New Jersey Monarch Butterfly Conservation Guide

New Jersey Department of Environmental Protection *2017*

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Acknowledgements

A great deal of research has been done over the decades on the biology and ecosystem function of monarch butterflies. This report relies on research provided by educational institutions, nongovernmental organizations, citizen science initiatives, and various government agencies. The New Jersey Department of Environmental Protection (DEP) would like to acknowledge all sources cited in this document for their contribution to the formation of this plan. The Center for Environmental Cooperation's "North American Monarch Conservation Plan" inspired the general structure of this document. The Xerces Society for Invertebrate Conservation, the Pollinator Partnership, the New Jersey Audubon Society, Monarch Watch, Monarch Joint Venture and others cited frequently in this report are among the immensely valuable sources that have contributed to the successful formulation of this guide.

Special recognition is given to volunteer April Nicklaus for her invaluable research, writing and design work on this project during her tenure with the department.

Introduction

The annual migration of the monarch butterfly through New Jersey is a much anticipated phenomenon, one that holds environmental, educational, and economic value to the state.

Yet the monarch butterfly is facing severe decline, with the unique and fascinating migration of the eastern monarchs through New Jersey each fall having dwindled. Tourists once flocked to Cape May to see the monarchs pass through the region on their grand journey to Mexico, but in recent years the spectacle many once enjoyed has been reduced to a fraction of what it once was, and the tourism it brought to the area has fallen with it.

Formerly a common feature of the summertime, the source of many childhood experiences with nature, and with symbolic significance like that of no other insect in North America, the monarch butterfly holds significant environmental value as well. Monarch butterflies are among the group of native pollinators that aid in the successful reproduction of many key fruit and vegetable crops across the state, and are crucial to New Jersey's agricultural and economic success. Monarchs are also an indicator species for environmental health: monarch health often reflects the overall health of the environment. The monarch butterfly's rapid decline in numbers indicates a need for awareness and action, lest this once populous butterfly become even scarcer in our state.

The New Jersey Department of Environmental Protection (DEP) has a mission to protect the wildlife and natural resources in the state for continued benefit of the public. The purpose of this guide is to educate people about the monarch butterfly and to provide recommendations to enhance its habitat and numbers. An overview of the monarch lifecycle and migration pattern is followed by a review of its habitat needs, both in its overwintering sites and in its summer breeding range, including New Jersey. The cultural and environmental significance of the monarch butterfly is described. The report summarizes the many factors contributing to population decline, as well as the efforts that have been made across the continent in the areas of monarch research, conservation, and public education. The final section contains actionable recommendations that governments, businesses, educational institutions, nonprofits and individuals in New Jersey can use in their efforts to aid the monarchs.

Background: The Monarch Butterfly

The monarch butterfly (*Daneus plexippus*) is the most iconic butterfly in North America: its flashy orange and black wings and expansive migration and breeding grounds make it easily recognizable across the continent. In addition to its scientific and environmental value, the monarch has huge cultural significance to people across Canada, the United States, and Mexico. While monarchs are native to all areas of North America and have been introduced to Hawaii, the Caribbean, Australia, and some areas of Europe, the concern of this document is primarily for the famed eastern migratory subpopulation of monarchs, with habitat ranging from the eastern side of the Rocky Mountains to the east coast. Members of the eastern monarch population are seen in New Jersey in the summer months, and can be observed in Cape May each year as they begin their epic fall migration to wintering roosts in central Mexico.

Life Cycle

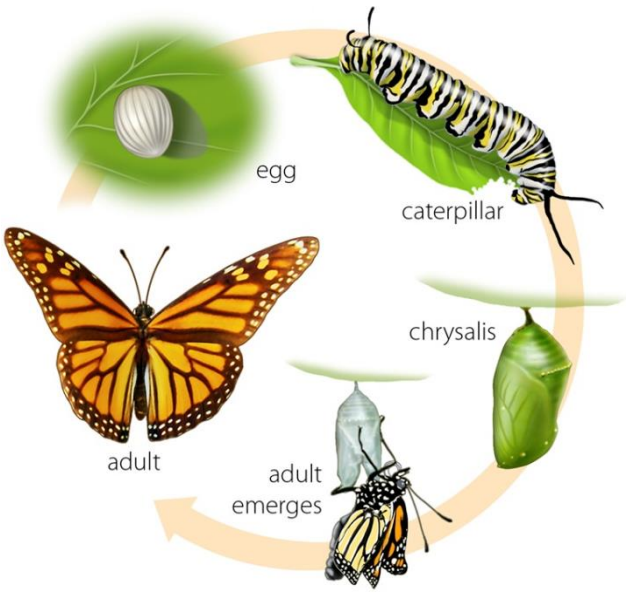
It is important to distinguish between the spring and summer breeding monarchs and the generation that makes the phenomenal fall migration. It takes four to five generations of monarchs to complete the annual cycle of migration and breeding.

The National Geographic Society's *time-lapse video of the monarch life cycle,* excerpted from its National Geographic Channel program *Great Migrations,* is an excellent resource for learning more about the monarch's annual migration and breeding cycle. The monarch life cycle is described below.

For non-migratory monarch generations

An average monarch butterfly in summer breeding grounds will complete its lifecycle in six to eight weeks. A female monarch ready to lay eggs must seek out milkweed *(Asclepias)*, as it is the only host plant that can support monarch caterpillars. There are about 140 recorded species of milkweed, many of which are widespread in different areas of the monarch's breeding range and play an integral role in successfully rearing the next generation of monarchs. Once an egg is laid on a milkweed leaf, it will develop for three to five days before hatching into a caterpillar.

For 10 to 14 days, the monarch caterpillar will grow. Aside from the initial task of eating its eggshell and the occasional snack of the molten skin it has outgrown, the caterpillar subsists solely on milkweed leaves.



Monarch Life Cycle – Illustration by: Paul Mirocha

Milkweed offers a particular kind of defensive benefit to monarchs: its cardenolides, a toxic chemical, make milkweed a foul and unsavory option for any animal -- even mammals as large as livestock -- who may try to eat it. However, the monarch caterpillar has a mechanism to sequester this toxin, and accumulates enough in its system as it grows so that it, too, may ward off predators with its bitterly toxic taste. The caterpillars cannot subsist on any plant other than milkweed. This adaptation, known as monophagy, may allow the species to be particularly well adapted to its selected food source, but places the species in a precarious position when that food source is less abundant.

