound is saturated. I estimate this will be a more effective treatment than the surface treatment as we are applying the pesticide directly to the mound. It will also be expensive as we will be using a large amount of pesticide in order to saturate each mound. However, by using this treatment method, it is expected that many of the native ants will live, as they are not being directly affected by the pesticide.

The third section of each plot will be treated with the bait treatment. The undergraduate minions will mix the recommended amount of pesticide into a large size side of KFC gravy. It has been scientifically proven that everyone enjoys KFC gravy (reference needed) and so it can be extrapolated that the red imported fire ants will enjoy it too. The bowl of KFC gravy and pesticide will be placed approximately 12 inches away from each mound. It is estimated that this method will be efficient as we can individually treat each mound, just as in the individual mound treatment, and we would be using less pesticides. However, because KFC gravy is so well liked, the native ants may travel from their mounds in order to consume it, and potentially be killed as well. Additionally, the cost may be a lot higher than expected as the undergraduate minions may consume the KFC gravy before it is applied to the mounds.

After applying all of the pesticides, the plots will be checked one month after the application. Each plot will have the number of remaining red imported fire ant hills divided by the original number of red imported fire ant hill. This will be considered the fire ant survival rate of the pesticide.

(Remaining red imported fire ant hills)/(Original red imported fire ant hills)=fire ant survival rate (%)

Additionally, we must see which pesticide left the most native ant hills. The remaining number of native ant hills will be divided by the original number of native ant hills to get the native ant survival rate

(Remaining native ant hills)/(Original native ant hills)=native ant survival rate (%)

To determine the best pesticide/treatment, we will look at both the killing rate and the survival rate of each pesticide/treatment combination. We are looking for the lowest fire ant survival rate and highest native ant survival rate. In order to score the pesticides, we will use the formula

100((1-fire ant survival rate)+native ant survival rate)=score

For example, if treating a section of Maggie’s Farm (Dylan) with the individual mound method and firpronil left 15% of the red imported fire ant hills alive and 80% of the native ant hills, it will be given a score of 165.

100((1-.15)+.8)=165

To account for any variation in our experiment, all 5 plots with the same treatment method and pesticide will be averaged. The method and treatment combination that gives the highest score will be considered the best. However, we will still have to account for the cost and the difference between the scores of the small plot of land from Maggie’s Farm (Dylan) and the large plot of land from the National park.

We will also add up the cost of each method and treatment combination, as being the best does not always correlate with being the most cost effective treatment. And if this experiment was reproduced in the real world, money would be an issue. In order to calculate the efficiency, we would calculate cost of each treatment method by estimating the cost of applying pesticide to one mound. To estimate the cost of the surface treatment, we will find out how much it costs to apply each pesticide to one hectare of land, and the average number of red imported fire ant

hills on each hectare. We would also have to calculate the cost of a truck and labor, but we are going to omit those for simplicities sake. For the individual mound treatment, we would have to calculate the cost to apply each pesticide to one mound, and then multiply by the average number of red fire ant hills per hectare. The bait treatment will also be calculated the same way as the individual mound treatment, however, we would also have to include the cost of the KFC gravy. To simplify things even further, we will average each treatment/pesticide combination of both Maggie's Farm (Dylan) and the National Park in order to see which treatment/pesticide combination works the best on both a large and small scale.

Now we will finally take the averaged points from each combination and divide them by the cost per hectare to find the efficiency. For example, if the average of both the large and small averages of the surface method/spinosad treatment was 150 points and cost $100 per hectare, the efficiency would be 1.5 points/$1

(150 points)/($100)=1.5 points per $1

After the calculation of all 15 treatments combinations, the one with the highest efficiency will be selected as the most efficient treatment for the red imported fire ant dilemma.

Even though the use of pesticides can potentially be a viable option of eliminated the red imported fire ants, it can be very expensive and pose other serious problems for our environment. This study does not take in to account the effects the pesticides have on other insects on Maggie's Farm (Dylan) and the National Park. However, the only other proposed method of eradicating the red imported fire ant is to release a natural predator. One of the red imported fire ants' main predator in South America is the phorid fly. "These flies lay their eggs in the ants' head; as the larvae develop, they take over ("zombify") and eventually decapitate their ant host." (Solution For Your Life-The University of Florida). However, by releasing yet another invasive species we could encounter other deleterious effects on our environment, just like the red imported fire ant did.

We can all relate to ants in some way or another. Some people even argue that Bob Dylan likes ants. In his song, Blowin' in the Wind, many people misheard him saying, "The ants are my friend" rather than the correct lyrics, "The answer my friend". However, even though he did not really say the ants were his friend, I'd believe Bob Dylan would enjoy ants and would want the native ants to be saved from the red imported fire ants, thereby saving the southern United States millions of dollars per year and protecting the environment from a loss of biodiversity.