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THE Endangered Insects of North America: A Brief Survey

Angela Anthony,

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Cover Illustration of American Burying Beetle, completed by author.

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FOREWORD

The “creepy and the crawly” have always captured my imagination, a lifelong fascination that began with my early years of filling my pockets with eastern tent caterpillars that I found in the red cedar trees that wept sticky sap outside of my kindergarten classroom. In my teens and early adulthood I flipped hundreds of rocks across Tennessee in the quest to find salamanders and snakes, always searching for what countless other peopled deemed terrifying. Now, more than ever, the creepy crawlies need the attention and adoration of as many people as they can get.

In recent years, and under the current administration, the Endangered Species List (ESL) has been under terrifying scrutiny. The very animals that the ESL was put into place to protect are under the gun both literally and figuratively and we may, in this lifetime, see ESL funding, and thus protection, come to a screeching halt. The Endangered Species List is ever changing and dynamic, with new animals being listed yearly, and success stories (though few and far between) proving the power that conservation laws and enactments can have for the survival of species from your own North American backyard to the savannahs of Africa.

Due to the changing atmosphere of the Endangered Species List, even during times in which the list is not under a giant magnifying glass by our elected officials, this book was not meant to be a comprehensive guide of all of the endangered insect species of North America. Instead, it is a brief survey of some of the most well-known, and in the author’s opinion, interesting, currently endangered and potential to be listed invertebrates. I wrote the book with the intention to appeal to all audiences, but with a special emphasis to be friendly enough for the casual, “armchair”, naturalist.

At the very least, I hope that this book serves to ignite interest in a decades old debate, and spurs the reader to get involved in conservation, whether insect related or not.

-Angela Anthony
October 2018

INTRODUCTION

Since North America was first settled, man and beast (and plant) have been in a delicate dance to survive. As humans migrated across the continent their presence has altered the ecosystems they passed through. It wasn't until the 1900's that the true impact humans have had on the species within North America came to light, as animals that were once numerous and plentiful across the landscape began to disappear. White tailed deer, American buffalo, passenger pigeons, American alligator, great egrets, and the Carolina parakeet are just a few examples of animals that found themselves on the brink of extinction as man pushed westward across the continent and needed food for his belly, fur for his coat, and feather for his hats.

As the plethora of these creatures disappeared from the landscape people began to take notice. Thus, the modern idea of conservation was born, stirred by the ideas of such historic personalities as Theodore Roosevelt, Rachel Carson, and Aldo Leopold. The turning point for endangered species came in 1973, when the government decided to become involved and the Endangered Species Act of 1973 was enacted. Led by the United States Fish & Wildlife Service, a division of the Department of the Interior, the ESA gave the federal government the ability to protect any and all species that fell within the borders of the United States from the possibility of extinction (Metrick and Weitzman, 1996). Along with the internationally recognized IUCN Red List, which lists endangered species internationally and is managed by the International Union for Conservation of Nature, the ESA categorizes species as having one of several categories. These include animals that are Of Least Concern, Threatened, Endangered, Critically Endangered, and Extinct (Cooke, 2008).

The Endangered Species Act, and the Endangered Species List, a part of the ESA that names all of the current endangered plants and animals in the country, is funded by the taxpayer dollars and has been fraught with controversy since its birth. For example, adversaries of the Endangered Species List have argued that what species actually appear on the list are more in line with what species are "popular" to the public and not necessary which species need protection. The fact that species are ranked by the United States Fish & Wildlife Service from 1 (the highest priority) to 18 (the lowest priority), and this assigned rank decides what species gets the most funding, does nothing but support this argument (Metrick and Weitzman, 1996).

In light of this, experts of other subjects of academia have weighed in on the ESL. Sociologists have argued that what our society has decided to conserve, and how we conserve it, says quite a bit about the American culture in which we live (Metrick and Weitzman, 1996). This is especially disconcerting considering that the two largest groups of animals on the ESL are birds and mammals.

Invertebrates, including the insects that are highlighted in this text, as well as plants, are among the fewest represented species (Wilcove et al., 1993). It is worth mentioning here that for a better part of the ESL through the 1970's to the mid-1990's, of the ten species in which the federal government spent over $10 million dollars to protect, not a single one was an invertebrate (Metrick and Weitzman, 1996)! In fact, some experts argue that the reasons to list certain species go off of weak arguments and no logic at all (Wilcove et al., 1993).

Economists have also gotten involved in the ESL debate, arguing that the dollars spent on protecting a species from extinction is often not returning any investment. Since the ESL began, of the 1,300+ species that have appeared on the list, only around one half of those have shown improvements in population numbers or have numbers that have at least remained stable. If the species are looked at over the span of thirteen or so years, around 35% of the species have shown a decline in numbers even after being listed. While this data is correct, to allow non-scientists to decide what species should be saved and which ones should not is a slippery slope to be on. Scientists simply cannot predict which species will or will not make a recovery and be delisted. There isn't a magic formula to go off of, and other natural factors are often at play (Male and Bean, 2008). Instead, researchers try to look at such aspects as population numbers, population demographics, the species' range in the wild, and connectivity of other populations (Cooke, 2008). While the numbers of species that have been delisted may seem as failures, in truth any delisting is a success story in itself (Male and Bean, 2005).

So, in reality is any of the above arguments true? To an extent, yes. Scientific input from researchers who have spent their careers studying a potentially endangered species is certainly needed (Cooke, 2008). But the truth is that only 15% of species found within the United States have been studied to any extent (Wilcove and Master, 2005). To further complicate this approach, what if everything is not known about the species, should we simply decline to list them? An example of this is found within the pages of this book, where very little is known about the reproductive habits of the Zayante band-winged grasshopper. Because we do not have all of the information on this species that we have, for example, on a Monarch butterfly, does that mean we should not make an attempt to save it? We do know its habitat is declining, and that the species numbers are rapidly declining. Where then, is the turning point?

Researchers have tried to set parameters to answer this very question. The idea of "taxonomic uniqueness", i.e. that the species is vastly different than any other and thus worth saving, has been tossed around within the conservation community (Metrick and Weitzman, 1996). Where then does species such as the Karner blue butterfly, another species that we will discuss, fit into this thought process? After all, the Melissa blue butterfly is quite similar in many ways. Another question is whether the species to potentially be listed is of commercial value (Metrick and Weitzman, 1996).

In the case of some insects, such as honeybees and butterflies, who are touted to help pollinate the food that goes on our table, this question seems straightforward. X amount of bees pollinate X amount of plants which equals X amount of crop to be sold which in turn equals X amount of dollars. Simple, right? But what about the American burying beetle, who spends a good portion of its life underground and thus unknown by the average American citizen? One can argue it performs just as important of a service as pollination, as it serves as a decomposer of carcasses of small birds and mammals in the environment.