Once the monarch has completed its two-week phase of growing, molting, and eating, it will enter the pupal stage. The location of monarch pupation is not as specialized as the location of laying eggs: they often move to any nearby location that can accommodate their need to hang upside down during this stage. This they do in a hard shell called a chrysalis, formed around the pupa for protection. In a natural environment this typically means situating on the bottom of a leaf or branch of another plant, but those who rear butterflies may have them forming this chrysalis attached to manmade objects or structures. The monarch will remain in the pupal stage for 10 to 14 days as it develops into an adult monarch butterfly.

Did you know?

Monarch caterpillars shed their skin FIVE times before pupation

Once the monarch emerges from its chrysalis, its wings dry and harden, and it will begin its life as an adult butterfly. The adult monarch will reach sexual maturity within four to five days of emerging from its chrysalis, and reproduce shortly thereafter to complete its life cycle. While monarch caterpillars are specialists and can subsist on only one type of plant for food, it is important to note that adult butterflies are generalists that can feed off of a wide variety of nectar-producing plants. An adult monarch can only survive in a habitat that contains nectar sources throughout the breeding season; given the relatively brief flowering period of any given milkweed species, this indicates a need for a variety of nectar plants with a diverse array of flowering times.

For the migratory monarch generation

The migratory monarch generation is very different from the non-migratory generations that precede it in the annual cycle; after completing the first three phases of their life cycle—egg, caterpillar, and pupa—as normal, they enter a phase called “diapause” which causes them to be physiologically distinct from previous generations. Diapause refers specifically to the prolonged state of sexual immaturity of the butterflies, where neither the males nor females are sexually developed enough for reproduction.

In conjunction with this change comes the migratory behavior of this monarch generation, where they begin an epic journey south to Mexico for the winter. This generation of monarchs can live for about eight months, compared to the much shorter lifespan of an average breeding monarch. This expanded lifespan will allow the monarch to migrate all the way to its wintering roosts in Mexico -- some coming from as far away as southern Canada -- and then to migrate again after winter's end, with most making it as far as Texas and the Gulf States before coming to rest at their new breeding grounds.

Did you know?

Day length, temperature, and quality of milkweed plants are all cues monarchs use to know when to produce their migratory generation

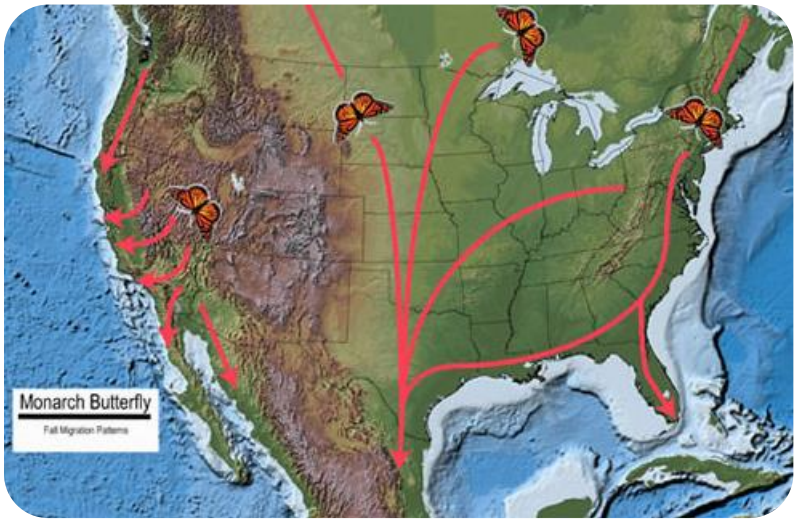
These monarchs have other physiological differences that allow them to make their great flight, including thicker abdomens to accommodate extra fat storage for the long journey. Migratory monarch populations also generally have larger and better adapted wings for flying compared to non-migratory populations, and females in the migratory population are generally found to be better flyers than males due to well adapted wings and a lighter overall body weight.[1, 2]

This generation of monarchs will not reach sexual maturity until the winter is over, upon which they will begin their northerly trek back into the United States. When they reach the breeding grounds in Texas and the Gulf States, they will finally reproduce and complete their life cycle.

Migration

Monarchs have a very distinct and fascinating migration pattern. The annual cycle of eastern migration begins with the fall migration, during which monarchs on the eastern side of the Rocky Mountains -- from southern Canada to the U.S. Midwest --follow different paths to the wintering sites they return to year after year.

These general pathways of migration are known as monarch "flyways," represented on the map by red arrows.



Monarch Butterfly Fall Migration Patterns. Credit: Base Map, USGS National Atlas, USFWS.

[1] Altizer, Sonia; Davis, Andrew K. "Populations of Monarch Butterflies with Different Migratory Behaviors Show Divergence in Wing Morphology." *Evolution* 2010: 1018. *JSTOR Journals.* Web. 31 May 2016

[2] Andrew K. Davis and Michael T. Holden, "Measuring Intraspecific Variation in Flight-Related Morphology of Monarch Butterflies (Danaus plexippus): Which Sex Has the Best Flying Gear?," Journal of Insects, vol. 2015, Article ID 591705, 6 pages, 2015. doi:10.1155/2015/591705

The western population, also shown on the map, overwinters primarily in coastal California, with some heading south towards Mexico. During the migration, monarchs need to rest and refuel at “stopover” sites along the flyway. Cape May, New Jersey is one such site where the butterflies can be seen congregating each year.

While the majority of eastern monarchs overwinter in central Mexico, some are known to wait out the cold in southern Florida. On occasion, monarchs found overwintering in Florida and parts of Mexico do not migrate north in the spring—these are then known as “residential” populations, because they stay in their warm weather residence throughout the year.

The fall migration is complete once the monarchs reach their overwintering sites. While each migrating flock is at least 4 generations removed from the previous generation to make the flight, they find these sites consistently through each cycle. There is evidence that the butterflies have a biological compass guided by sunlight to steer them towards Mexico, but how they find the exact sites of the sanctuaries remains a mystery.

2008 monarchs clustered on Oyamel fir in Sierra del Chincua sanctuary, Michoacán Mexico. Photo: Mario Vazquez/AFP/Getty

There are a handful of sites in Mexico that are designated monarch sanctuaries, in which millions of monarchs gather each year for protection throughout the winter. These sites include El Rosario and Sierra del Chincua in the state of Michoacán, and La Mesa and El Capulin in the state of México. Overwintering monarchs require a delicately balanced habitat to survive, and these sites provide the water access, tree cover, and microclimate the butterflies need to make it safely through the cold season.

Habitat Needs

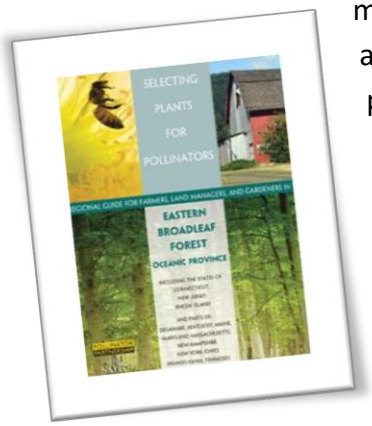
Monarchs have a large habitat range, spanning across the entire North American continent. Across this vast area, monarchs require certain features in their habitat in order to survive. Of the large continental range of potential habitat, only a relatively small portion will be appropriate breeding space, and the delicate needs of overwintering butterflies can be met only by a handful of locations in Mexican forests.

Summer Breeding Ground Habitat

A primary and well-known feature of monarch habitat is milkweed, as it is the only plant upon which monarch caterpillars can live and feed. Different species of milkweed are native to different regions of the continent; the United States Department of Agriculture's (USDA) Natural Resources Conservation Service hosts a PLANTS Database that clarifies which species of milkweed (*Asclepias*) are native to different regions. To access the database, click the graphic on the left or go directly to *plants.usda.gov*.

However, there is more that goes into a successful monarch habitat than just milkweed!

As discussed above, while milkweed provides sustenance for the caterpillars, adult butterflies need more than just milkweed to survive. Viable monarch habitat must support all stages of monarch life, which means nectar plants for the adult monarchs must be available for the entire breeding season. Milkweeds may be good nectar plants, but any given species of milkweed will not flower throughout the entire breeding season; therefore, native wildflowers are needed to supplement milkweed in a monarch habitat. While monarchs are able to feed off of non-native nectar plants, native species have a number of benefits: they are well adapted to growing in that environment, they are more easily recognized as a food source, and they can provide a variety of services to native pollinators and other fauna beyond just the monarch butterfly. The Pollinator Partnership has a helpful *ecoregional planting guide* containing information on bloom times for native nectar plants.



Fundamentally, monarchs need the same resources in their breeding environment that any other organism needs: access to food, water, and shelter. Milkweed and other native nectar plants cover the food requirement, but access to water and shelter is just as crucial. Milkweed doubles as a shelter area for monarch caterpillars, but adult butterflies should have other options available in the event that poor weather drives them to take cover under leaves. Fallen logs and leaf litter are amongst the types of suitable shelter.

While water does not need to be on-site along with the milkweed and other resources, it must be within brief flying range to be of use. Particularly for those monarchs preparing for migration, scarce or far-spread food and water resources will result in a depletion of vital energy that would otherwise be spent in flight.

Did you know?

Monarchs and other butterflies sometimes drink from mud puddles to obtain both water and minerals. This behavior is called "mud-puddling"

Overwintering Habitat

Monarchs are unable to survive freezing temperatures for extended periods, making temperature the driving factor of their extensive migration. Compared to the vast spread of their breeding range, the overwintering area in Mexico is incredibly small: while summer monarchs can span the continent, the overwintering grounds can cover just five to 50 acres. However, while the clusters of monarchs condense in tight areas during the winter, the exact locations of the clusters vary from year to year within the same general area. All factors contributing to the suitability of these particular sites are not fully understood. Forested areas in which monarchs cluster must also be surrounded by a swath of additional forest, to act as a buffer zone and maintain the precise microclimate that monarchs need to survive the cold. Hence, the total area required to sustain the overwintering monarchs is much larger than the core of their cluster in a given year.

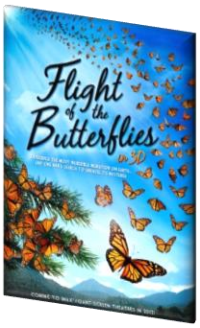
These sites are in remote, mountainous locations of central Mexico, and had for a long time remained undiscovered by researchers. The area in which monarchs spend the winter is a forest of Oyamel fir, fairly rare in Mexico; it is unclear why the butterflies are flock to these trees more so than any others when seeking out their winter habitat. While the butterflies' choice destination does have nighttime temperatures below freezing, these cold periods are relatively short and, most importantly, dry. The monarchs generally do not freeze during brief colds spells as long as they do not get wet. The cool, dry mountains of Oyamel fir forest provide a well-protected and secluded microclimate for the monarch butterflies to cluster in semi-dormancy until winter's end.

Environmental and Cultural Significance

Monarch butterflies and their epic migration have long been a fascination across the North American continent, and have become an integral piece of education, science, and rich cultural tradition. The peoples of Mexico, Canada, and the United States all have a unique connection with this iconic insect, with appreciation and concern for monarchs a natural point at which the continent unites.

Monarchs on a traditional "Día de los Muertos" skull. Photo: Alfonso Castillo

In Mexico, the arrival of migrating monarchs has a particular traditional significance. The migration coincides with the fall celebration of "Día de los Muertos," or Day of the Dead, a holiday intended to honor deceased ancestors. Local legend views the monarch arrival as the return of souls of the dead in time to be honored by this holiday.



In Canada, monarchs have become a focal point of *tourism and natural education in national parks*, and citizen science efforts in various Canadian provinces are quite active. Indeed, it was a Canadian research team, led by Frederick and Norah Urquhart, that first identified the elusive location of the eastern monarchs' overwintering sites in central Mexico in 1976. The riveting tale of this discovery was captured in a film ("Flight of the Butterflies") by a *Canadian film company*, and is making its rounds through theatres across the continent as a fusion of entertainment and education.