Two final questions that have been suggested as potential deal breakers to decide whether or not a species is to be listed include whether the species plays an important role in the ecosystem, and whether people would care if that particular animal ceased to exist. The first question literally wants the scientist to figure out if the ecosystem would collapse if the species was removed from it. This is something that may not be measurable until decades after the species is removed from the ecosystem (i.e. extinct), by then it is simply far too late. The second question brings us back full circle to earlier, when we discussed what value should be placed on the head of a species that has evolved to fill an ecological role in the environment (Metrick and Weitzman, 1996). But the true question we should be asking is this- why are these species on the list to begin with?

Habit destruction is by far the number one reason why most species are listed, and it has been the top reason for the last two decades. While natural disasters do fall within the realm of habitat destruction, most true habitat destruction is done at the hands of humans. Road development, agriculture, grazing, mining, logging, infrastructure development, outdoor recreation, water development, commercial development, urban development, and even fire suppression are all human led habitat destruction (Wilcove et al., 1998). In fact, I urge the reader to take a close look at the reason behind the ESL listing of each of the insects that appear in this book. The decline of every single insect within this text can be linked back to at least one of the factors that constitute habitat destruction. While habitat destruction is the number one cause of population decline within a species, it is certainly not the only reason a species can appear on the ESL. Other factors include climate change, the spread of invasive (non-native) species, overharvesting of the listed species, pollution of the environment in which the species resides, and even disease (Wilcove et al., 1998).

But how is it determined why a species is in decline, and is facing possible distinction? As noted before, research on the species must be done in order to learn as much as possible. But how is research conducted? In order to understand a species researchers must conduct field studies, which observe and study the species in its natural environment. However obtaining data is sometimes easier said than done. For larger species, such as mammals, they are relatively easy to find and in some cases, like on the prairies of the Midwest, easy to watch. The key to studying any animal, especially in the wild, is to allow natural behaviors to occur without interruption (Cooke, 2008).

In some cases obtaining this needed data becomes a “touchy” subject, as the animal must be fitted with tracking devices (termed biotelemetry) so scientists can track the daily movement of individual animals. Unfortunately biotelemetry brings its own host of problems in the form of cost (tracking devices can run in the thousands of dollars and are often lost when they detach from the animal or when the battery runs out and they can no longer be traced). Acoustic telemetry is often used for animals that create sound, including bats, who emit noises that cannot always be audible to the human ear. However biotelemetry cannot always be used, and insects are a perfect example of how difficult conducting research on a potentially endangered species can be. Insects are oftentimes hard to catch, have an unknown range, migrate long distances, and are too small to fit with a telemetry device. Add in the fact that the weight of an adequately insect sized tracking device can compromise flight, and thus foraging, of an individual and monitoring insects becomes quite difficult indeed (Cooke, 2008). There are some exceptions to this conundrum, and the Monarch butterfly is one of these.

Before we dive into discussing individual species, a note should be made on the process of how a species ends up on the ESL, should researchers deem it necessary. After research is conducted proving

the potential need for listing, the species is listed as a candidate for the ESL. Money is allotted by federal government to gather additional scientific information, and a proposal to list is then made. This proposal contains information about why the species is in peril, along with the recommendation to list. A period is open for the public to make comments about the listing, and a final decisions is then made. If the species is listed, a recovery plan is then enacted and such actions as purchasing land to set aside for habitat, the decision to captive breed the species, to outlaw commercial or recreational harvest, and to not disturb known habitat where the species resides are made (Metrick and Weitzman, 1996).

Now that we have covered the basics of the Endangered Species List, and how insects end up on it, let's take a closer look at some of the insect species that are currently facing extinction.

AMERICAN BURYING BEETLE

Fast Facts

Common Name: American Burying Beetle

Scientific Name: *Nicrophorus americanus*

Size and Description: 30 to 35 mm. Large black beetle with orange antennae, orange pronotum, black legs, and black and orange elytra. Males and females have different markings above mandibles.

Range: Once found in 35 states, the ABB is now found in six states including Nebraska and Oklahoma

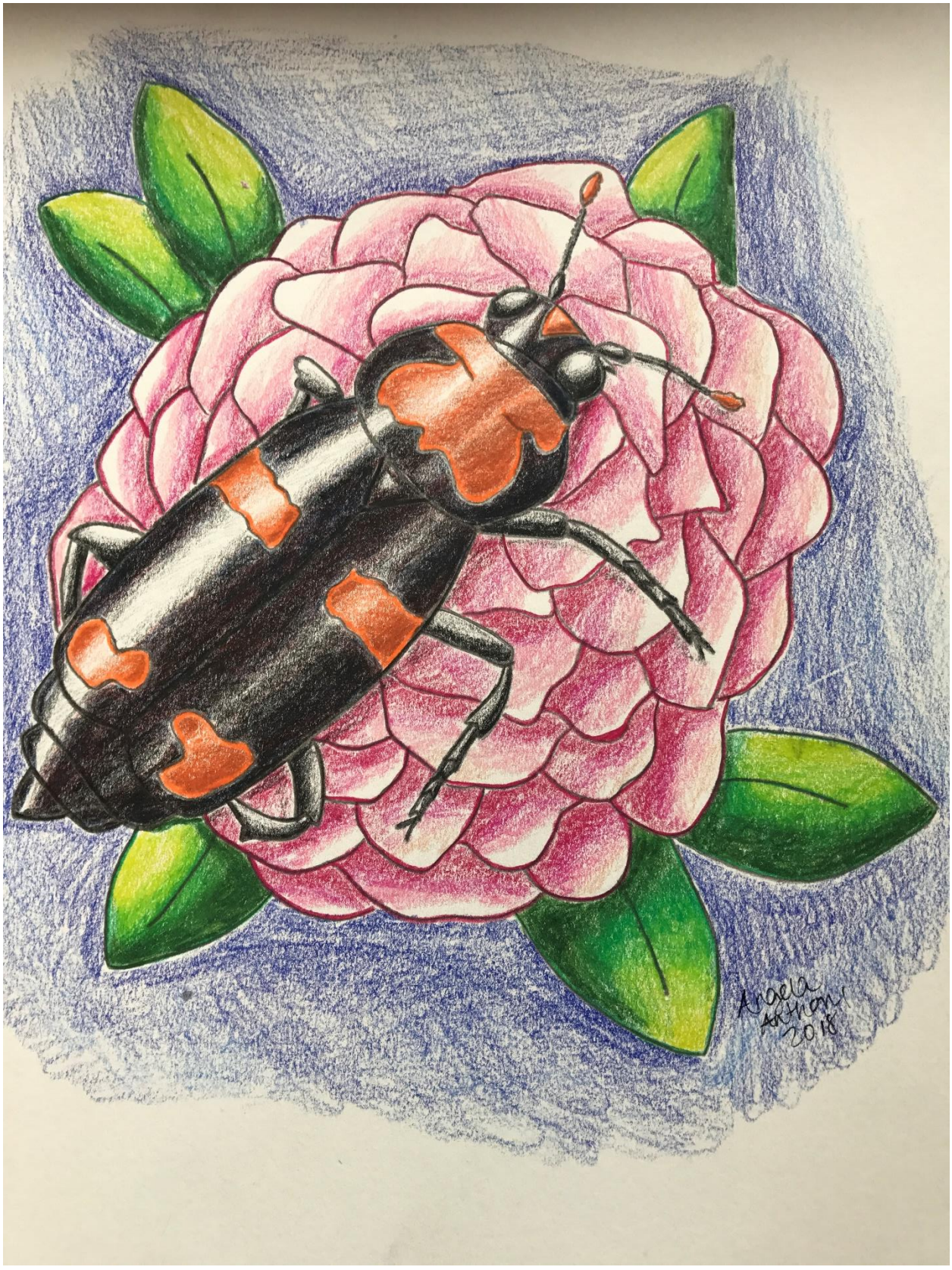
Diet: Carcasses of small birds and mammals