In the United States, professional and citizen science are both influential in tracking and understanding these unique creatures. *Government agencies*, many educational institutions, and groups like the *Monarch Joint Venture* and *Journey North* promote monarch conservation practices and tagging of butterflies to track migration. The New Jersey Audubon Society hosts an annual *Monarch Monitoring Project* at Cape May to track the fall migration.

Did you know?

Many universities have monarch-focused programs, including the *University of Minnesota*, *California Polytechnic*, *University of Kansas*, and *University of Northern Iowa*

The monarch is a popular figure everywhere from art exhibitions and cultural celebrations to elementary school science classes, but they play an even more important ecological role: monarch butterflies are pollinators, and a highly visible indicator species that acts as a cue to environmental health.

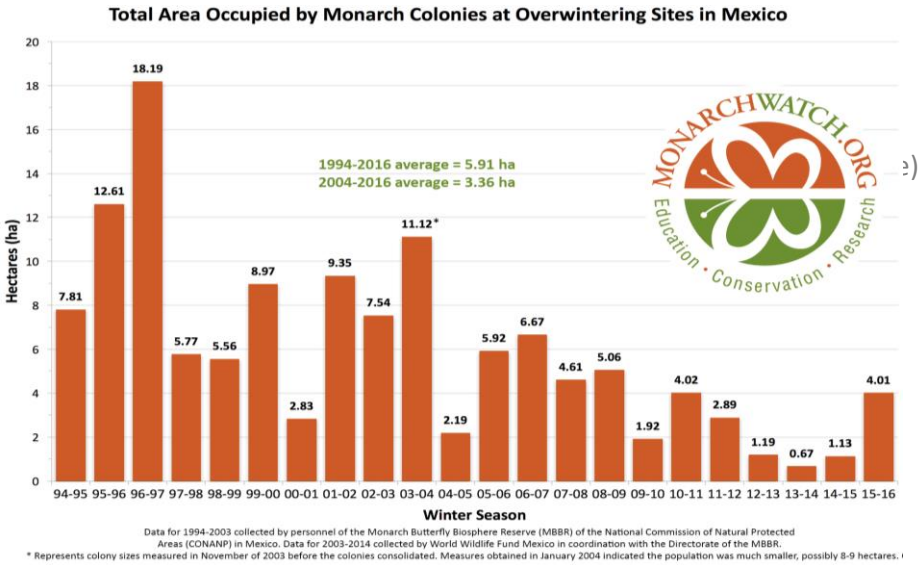
Pollination brings us food, another need shared in common with our neighbors to the north and south. Every third bite of food an average person eats is the product of pollination from monarchs and many other pollinator species.[3] It is imperative to preserve pollinators for the sake of food security, and the security of the environment as a whole. Monarchs and other butterflies are sensitive to environmental changes, and their decline serves as a readily visible sign of the condition of the environment for other living things as well. Efforts to aid monarch recovery concurrently benefit species at all levels of the ecosystem. Monarchs and other insects are near the base of an ecosystem's food chain; they respond strongly to fluctuation in available food (plants), and the high visibility of butterflies translates the changes in plant life into something humans will notice. Their placement in the overall food chain also means that other animals that rely on monarchs and other insects for food are affected by their population decline, and by efforts to aid them.

[3] "Insects & Pollinators." *National Resources Conservation Service*. United States Department of Agriculture, n.d. Web. 09 June 2016. <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/>.

Population Decline

Over the past several decades, the number of monarch butterflies in North America has steeply declined. The great migration of the eastern monarchs has been named a “threatened phenomenon” by the International Union for Conservation of Nature and Natural Resources (IUCN). As of a 2014 estimate, the monarch population has declined some 90% since 1990, from approximately one billion butterflies to 35 million butterflies.[4]

Monarch migration covers a vast expanse of area, making precise estimates of the monarch population difficult. However, estimates taken at the monarch overwintering sites, which provide a look at the butterflies when the population is concentrated in a small area, show a very clear decline. A graph from *Monarch Watch* illustrates the substantial decrease in recorded overwintering area (measured in hectares) since 1994. In the 2014 measurement, overwintering monarchs covered an area of less than one hectare, the lowest on record. The population seemed to rebound somewhat in 2016, but a severe winter storm shortly after the recent estimates were taken may have diminished the apparent step toward recovery.



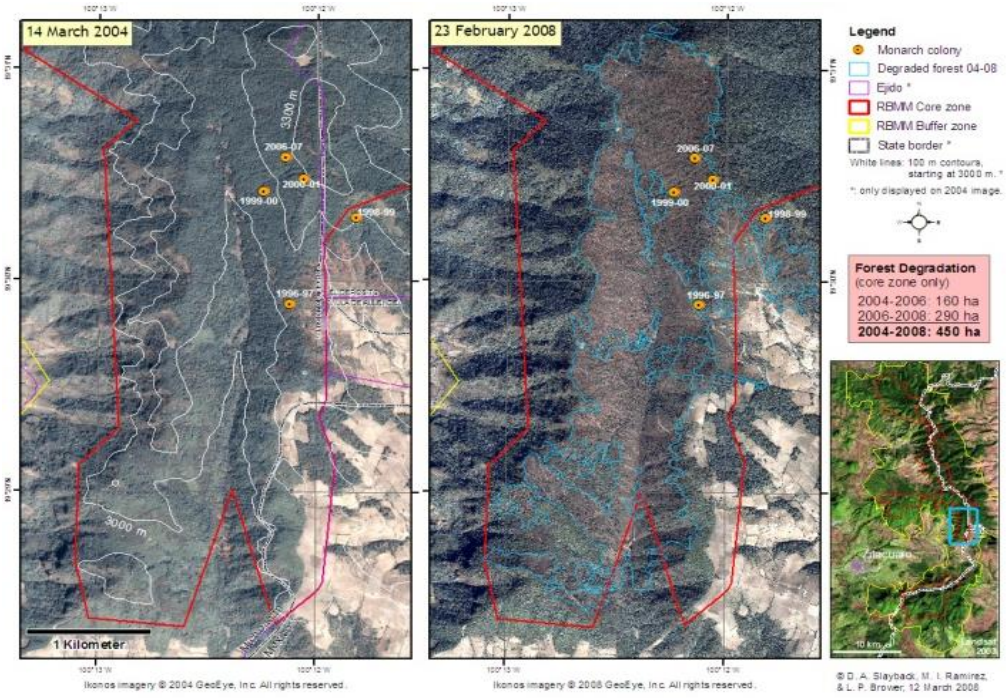
[4] "After 90 Percent Decline, Federal Protection Sought for Monarch Butterfly." *The Xerces Society*. The Xerces Society for Invertebrate Conservation, 26 Aug. 2014. Web. 06 June 2016. <http://www.xerces.org/after-90-percent-decline-federal-protection-sought-for-monarch-butterfly-2/>.

Factors in Population Decline

Habitat Loss and Fragmentation

Of great concern is the loss of overwintering habitat in Mexico, threatened by local subsistence farming, improperly managed tourism, and illegal logging. Between 2004 and 2008 alone, about 450 hectares (1,112 acres) of territory within the Monarch Butterfly Biosphere Reserve in Michoacán, Mexico were severely degraded by illegal logging activities. [5] Monarchs survive the winter in a very small territory of a specific microclimate, and destruction of that territory greatly effects survival through the cold season. Despite this area being legally protected by the Mexican government, degradation of monarch habitat continues.

MMBR Core Zone Deforestation at Lomas de Aparicio Monarch Colony Site (*Crescencio Morales*)



Ikonos imagery, copyright GeoEye, Inc. The current images were created by Lincoln Brower (Sweet Briar College), Dan Slayback (SSAI, Inc) and Isabel Ramirez (Universidad de Mexico, Morelia), and funded by the Monarch Butterfly Sanctuary Foundation.

(Click image to enlarge)

A significant amount of summer breeding habitat has also been lost as a result of development of land for commercial or residential use, conversion of habitat to agricultural use, illegal logging in overwintering habitats, as well as many of the additional factors described below. As of a 2014 estimate, between agricultural and development losses, about 167 million acres of monarch summer breeding habitat have been lost since the mid-1990s; this means that habitat

[5] Brower, Lincoln. "Illegal Logging of Monarch Sanctuary in Mexico." *Learner.org*. Journey North, 12 Mar. 2008. Web. 06 June 2016.

amounting to roughly the size of Texas was lost in the past two decades.[6] This number has likely increased in the years since the last estimate was made.

Changes in Climate and Extreme Weather

Monarchs are very sensitive to temperature change and weather conditions; changes in climate effect both the overall climatic suitability of habitat and the frequency and severity of extreme weather events in the monarchs' broad habitat range. The changing climate may shift the availability of summer breeding habitat and disturb the even more fragile microclimate of the monarchs' overwintering sanctuaries in Mexico.

Disruptions to overwintering habitat due to shifting climate and erratic weather can be devastating. In January 2002, a winter storm hit the monarch sanctuaries in Mexico and caused the death of an estimated 500 million monarchs, averaging about 75% mortality of the eastern monarch colonies wintering there.[7] In January of 2004, another winter storm hit, causing the death of an estimated 70% of the population.[8] A late-winter storm in March of 2016 created additional concern of widespread destruction, though many monarchs are thought to have left the overwintering sites for the northern migration before the storm hit. Mortality estimates from the 2016 storm are limited at this time. Climate change increases the frequency and magnitude of severe weather events.[9] Additional fierce storms will likely cause monarch mortality in the future.

Further concern about climate change impacting monarchs comes from the overall effect of warming. Extended exposure to the cold temperatures of their overwintering areas is what signals them to turn around and begin their spring migration back north, and without exposure to cold the monarchs would continue flying south.[10] Thus, a warming climate may remove the signal that stimulates their return migration, and disable their ability to find their way back to the summer breeding habitat in New Jersey and elsewhere.

Pesticides and Genetically Modified Crops

The increased use of herbicide tolerant (HT) crops has been an issue for the monarch caterpillar's only host plant, milkweed. Much of the corn and soybean crops grown in the U.S. are now genetically modified to be resistant to glyphosate, a synthetic systemic herbicide used

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[6] Taylor, Orley. "Monarch Population Status." *MonarchWatch.org*. N.p., 29 Jan. 2014. Web. 26 May 2016. <http://monarchwatch.org/blog/2014/01/29/monarch-population-status-20/>.

[7] Oberhauser, Karen Suzanne, and Michelle J. Solensky. *Monarch Butterfly: Biology & Conservation* (pp. 162): Cornell UP, 2004. Print.

[8] Taylor, Orley. "MONARCH BUTTERFLY PRESS BRIEFING." *MonarchWatch.org*. N.p., Apr. 200. Web. 6 June 2016. <http://www.monarchwatch.org/press/Monarch-Press-Briefing-200904.pdf>.

[9] "Extreme Weather." *NCA.gov*. U.S. Global Change Research Program, 2014. Web. 22 June 2016.

[10] "Cold Triggers Northward Migration." *Learner.org*. Journey North, n.d. Web. 09 June 2016. <https://www.learner.org/jnorth/tm/monarch/cold_triggers_migration.html>.

against perennial weeds. The glyphosate-resistant nature of the crops allows for broad spraying of the herbicide over fields, eliminating all plant life without that resistance that may otherwise compete with the crops for nutrients, sunlight, and other resources. Unfortunately, milkweed cannot withstand glyphosate spraying, and thus the milkweed that previously thrived in farm fields is rapidly disappearing. The government of Alberta, Canada *provides a list* of products that contain glyphosate.

While the presence of herbicides on crop fields poses an enormous threat to milkweed there, the practice of broadly spraying these herbicides presents another issue: these chemicals may drift into surrounding areas outside the realm of the crop field, thus posing a danger to milkweed growing in natural meadow areas outside the farming dominion. This phenomenon, known as "pesticide drift", poses a further threat to the milkweed and other nectar plants upon which monarchs and many other species depend.