Lifespan: One year

Listed: 1989

Threats: Habitat destruction, deforestation, inability to find food resources, competition with other species for food

Cool Fast Fact: ABB can lift over 200 times their body weight, which would be like a human lifting an elephant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The American Burying Beetle (ABB) is a large beetle that once occurred over much of the eastern United States, ranging from the Midwest to the Northeast. In recent years populations have only be found in six states, including Nebraska and Oklahoma in the west, and Rhode Island in the east (USFWS, 1997). It has been estimated that the American burying beetle had disappeared from most of its range by the 1920's (New York Department of Environmental Conservation, 2108). Even where found today, the American burying beetle boasts a patchy distribution, and much of the early research completed to conserve the species focused on simply finding populations of the beetles (Bedick et al., 1999).

While there are many other species within the genus *Nicrophorus,* the American burying beetle is the largest, at an impressive 1 ½ inches in length (Bedick et al., 1999). The American burying beetle is black in coloration, with an orange pronotum (the upper portion of the thorax), orange antennae, and orange markings on its face (USFWS, 1997). Males and females can be distinguished by the markings that occur directly above their mandibles, as males sport a rectangular orange mark while females have a slightly smaller, orange triangle (New York State Department of Environmental Conservation, 2018).

American burying beetles are nocturnal in nature, and are active across their range from April to September (New York State Department of Environmental Conservation, 2018). They prefer old growth oak and hickory forests and grasslands with soil that is conducive to burying their prey, which is usually the size of a dove or chipmunk (USFWS, 1997). Soil type has a role in whether American burying beetle appears in certain areas, as loose soils makes it easier for the insects to bury their prey and thus compete with other animals that use the same resource (Holloway and Schnell, 1996).

Flying upwards of six kilometers in a single night to locate prey (Bedick et al., 1999), the male American burying beetle locates a small deceased bird or mammal, which is their preferred prey (Holloway and Schnell, 1996). Multiple male beetles will arrive at the carcass, and battles between the males will ensue in competition for the right to bury the carcass and mate. It is not unusual for older American burying beetles to have missing legs and battle scars from these nocturnal battles. It is interesting to note that the largest male always wins (Bedick et al., 1999). Once the male has secured the carcass he will emit pheromones to attract females, in which he will mate with the largest (USFWS, 1997).

The "burying" part of the American burying beetle's name comes from the act of burying the prey, which is done by both the male and the female insect in an attempt to seclude their resource from other competition, both insect and vertebrate alike. Other burying beetle species will attempt to utilize the carcass, and the beetles do lose some carcasses to vertebrate scavengers such as opossums, skunks, crows, and foxes. Once the male and the female have decided to bury their prey, they typically will carry the carcass up to one meter using a conveyor like motion with their legs (New York Department of Environmental Conservation, 2018). This is no small feat considering the carcasses can weigh up to 300 grams (Lomolino et al., 1995) and is 200 times the weight of the beetle (New York State Department of Environmental Conservation, 2018). They will then bury the carcass, the female will lay around 12-15 eggs near the carcass, which will pupate in the soil and emerge within 45-60 days (USFWS, 1997).

American burying beetles are social insects, and both the male and the female provide care for the young once they are hatched, protecting them from predators as well as feeding them via oral secretions that are regurgitated by the parents. These secretions have a dual purpose as they also delay

decay of the carcass that the beetles have buried (Lomolino et al., 1995). Once hatched, American burying beetles have a typical lifespan of one year (USFWS, 1997).

Due to their habitat preference, American burying beetles are considered an indicator species where they are found, and have a valuable role in their ability to return nutrients to the soil in burying the carcasses of small birds and mammals that they utilize for both food and reproductive purposes (USFWS, 1997). In recent years, with habitat destruction in the form of deforestation being the lead cause in declining beetle numbers (Holloway and Schnell, 1996), American burying beetles must search wider areas for the carcasses that are needed for its life cycle. This species typically uses larger carcasses than other beetles of the same genus, and this is thought to potentially explain why other closely related species are often abundant in numbers where American burying beetles are found (Lomolino et al., 1995). Other scientists have hypothesized that the now extinct passenger pigeon may have been a specialized food source for the beetles, and that with the pigeon's extinction the American burying beetle has had trouble finding suitable resources (USFWS, 1997). The American Burying Beetle was listed on the Endangered Species List in 1989 (Holloway and Schnell, 1996).

KARNER BLUE BUTTERFLY

Fast Facts

Common Name: Karner Blue Butterfly

Scientific Name: *Lycaeides melissa samuelis*

Size and Description: One inch. Both males and females have wings whose underside are grayish in color, with orange crescents and black spots. Males: the topside of wings silver to dark blue, Females: grayish blue, tops have orange spots.

Range: Patchy distribution in northern states: Wisconsin, Michigan, Indiana, Ohio, Minnesota, New York, New Hampshire

Diet: As larvae, lupine specialists. Adults feed on nectar of flowering plants.

Lifespan: Five days

Listed: 1992

Threats: Habitat destruction, lack of natural disturbance, inability to find food resources, climate change

Cool Fast Fact: Named after where first described, in Karner, New York


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Karner Blue butterflies (KBB) start their life as a pale green, round egg that is 0.7 mm in length. Laid on the leaves of wild lupine that grows in the northern states, the eggs will soon hatch into larvae (also known as caterpillars) with black heads and green bodies. There are four larval instars, and the larvae are typically active from around 8:00 a.m. to 7:00 p.m. Interestingly enough, scientists have discovered that the larvae have a close relationship to up to twenty seven species of ants that tend to the caterpillars. These ants eat the high sugar juice that is secreted by the caterpillars, and in turn protect the caterpillars from predation and parasitism. The ants find the caterpillars through sounds that emit from the larvae (Haack, 1993). The caterpillars pupate in early May, and by the end of June the adults will emerge and mate, laying their eggs on wild lupine (USFWS, 2008) preferring lupine that is in moderate shade (Grundel et al., 1998). There are two generations of Karner blues per year, and the first generation appears in April from eggs that were laid the year before (USFWS, 2008).

The overall lifespan of the adult Karner blue is a mere five days, and their density where found can vary widely- from zero individuals to the hundreds (Brown and Boyce, 1997). The wingspan of both males and females is one inch, and while the underside of the wings of both sexes is gray in color, with both orange crescents and black spots, the topsides of the wings differ. In males the topsides of wings appear silver to dark blue, while the female Karner blue has more of a grayish blue coloration with orange spots (USFWS, 2008). Natural predators of both larvae and adult Karner blue butterflies include wasps, ants, spiders, stinkbugs, robber flies, and various birds (Haack, 1993).

The largest populations of Karner blue butterflies are in Wisconsin and Michigan, however the butterfly can be found in other states including Indiana, Ohio, New Hampshire, New York, and Minnesota. The biggest factor as to whether or not Karner blue butterflies are present stems on whether or not lupine, the plant that is needed for both egg laying and larval consumption, is available. Lupine grows in pine and oak savanna and needs natural disturbance in which to grow, such as fire and large mammals (USFWS, 2008). The age of lupine is also a factor in whether or not female Karner blue butterflies will utilize an individual plant in which to lay their eggs, as lupine in which blooms are present are preferred (Grundel et al., 2008). Lupine is an early succession plant, and appears soon after disturbance of a habitat occurs. Preferred natural disturbance includes fire, injured pockets of habitat from frost, disturbance caused from the grazing of large mammals, and tree disturbance (Brown and Boyce, 1997). Unnatural disturbance in the form of maintaining power line corridors has also been found to boost lupine growth, and thus Karner blue numbers, as long as the habitat is not treated with pesticides (Forrester et al., 2005).

The majority of the decline of the Karner Blue, named after where first described in Karner, New York, has occurred in the last one hundred years (Haack, 1993). The Karner blue butterfly has shown a 99% range decline in the last twenty five years, although the closely related Melissa blue butterfly is quite common in its natural range (Gompert et al., 2006). In addition to the habitat destruction and lack of disturbance previously mentioned as reasons why the Karner blue butterfly was listed on the ESL in 1992 (USFWS, 2008), infection of a type of bacteria called *Wolbachia* that crossed over from populations of the Melissa blue has impacted the Karner blue, especially in regards to mating (Nice et al., 2009).

HINES EMERALD DRAGONFLY

Fast Facts

Common Name: Hine's Emerald Dragonfly

Scientific Name: *Somatochlora hineana*

Size and Description: 2.5 inches in length, wingspan of 3.3 inches. Bright green eyes, body is metallic in coloration with yellow thoracic stripes.

Range: Historic range of Alabama, Indiana, Ohio. Currently found in Illinois, Michigan, Missouri, and Wisconsin

Diet: Nymphs and adults are both predatory, eating other smaller invertebrates

Lifespan: Adult lifespan around one month, but this species can live as a nymph for 2-4 years

Listed: 1995

Threats: Habitat destruction, urban and infrastructure development, pollution in aquatic marshlands

Cool Fast Fact: Nymphs can survive drought conditions by living in abandoned crayfish burrows


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Hine's emerald dragonflies are named after their large, bright green eyes. A large dragonfly, the Hine's emerald is typically 2.5 inches in length, and boast a wingspan of upwards of 3.3 inches. These dragonflies have metallic green bodies, with bright yellow stripes on their thoracic cavities (USFWS, 2006). Males can be distinguished from females by the appendage that occurs on the terminal end of their abdomen. Hine's emerald dragonflies were first described in 1931, and adults are typically found in their range from June to July flying one to three meters above the ground (O'Brien, 2002).

The historic range of Hine's emerald dragonflies ranged from Alabama, Indiana, and Ohio although now the dragonflies are found in Illinois, Michigan, Missouri, and Wisconsin. They prefer spring fed marshlands and sedge meadows which are high in a mineral called calcium carbonate (USFWS, 2006). This particular mineral comes from the underlying bedrock comprised of limestone (O'Brien, 2002). Hine's emerald dragonflies also prefer cool, shallow water that is slow moving in which to lay their eggs (Lee et al., 2006).

Hine's emerald dragonflies begin their lives as aquatic nymphs, living two to four years in this stage. They are predatory in nature, feeding upon smaller invertebrates such as mosquitoes. Nymphs are also important in their aquatic habitat as food sources for larger predators such as freshwater fish (USFWS, 2006). In addition to serving as food while underwater, during their molting phase the nymphs typically crawl out of the water onto firm vegetation such as cattails. During this time frame they also serve as an important prey animal for marsh dwelling birds. The nymphs are extremely sensitive to the water quality of their habitat, and thus serve as an indicator species for the marshlands in which they reside. Nymphs, however, are able to survive drought conditions by spending time in abandoned crayfish burrows that occur along their habitat (O'Brien, 2002).

Adult male Hine's emerald dragonflies defend their established breeding territory by flying across the marshland. Mating occurs when a female enters the male's territory. Eggs are laid by the female in the water of the marshland, and she does so by plunging the end of her abdomen into shallow water. The lifespan of an adult Hine's emerald dragonfly is roughly one month (USFWS, 2006). Like most dragonflies, Hine's emerald dragonflies are diurnal for the duration of their adult lives (Cobb and Bradbury, 2008).

While some adult Hine's emerald dragonflies are accidentally killed while crossing roadways that have been erected over their habitat (Furness and Soluk, 2005), the majority of the reason why this species is endangered is due to the requirements for the survival of the nymphs. Pollution in the habitat due to agricultural (i.e. pesticide) runoff is common, as well as groundwater runoff from nearby cities which can pollute the habitat. In addition, habitat destruction in the form of marshland drainage to make way for construction is quite common in the Hine's emerald dragonfly range (USFWS, 2006). Other potential reasons for the decline of Hine's emerald in recent years include their potential to hybridize with other closely related dragonfly species, and invasion of non-native plants in their wetland habitats. Complicating the ability to save this species from extinction includes the fact that their habitat is often a patchwork of managed government lands dispersed between private landownership. The Hine's emerald dragonfly was listed as endangered in 1995 (Monroe and Britten, 2014).

HAWAIIAN PICTURE WING FLY

Fast Facts

Common Name: Hawaiian Picture Wing Fly

Scientific Name: *Drosophila sp.*

Size and Description: Small flies that have clear wings with varying patterns on them. Pattern denotes the species.

Range: Islands of Hawaii, species occur across varying habitat types within the islands

Diet: Decaying organic matter. Some species are specialists of certain plants

Lifespan: Adult lifespan around one to three months depending on the species

Listed: 1995

Threats: Habitat destruction, loss of biodiversity through hybridization, predation by invasive insects

Cool Fast Fact: Considered the “birds of paradise” of the insect world due to male courtship behavior and beautiful colorations


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2018.