Most of the milkweed that has been lost due to agricultural practices has been in the Midwestern United States, where a large amount of the nation's corn and soy is produced. Milkweeds in the Midwest are estimated to have declined by 58% between 1999 and 2010, while during that same period there was an estimated 81% decline in monarchs produced (from breeding) in that region, as well as notably smaller overwintering populations in Mexico.[11]

Some concern also exists regarding insecticides known as neonicotinoids, and the detrimental effects they may have on monarch larvae. Neonicotinoids are considered a factor in the massive decline of bee species, and recent research on clothianidin (a particular type of neonicotinoid) indicates that the systemic and widely used insecticide may affect the viability of monarch larvae that feed on milkweed contaminated by nearby agricultural productions.[12] Research is not yet sufficient to definitively state the significance of the impact that neonicotinoids have specifically on monarchs.[13] However, recent research has provided substantive evidence that clothianidin is, at the very least, a stressor to monarch populations.[14]

[11] Pleasants, John M., and Karen S. Oberhauser. "Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population." *Insect Conservation and Diversity* 6.2 (2013): 135-144.
[12] Pecenka, Jacob R., and Jonathan G. Lundgren. "Non-target effects of clothianidin on monarch butterflies." *The Science of Nature* 102.3-4 (2015): 1-4.
[13] Godfray HCJ, Blacquie`re T, Field LM, Hails RS, Petrokofsky G, Potts SG, Raine NE, Vanbergen AJ, McLean AR. 2014. "A restatement of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators." Proc. R. Soc. B 281: 20140558.
[14] Pecenka, Jacob R., and Jonathan G. Lundgren. "Non-target Effects of Clothianidin on Monarch Butterflies." *The Science of Nature* Sci Nat102.3-4 (2015): n. pag. SpringerLink. Web. 2 Sept. 2016.

Of the 167 million acres of monarch summer breeding habitat estimated to have been lost by the mid-1990s, approximately 150 million acres were directly or indirectly related to the rise of HT corn and soy.[15]

Invasive Species

Unlike native plants that have co-evolved with all other organisms in their environment, plants that are not native to a particular region have no natural predators, and often thrive without a balanced ecosystem to keep them in check. While not all non-native species are deemed invasive, the propensity for such plants to take over an ecosystem at the expense of native plants cannot be ignored. Invasive species crowd out native plants, and decrease habitat for native species such as butterflies. Monarchs are losing milkweed and native nectar plants not just in agricultural fields and surrounding areas, but also even relatively chemical-free areas that are being overtaken by destructive introduced species that may not be usable to monarchs and other butterflies for food or other survival needs.

Photo by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Particular concern exists regarding two invasive species, pale swallow-wort (*Vincetoxicum rossicum*) and black swallow-wort (*Vincetoxicum nigrum*). These may act as a population "sink" for monarchs; research has indicated that east coast female monarchs may lay their eggs on these swallow-worts, even in the presence of a viable milkweed hosts.[16] Monarch caterpillars are unable to feed on the leaves of black or pale swallow-wort, and the caterpillars starve due to their inhospitable hatching place. It is difficult to fully eradicate these invasive species through simple manual removal, and as of now no biological controls have been approved in the United States to deal with these swallow-worts. There are numerous sources of information on swallow-worts and other invasive species, including *Bugwood.org* and the *New Jersey Invasive Species Strike Team* website.

Photo by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

[15] Taylor, Orley. "Monarch Population Status." *MonarchWatch.org*. N.p., 29 Jan. 2014. Web. 26 May 2016. <http://monarchwatch.org/blog/2014/01/29/monarch-population-status-20/>

[16] "Invasive Species Alert." *Monarch Joint Venture*. Monarch Joint Venture, n.d. Web. 7 June 2016. <http://monarchjointventure.org/images/uploads/documents/Swallow-wort_flyer.pdf>.

Disease and Natural Predators

Disease is a substantial and increasing threat to monarchs. Various parasites, parasitoids, viral and bacterial pathogens, and fungi can harm monarchs. Parasitoids are similar to parasites, except they ultimately kill a host, whereas parasites tend to weaken the host through "sublethal" effects. Tachinid flies are a primary parasitoid that monarchs face, and infection usually occurs when the monarch is still in egg or caterpillar form. The parasitoid larvae grow inside the infected caterpillar, and typically burst out of the caterpillar slightly before or during the pupation stage. Additional information on other parasitoids and diseases facing monarchs can be found at Monarch Lab's website.

Did you know?

A "parasitoid," typically a wasp or fly, lays eggs inside the host and often eats the host from the inside out

The most prevalent and well-studied disease facing monarchs is infection from *Ophryocystis elektroscirrha* (OE), a protozoan (single-celled organism) parasite most often transmitted from infected adult female butterflies to newly laid eggs or milkweed leaves in the form of spores. The OE spores fall onto the eggshells or leaves, and when the caterpillar hatches it consumes these contaminated surfaces, giving rise to an OE infection that will continue throughout the growing monarch's life cycle. Sometimes OE causes monarch death before the butterfly emerges from the chrysalis, but even those that break out of their chrysalis are often too weak to properly unfold their wings and fly, and die very shortly after emerging. Those that survive are much smaller and weaker than uninfected butterflies, and at a disadvantage for any migratory journey they may have to make.

The overall rate of disease is much higher in resident (non-migratory) populations, such as the year-round breeding population of southern Florida. This is likely because migration allows monarchs to remove themselves from infected habitats, and the butterflies weakened by OE are unable to make the full journey to overwintering sites, resulting in a lower infection rate among the remaining monarchs that successfully overwinter and make the return migration in the spring. The resident population of southern Florida does not migrate and continues to spread OE from adult to egg, and onto milkweed leaves in their infected habitat.

In addition to parasites, monarchs also face an array of natural predators. Winter predation by black-backed orioles *(Lcterus abellei)* and black-headed grosbeaks *(Pheucticus melanocephalus)* accounts for about 60% of monarch fatalities in the Mexican overwintering sites.[17] The scansorial black-eared mouse *(Peromyscus melanotis)* also preys on overwintering monarchs as they cluster in the fir forests. Ants, spiders, and wasps prey on monarch larva as well. In a

[17] "Parasites & Natural Enemies." *MonarchLab.org*. Regents of the University of Minnesota. Web. 14 June 2016.

balanced ecosystem, these natural predator-prey relationships do not have excessive impact. But on top of the many other factors contributing to population decline, predation and parasitism pose additional threats to the survival of a precarious monarch population.