The term Hawaiian Picture Wing Fly is used to describe more than one hundred and eleven species of flies that reside on the island chain of Hawaii (Center for Biological Diversity, 2018). Hawaii has a highly unusual number of fly species in general, with seven hundred and fifty species occurring across the islands (Montgomery, 1975). According to the USFWS, thirteen of the one hundred and eleven picture wing species that occur on the islands are endangered. In fact, Hawaii has more endangered species, invertebrate or not, residing within its borders than any other state in the nation (USFWS, 2010).

Hawaiian picture wing flies migrated from the mainland of North America over five million years ago, and have evolved to fill habitats across the state of Hawaii from deserts to rainforests. Each species is found on a single island, and most species are plant specialists, feeding off of the decaying organic matter of that one plant species. Adult picture wing flies live one to three months depending on the species, and they are able to reproduce year round due to the favorable climate of the Hawaiian Islands. There is, however, a typical increase in breeding activity after the rainy season. Adult picture wing flies are identified by their wing coloration (Center for Biological Diversity, 2018).

Mating occurs in areas termed “leks”, where males congregate to battle for the ability to reproduce. Here they butt heads with one another, buzz, fly, and wrestle. This phenomenon has given them the moniker of the “birds of paradise” of the insect world, as like birds of paradise, these flies exhibit strange mating rituals and wing coloration. Both the mating rituals, and the wing coloration, is specific to one species. Once mating has concluded, the females will lay anywhere from fifty to two hundred eggs. Once the larvae (termed maggots) emerge, they will undergo three molts and reach adulthood within a month (Center for Biological Diversity, 2018).

Picture wing flies are faced with several reasons as to why they are currently on the endangered species list, and some of these reasons are typical while others are not. Picture wing flies were originally listed in 1995, although several more species have been added since this timeframe (Center for Biological Diversity, 2018). Like many other insects, Hawaiian picture wing flies face habitat destruction within their range. Due to the delicate balance of life on an island, this has led in some cases to loss of biodiversity among the species through hybridization. This hybridization in turn leads to a decrease in population sizes as well as changes the distribution of the species across the island (Price and Muir, 2008). While land has been set aside as critical habitat for these flies, only 9,000 acres are currently protected, with the historic low of protected acreage falling to around 18 acres. Predation by non-native introduced species such as yellow jackets has not helped the plight of these unique creatures either (Center for Biological Diversity, 2018).

ZAYANTE BAND-WINGED GRASSHOPPER

Fast Facts

Common Name: Zayante band-winged grasshopper

Scientific Name: *Trimerotropis infantilis*

Size and Description: Cryptic tan and brown coloration. Males are 0.5 to 0.6 inches, females are 0.7 to 0.8 inches. Hindwings are yellow in color, lower legs are blue.

Range: Zayante Sandhills of Santa Cruz Mountain Range, California.

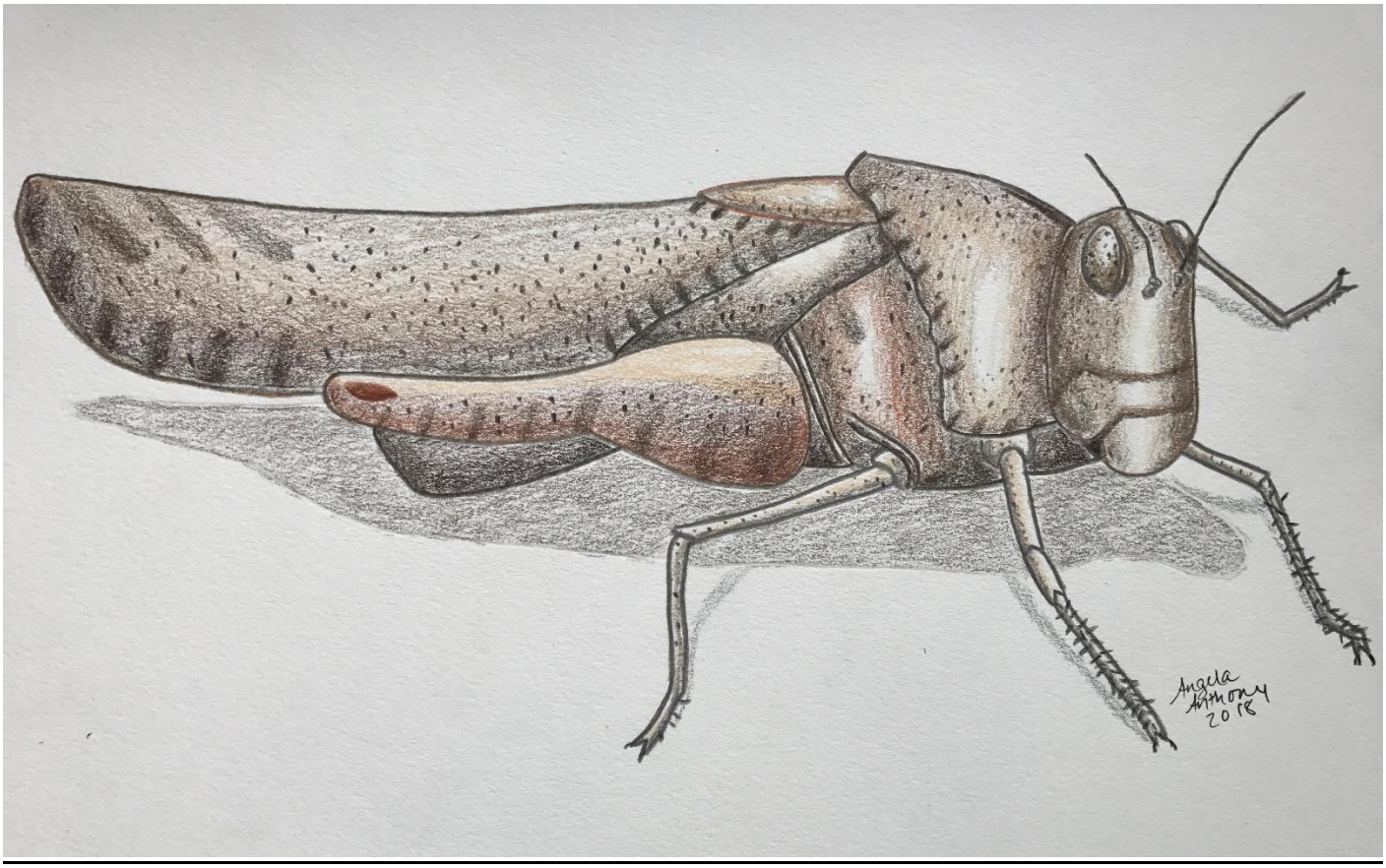
Diet: Lupine and other green foliage occurring in range

Lifespan: Potentially one year

Listed: 1997

Threats: Habitat destruction through mining, agriculture, and urban development

Cool Fast Fact: These grasshoppers will not dine on non-native plants within their range.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Of all of the insects that are showcased within this book, the Zayante band-winged grasshopper has the distinction of being the insect species of which the least is known. In fact, this insect was first described in 1981 (Rentz and Weissman, 1984) and little has been learned in the meantime regarding its reproductive behavior. What is known is that females are generalists when it comes to laying their eggs, depositing them anywhere from on bare ground to piles of manure. Dozens of eggs are typically laid, and they resemble thin grains of rice (Glenn, 2006).