Current Protections and Conservation Efforts

There are many well-established and emerging efforts to conserve and protect the monarch butterfly, though additional support is greatly needed. Each country forming part of the eastern monarch population's migratory habitat has recognized the population decline in some manner and has proposed and implemented measures to mitigate it. The following sections are organized geographically, addressing monarch protection measures taken by governments, nonprofits, educational institutions, and others in each of the three North American countries and recognizing the governmental and non-governmental efforts that have crossed national borders on behalf of monarch conservation.

Canada

The monarch is listed as a species of special concern under Canada's federal "Species at Risk Act" (SARA), a designation affording some mindfulness of conservation of the species. The Ontario province in Canada passed the "Fish and Wildlife Conservation Act," requiring special permits for those capturing, breeding, or tagging protected invertebrate species, including monarch butterflies. The "Canada National Parks Act" protected the monarch reserve at Point Pelee National Park in Ontario. Point Pelee National Park, as well as Long Point National Wildlife Area and Prince Edward Point National Wildlife Area, have been protected as monarch reserves in accordance with a joint declaration by Canada and Mexico to create an International Network of Monarch Butterfly Reserves.

United States

The Pollinator Health Taskforce, co-chaired by the USDA and the United States Environmental Protection Agency, was established in 2014 to create a federal strategy to address the population losses of monarch butterflies, among other important pollinators. The taskforce has since released a *National Strategy to Promote the Health of Honey Bees and Other Pollinators*, which highlights increases in monarch population and habitat as a major goal of the pollinator health strategy.

In August of 2014, a petition was filed with the U.S. Fish and Wildlife Service (USFWS) to have the monarch butterfly listed as an endangered species pursuant to the Endangered Species Act, 16 U.S.C. 1531 et seq. (ESA). The USFWS recognized the validity of the petition and has commenced a review of the species, though no concrete protections have been put in place yet.

While no federal protection under the ESA has been granted to monarchs at this point, some protections have been granted at the state and local level in various areas. California, for example, has a "patchwork" of ordinances at the city and county levels that offer protection to wintering habitats for the western population of monarchs. However, these protections usually extend only to times when monarchs are actually present in the area, which often is not sufficient to create a lasting habitat safe from pesticides and development. The Texas Parks and Wildlife Department is active in monarch conservation through the Texas Monarch Watch program. The State of New Jersey has implemented a number of monarch enhancement initiatives in its parks and forests (see following section), as have some other states. Additional effort and coordination across the country could help improve protection of the monarch.

An array of monarch education, tracking, and conservation programs exist at educational institutions, and conservation organizations have been very active on behalf of the monarch butterfly. Some of these programs include: *Monarch Watch* at the University of Kansas, *The Monarch Butterfly Fund*, *Monarch Lab* at University of Minnesota, *Project Monarch Health* at the University of Georgia, *The Monarch Program*, the *Monarch Joint Venture*, and the *Xerces Society*, *Monarch Teacher Network* as well as numerous others.

New Jersey

Monarch education and conservation efforts are underway in New Jersey, and with continued expansion will help achieve monarch rebound. There is growing interest in community or municipally sponsored pollinator gardens. In Cape May County, for example, a monarch garden has been planted at the 4-H Fairgrounds in Cape May Court House, New Jersey.[18] The Borough of Leonia in Bergen County pushed for milkweed plantings and butterfly gardens in a charge led by local Girl Scouts and aided by the Bergen County Audubon Society and the Rutgers Agricultural Extension Office.[19] Other efforts have occurred at the community level, and more would be welcome.

Municipal governments have been active in promoting conservation through the *Mayor's Monarch Pledge* program of the National Wildlife Federation (NWF). This program encourages mayors to take a pledge to help the monarch butterflies by following program guidelines. New Jersey *signatories in this program* thus far include: Roosevelt in Monmouth County, Caldwell in Essex County, East Amwell Township in Hunterdon County, Middle Township in Cape May County, and Princeton in Mercer County.

[18] "4-H Club Creates Monarch Butterfly Garden on Cape May County 4-H Fairgrounds." *Cape May County Herald*. Cape May County Herald, 7 June 2016. Web. 14 June 2016.
[19] Shkolnikova, Svetlana. "Bringing Monarch Butterflies to Leonia Streets." *NorthJersey.com*. N.p., 15 May 2015. Web. 14 June 2016.

Schools have taken an active interest in conservation as well. For example, a student group at Hillside Intermediate School in Somerset County has established a wildflower meadow on school property as part of a broad array of wildlife conservation efforts, and the environmental club of the William Davies Middle School in Atlantic County has created a butterfly garden in its outdoor classroom area. The Roosevelt Public School in Monmouth County raises captive monarchs and has a certified *Monarch Waystation* on school property.

Monarch habitat creation and conservation has also been underway at various State facilities. DEP's Division of Fish and Wildlife has provided milkweed seed to the New Jersey Forest Nursery for propagation; when large enough, the nursery distributes the seedlings to Parks and Wildlife Management Areas. Bass River State Forest, Cape May Point State Park, Allaire State Park, and numerous others have planted butterfly gardens. The Kittatinny Valley State Park's butterfly gardens won the Rutgers Master Gardener Award for Excellence in 2007. Brendan T. Byrne State Forest has designated "no mow" areas to preserve native wildflowers for pollinators, pollinator gardens have been incorporated at Whitesbog Village, and public educational handouts on pollinator plants will be available. Liberty State Park is actively engaged in habitat creation, educational outreach, and monarch population monitoring efforts. The Division of Fish and Wildlife developed a new quail seed mix based on the Xerces Society's Pollinator mixes for use in planting fields; it includes a variety of flowers beneficial to pollinators. Visit the following DEP address for details on other monarch initiatives on state land: *http://www.nj.gov/dep/parksandforests/* .

Non-governmental organizations are also active in monarch conservation in New Jersey: the *Stony Brook-Millstone Watershed Association* in Central Jersey, for example, plants milkweed and other native nectar plants, raises monarchs in its Butterfly House, and partakes in the Monarch Watch tagging program to track the butterflies it raises. Monarch conservation, education, and monitoring efforts in the state are also hosted by several other organizations, including the New Jersey Audubon Society, the Xerces Society, The Garden Club of New Jersey, Rutgers University and Duke Farms.