Zayante band-winged grasshoppers are found in the sandy areas of the Zayante Sand Hills, hence their common name. These sand hills make up the foothills of the Santa Cruz Mountain Range, which is located in central and northern California. It is estimated that up to 60% of these sand hills are now disturbed (The Xerces Society, 2018). The historic size of the Zayante Sand Hills encompassed 240 hectares, however currently only around 80 hectares remain (Chu, 2002). Loss in acreage is due to urban development, mining, and agricultural practices (The Xerces Society, 2018).

These grasshoppers are gray, tan, and brown in coloration, with a mottled appearance. Their eye color is similar in coloration to their body. The Zayante band-winged grasshopper's hindwings, visible in flight, are yellow, and their lower legs are blue. It is thought that the coloration of the hindwings serves to startle potential predators when the grasshopper takes defensive flight. Short bursts of flight of three to seven feet are common (The Xerces Society, 2018). A noise termed stridulation occurs in flight, made by the wings (Chu, 2002). Males are smaller than females, with males ranging from 0.5 to 0.6 inches, while female are 0.7 to 0.8 inches (Glenn, 2006).

Zayante band-winged grasshoppers are diurnal, and can be found annually from May to August (Glenn, 2006). They are found in sparsely vegetated areas of their habitat, and are often seen alighting on bare ground, which can make them easily spotted by predators such as birds. Adults feed on lupine and other green foliage that occurs within its habitat, taking care to avoid non-native plants. Zayante band-winged grasshoppers were initially listed on the Endangered Species List in 1997 (Chu, 2002).

SALT CREEK TIGER BEETLE

Fast Facts

Common Name: Salt Creek Tiger Beetle

Scientific Name: *Cicindela nevadica lincolniana*

Size and Description: 0.5 inches in length, dark green to metallic brown with cream colored patterns along dorsal edges

Range: Saline wetlands of eastern Nebraska

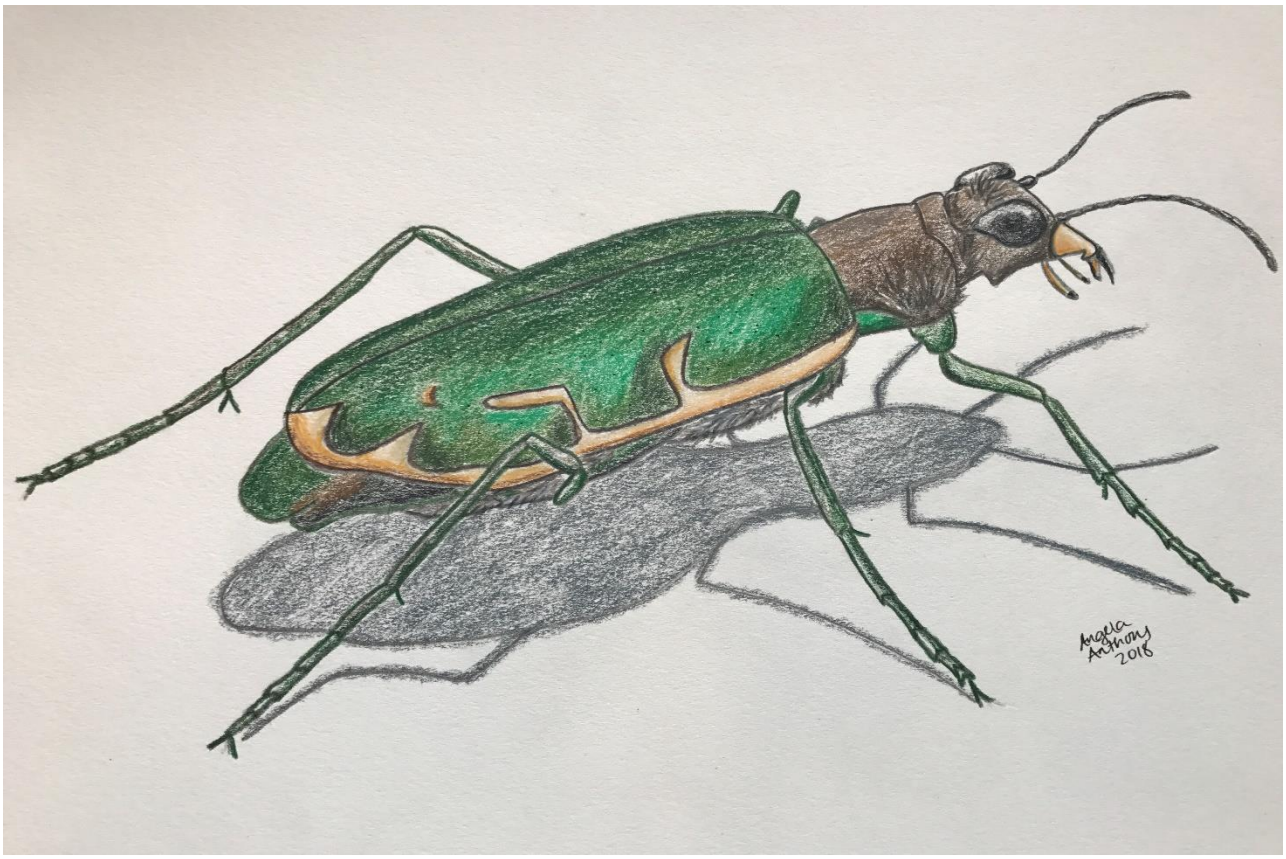
Diet: Other insects

Lifespan: Two years

Listed: 2005

Threats: Habitat alteration and destruction, to a lesser extent artificial lighting

Cool Fast Fact: Salt Creek tiger beetles get their name from their hunting strategy, which is similar to a tiger grabbing its prey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Salt Creek Tiger Beetles, like other species of tiger beetles, get their name from their method of taking prey. Running along the ground at quick speeds they snatch up invertebrate prey in a manner that is similar to the way that a tiger hunts (USFWS, 2017). Salt Creek Tiger Beetles have been found to utilize sunlight as a means to warm themselves, allowing them to emit faster movement in an effort to catch their prey. This, in addition to their efficient eyesight, make SCTB formidable invertebrate predators (Knisley, 2011).

At around a half of inch in length, Salt Creek Tiger Beetles are dark green to metallic brown in coloration, with cream yellow patterns along their dorsal edges. Adult live an average of two years, in which eleven months are spent underground. For about six weeks from June to July they emerge from their burrows to hunt and to mate, capturing any insect smaller than them that passes within a few centimeters (USFWS, 2017).

Salt Creek Tiger Beetles are in sharp decline across their range, and currently only a few hundred remain. An indicator species for their saline habitat, they are found in the saline wetlands of eastern Nebraska. More specifically, the species is found around Salt Creek in Lancaster County and was historically also in neighboring Saunders County. Salt Creek Tiger Beetles inhabit the mud flats that are found along the banks (USFWS, 2017) and females lay their eggs in the muddy, sloping soil (Center for Biological Diversity, 2018). Larvae reside in burrows near where the eggs were laid, and are predators of smaller invertebrates that pass in front of their burrows (USFWS, 2017). Currently the number of molts that are needed to reach adulthood are unknown, however for closely related species the number is three (Center for Biological Diversity, 2018) and these instar stages can take up to three years to complete (Hoback et al., 1998). In addition, larvae can survive in their burrows in periods of brief flooding, up to six days (Hoback et al., 1998).

Salt Creek Tiger Beetles preference for small patches of habitat along Salt Creek has led in part to their placement on the Endangered Species List (Knisley, 2011). Listed in 2005, this species is susceptible to extinction due to habitat alteration and destruction. In addition, it is thought that artificial light emitting into the wetland may draw females away from breeding sites (Center for Biological Diversity, 2018).

RUSTY PATCHED BUMBLE BEE

Fast Facts

Common Name: Rusty Patched Bumble Bee

Scientific Name: *Bombus affinis*

Size and Description: Queens are 20-22 mm, workers and drones are between 13 to 17.5 mm. Similar in appearance to other bumblebee, however only workers and drones have rusty patch on abdomen which is where they get their common name

Range: Historically found in Northeastern and Midwestern states. Range is currently restricted to nine states

Diet: Nectar and pollen from flowering plants

Lifespan: Workers and drones live for a few months in one summer season. Queens can live over a year, wintering underground

Listed: 2017

Threats: Habitat destruction, pesticides such as neonicotinoids, climate change

Cool Fast Fact: Live in smaller colonies that European honeybees


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There are over 4,000 species of native bees in the United States alone (Lambe, 2018), and of the pollination services of these bees humans are able to obtain one in three mouthfuls of food that we eat (Juers, 2017). Rusty patched bumblebees, one of these important pollinator species, were first discovered in 1863 (Juers, 2017) and derive their name from the rusty patch of fuzz that occurs on the abdomens of the workers and drones of the colony (USFWS, 2018). Rusty patched bumblebees live in colonies consisting of one queen, many female workers and male drones, and their colonies are quite smaller than the European honeybee colonies that are kept by humans. For example, a typical European honeybee colony has somewhere around 10,000 bees, whereas a colony of rusty patched bumblebees can have anywhere between 50-1,000 adult bees. The sole job of the queen is to lay eggs that will turn into either workers or drones (USFWS, 2018).

Rusty patched bumblebees were historically found in twenty eight states across the Northeast and Midwest (USFWS, 2018), however their current range is only nine states (Lambe, 2018). This represents a decline of around 87% of their historical range (The Xerces Society, 2018). Within their range, rusty patched bumblebees are found in residential parks, prairies, woodlands, marshes, gardens, and agricultural landscapes where they pollinate agricultural crops and contribute greatly to our food security (USFWS, 2018). In fact, one of three bites of food that we as humans eat are the direct benefit of these aforementioned pollinator services (Juers, 2017). Rusty patched bumblebees are directly responsible for pollinating agricultural crops such as cranberries, plums, apples, alfalfa, and onion seed to name a few (The Xerces Society, 2018).

The female foragers, termed workers, are the bees that are responsible for gathering nectar and pollen to bring back to the colony. In addition to foraging, workers are also tasked with caring for the young and defending the colony from predators. Colonies are often found in abandoned underground rodent cavities (USFWS, 2018). Workers, and the male counterparts of the colony called drones, are typically around 13 to 17.5 mm in length, where the larger female queen is around 20-22 mm in length (Active Wild, 2018). The female workers do not typically travel farther than one kilometer from the colony to forage (Juers, 2017). The workers and drones are active from April through September, and die off at the end of the growing season. Queens overwinter in the ground, and must have undisturbed soil in which to hibernate. In the spring the overwintering queen emerges and begins looking for a nest, or colony, site. Sperm has been stored over the winter within the queen from fall mating flights of nearby drones from other colonies, and she lays her eggs to begin the process over again (USFWS, 2018).

Rusty patched bumblebees face the same hardships as many other bees in the race to survive. For example, habitat destruction is to blame for lessening numbers of bees, as urban development and an agricultural practice termed monoculture take over former grasslands and prairies (USFWS, 2018). Climate change is another factor in the listing of the rusty patched bumblebee on the Endangered Species List, as this particular species is well equipped to handle cooler temperatures due to its fuzzy body, but does not fare well as temperatures rise (Juers, 2017). Disease spillover from other species, including the *Nosema* parasite, which is found in European honeybee colonies managed by humans, has also lessened their numbers (Juers, 2017), as well as overuse of pesticides. One study concluded that over 400,000 tons of pesticides are used annually on agricultural fields, killing not only pest insect species but beneficial species, such as pollinating bees, as well (Lambe, 2008). Once common into the 1990's, the rusty patched bumblebee is on the brink of extinction (Schweitzer et al., 2012). Complicating matters, the rusty patched bumblebee has a shorter tongue than other bumblebee species, and thus

some plants it cannot use as food sources (Juers, 2017). In addition, while artificial nest boxes can be used to help other bee species, due to the habit of rusty patched bumblebee colonies occurring underground, this method seldom helps this particular species of bee (Schweitzer et al., 2012).

MONARCH BUTTERFLY

Fast Facts

Common Name: Monarch Butterfly

Scientific Name: *Danaus plexippus*

Size and Description: Wingspan of 3.4 to 4.1 inches. Males and females have a black body with orange and black wings. Males have thinner lines on hindwings as well as dark areas on the topside of the hindwing

Range: Across North America, including Mexico and Canada

Diet: Nectar and pollen from flowering plants

Lifespan: Depending on the generation, a few weeks to nine months

Listed: Not currently listed, but potential listing in next few years

Threats: Habitat destruction, logging of overwintering site, pesticides, climate change, loss of milkweed

Cool Fast Fact: Monarchs can travel over 3,000 miles over the course of a few months


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**Monarch butterflies are probably the single most recognizable insect species in all of North America, but unfortunately their numbers across the continent are in deep decline. Although not currently listed, they are being scrutinized with great care by scientists, non-profit organizations, and the average citizen for the potential to be included on the Endangered Species List.*

Monarch butterflies are frequent visitors to flowering plants in meadows and prairies, and even in medians and roadside ditches, where wildflowers- if left alone- can be abundant (Boy Scouts of America, 2018). Monarchs are large butterflies, with a wingspan of 3.4 to 4.1 inches (National Geographic, 2018) and begin their lives as small eggs laid in the hundreds on the underside of several species of milkweed plants. In fact, without the milkweed which is what Monarch larvae, termed caterpillars, feed on, the butterflies are unable to successfully reproduce. Unfortunately milkweed is viewed as an agricultural pest plant as it often invades fields of such cash crops as soybeans and corn, and farmers spray herbicides to control it as it can affect crop yields and thus the farmer's wallet (Pleasants and Oberhauser, 2013). Milkweed consumption by Monarch larvae are also the reason why Monarch butterflies are poisonous to potential predators (Brower and Glazier, 1975).

Both male and female Monarchs display the orange and black wing coloration, with a black and white spotted thorax and abdomen. The sexes can be differentiated by the thinner webbing and single black marks that are present on the topside of the male Monarch's hindwings (Boy Scouts of America, 2018). Monarchs, like all butterflies, have a four stage life cycle. After the egg hatches, the Monarch larvae emerges, and is easily recognizable by its alternating bands of yellow, black, and white. The caterpillars will attain the overall length of five centimeters, through four molting stages, before changing into the chrysalis and going through metamorphosis. This is the only butterfly chrysalis that is green in coloration with a gold rim along the upper portion of the chrysalis (Boy Scouts of America, 2018). Monarchs may be the longest lived butterflies in the world, as the southbound overwintering population lives for nine months. This is in sharp contrast to the three to four northbound generations, which are the reproductive generations that only live for two to five weeks (USFWS, 2014).

Found across the United States, Mexico, and Canada, there are actually two separate populations of Monarchs in North America. The western population is those insects that are found west of the Rocky Mountains and that overwinter in southern California in eucalyptus, Monterey pines, and Monterey cypress. The eastern population of Monarchs are those that make the historic trek to the overwintering site in Mexico, traveling upwards of 3,000 miles over the span of three to four months (USDA, 200). Both populations are in decline, with the western population declining 80% and the eastern population declining 90% in recent years (USFWS, 2014). The decline of both populations is a combination of many factors including overuse of pesticides and herbicides, habitat destruction, loss of milkweed needed to lay eggs upon and feed the larvae, climate change, and deforestation of the overwintering site, particularly in Mexico. The Transvolcanic Mountains, where the large overwintering site is located, has been in sharp decline in recent years, with the historic size of the site at 6.7 hectares being reduced to 0.67 hectares (USFWS, 2014). A protozoan parasite that affects Monarch flight has also contributed to the decline of the species as well (Bradley and Altizer, 2005).

High up in oyamel fir forests in a mountain range in Mexico, 2,400 to 3,600 meters above sea level, Monarchs overwinter in the thousands, clinging to the branches of the firs (USDA, 2008). Annual counts of the Monarchs are done in Mexico, and this is the main way that scientists have been able to prove the rapid decline in numbers of this iconic butterfly (Pleasants and Oberhauser, 2013). These

forests are perfect grounds for the overwintering Monarchs as they are humid, so that the butterflies do not dry out, and not too cold, so that the butterflies do not use up fat reserves that will help them on the migration north come spring. Prior to their arrival in Mexico, these butterflies have traveled 2,000 to 3,000 miles over the span of several months (USDA, 2008).

Early studies completed in the 1940's focused on tagging the butterflies to simply figure out where they were going (Brower, 1996). Monarch Butterflies are diurnal creatures, and their migration, unlike most birds, happen during the daylight as well (USDA, 2008). Both weather and winds help the Monarch complete both northern and southern migrations, as good weather and fair winds can help speed along the migration without depleting the butterfly of energy reserves. One study documented Monarchs flying at 50 kilometers an hour when given a strong, favorable tailwind (Brower, 1996).

Monarchs use both the orientation of the sun to navigate, as well as the earth's magnetic fields. In fact, it is thought that the higher magnetic field found in and around the overwintering forests in Mexico correlates with the magnetic particles that are found in the Monarch's thorax and that this helps lead them to the overwintering site (Brower, 1996). After spring arrives, the overwintering Monarchs will migrate north to Texas where they will lay the eggs that will hatch into the first of three generations that will get the Monarch butterfly species back to Canada (USDA, 2008). Much attention is currently being paid to Monarch butterflies, and citizen science has had a large role in attempting to reverse the decline in numbers of both the eastern and western populations.

CONCLUSION

So what can we, as American citizens, do to help the insects and other species that appear annually on the Endangered Species List? Surely there are ways that we can help boost declining numbers and waning populations. Well, the answer depends on the reason why the species is in decline to begin with. For habitat destruction, such as deforestation and clearing of wetlands for urban development, the answer is as simple as mitigating the number of trees that are harvested per year and utilizing existing buildings and structures that are sitting empty rather than clearing native habitat to build new infrastructure.

For bees and butterflies that are in decline, and there are many more on the Endangered Species List than what appears in this book, the answer may be to increase the amount of pollinator gardens while in turn decreasing the overuse of pesticides. In fact, a type of pest management called Integrated Pest Management, which utilizes several other practices outside of the spraying of pesticides, is a wonderful way to curb pest species while promoting beneficial species within the environment. Agricultural will also need to be modified, and instead of planting vast fields of a single crop, termed monoculture, we should practice good crop rotation and understand that while we see some plants such as milkweed as simple weeds, they actually do serve a purpose in the environment.

Education has always been the driving force of conservation, as mentioned in the introduction, as citizens won't save what they don't know or care about. Education also comes from innovative research conducted by scientists who are adequately funded by the governmental agencies that oversee them. Simply put, we must modify human behavior to stop extinction of species. No other questions should be asked other than the simple "Is this species endangered or not?" (Shogen et al., 1999).

How to Get Involved

If this book has stirred you to conservation action, or you simply want to learn more about a particular species mentioned in this book, the following websites may be beneficial and of use. This is by no means an exhaustive list of all of the organizations and federal entities that are actively working on ground to promote the wellbeing of endangered insects in the United States, and across the globe.

United States Fish & Wildlife Service, a division of the United States Department of the Interior, www.fws.gov

Monarch Watch, a non-profit organization geared towards to conservation of Monarch Butterflies, www.monarchwatch.org

National Wildlife Federation, a non-profit organization that promotes the conservation of all species within the United States, www.nwf.org

The Xerces Society, the non-profit organization that deals with all things invertebrate, www.xerces.org

Rusty Patched, a website dedicated solely to providing information about the endangered Rusty Patched Bumblebee, www.rustypatched.org

Amateur Entomologist's Society, an organization/club that provides ample information on all insects, www.amentsoc.org

Save the Bees Project, providing information on how to help North American bee species in decline, www.savethebeesproject.com

Center for Biological Diversity, another non-profit organization geared towards conservation, www.biologicaldiversity.org

Honey Bee Health Coalition, website and group that works to conserve both native and non-native (but beneficial) bees, www.honeybeehealthcoalition.org

The Honey Bee Conservancy, another group and website that promotes bee species and health, www.thehoneybeeconservancy.org

Bumblebee Conservation Trust, geared specifically at protecting and educating about bumblebee species, www.bumblebeeconservation.org

The Endangered Species List, managed by the USFWS, www.fws.gov/endangered

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