Mexico

Mexico has the monarch listed as being "under special protection" in the federal "Species at Risk" standard. Mexico has also enacted three federal decrees to protect monarchs, each with increasing specificity and protective power. Originally five areas comprising more than 16,000 hectares were designated as "Special Monarch Butterfly Biosphere Reserve," but this was later increased to span an area of more than 56,000 hectares to create the modern Monarch Butterfly Biosphere Reserve (MBBR). Mexico also has the Monarch Butterfly Conservation Fund to aid the ongoing monarch conservation efforts. The MBBR in Mexico has federal protection by

CONANP, Mexico's federal "National Commission of Natural Protected Areas." The MBBR has become a very popular tourist attraction and heavy tourism has dealt damage to the natural area, a fact that spurred the Mexican government to create a "National Strategy for Sustainable Tourism in Protected Areas" in 2007.

Intergovernmental and International Non-governmental Actions

The Center for Environmental Cooperation (CEC), a tri-national effort between the three North American countries, put forth a comprehensive *North American Monarch Conservation Plan* in 2008. The Trilateral Committee for Wildlife and Ecosystem Conservation and Management formed 13 original *"sister protected areas"* (SPAs) across the United States, Canada, and Mexico: there are seven SPAs in the United States, two in Canada, and four in Mexico. Each SPA is administered by the appropriate federal entity or entities responsible for the land in its respective country. As mentioned in previous sections, Canada and Mexico also signed a declaration (1995) to create an International Network of Monarch Butterfly Reserves. The North American Pollinator Protection Campaign (NAPPC) is tri-lateral partnership initiated by the Pollinator Partnership to unite governments, individual researchers, non-governmental organizations, and private sector groups across the continent on behalf of our mutual pollinators. *http://pollinator.org/PDFs/NAPPC.Monarch.broch.ver8.pdf*

Opportunities for Enhancing Migratory Monarch Populations in New Jersey

There is much work to be done to restore the monarch population to its former size and grandeur. Every individual, organization, and governing body can aid in monarch population recovery, using the recommendations detailed below as a guide.

Government

Government entities at all levels have many opportunities to address monarch decline. Government-led conservation and restoration efforts can include improving land management practices of state, county and municipally owned lands, encouraging or requiring changes in management practices on non-government lands, and offering educational initiatives for public benefit.

A primary opportunity for conservation comes in the form of land owned or managed at the state, county, or municipal level. The State of New Jersey owns more than 789,000 acres of land (2015 Land and Building Asset Management data), not including land managed in the form of easements;

additional land is owned or managed by New Jersey counties and municipalities. While many state parks, forests and wildlife management areas have already incorporated monarch gardens and “no mow” areas, additional areas may be suitable to use in monarch conservation. Efforts on state lands continue to expand. Planting milkweed and native nectar plants, reduction or elimination of pesticide use, and abstaining from mowing roadsides or other areas during the bloom season are all ways that public land can become a boon to pollinators like the monarch butterfly. Governments can further promote conservation efforts by maintaining land as certified monarch waystations as part of the Monarch Watch *Monarch Waystation Program.*

Policy can also be a powerful aid in monarch protection: rewarding or requiring (where appropriate) pollinator-friendly land management practices, for example, can act as effective stimulants of monarch conservation. Policies that provide positive incentives, such as a designation system to recognize monarch-friendly organizations and businesses, or that facilitate the management of lands to foster pollinators (e.g. use of utility easements or rights-of-way), are feasible ways to draw support for pollinator protection. Where possible, funded initiatives that spur additional monarch population research or investment in the fledgling industry of native milkweed seed propagation would also be a positive step forward for the monarch population.

New Jersey policymakers may view the recommendations put forth in the sections below (for businesses, educational institutions, and others) and consider how to help facilitate each group in taking action on monarch conservation.

This guide is an example of providing information to the public about monarch butterflies and the need for conservation. Appropriate government agencies may also consider creating Jersey-specific educational materials on how to build a native butterfly garden, pollinator-friendly buying practices, and more. State or municipal governments may also strive to incorporate monarch conservation programming as part of currently existing programs—conservation initiatives for monarchs and other pollinators may be credited in the Sustainable Jersey program, for example, or showcased at public environmental fairs.

Mayors of New Jersey municipalities should consider taking the National Wildlife Federation’s *Monarch Pledge*. The Mayor’s Monarch Pledge is a national NWF program that provides guidelines for mayors seeking to aid the monarch butterfly, and recognizes those mayors who take actions to help the monarchs.

Commercial

Agricultural/Farming Businesses

Farmers in New Jersey have an excellent opportunity to help foster monarchs; by avoiding broad spraying of pesticides whenever possible and providing buffer zones between sprayed fields and natural areas, farmers can encourage the safe growth of milkweed and other nectar plants that monarchs and other pollinators need to survive.

A wealth of information is available to farmers and others interested in the relationship between agriculture and pollinators. *The Nature Conservancy* offers information on pollinator habitat loss in our state, as well as an analysis of the economic benefits that pollinators offer to agriculture. The *Rutgers Cooperative Extension* also reviews how native pollinators benefit farmers, and provides information about pollinator-friendly farming practices.

Non-Agricultural Businesses

All companies owning or managing property can play a role in monarch habitat restoration by creating a pollinator-friendly garden or changing basic land management practices. Companies such as Ernst Seeds provide seed mixes for large restoration efforts, as well as helpful *planting guides* to determine the best approach to planting for a particular region. *The Xerces Society* offers numerous resources on pollinator conservation for all landscape types, from roadside meadows to golf courses. Large scale restoration projects *can acquire free milkweed* from Monarch Watch's Milkweed Market.

Even businesses that do not own property can contribute to monarch conservation: distributing informational pamphlets to customers or providing information online, giving back to the community by funding community butterfly gardens or public educational events, distributing milkweed seeds to patrons, and discussing conservation efforts with business partners are all viable options for businesses of any size or form.

Plant nurseries and those in related businesses should consider propagation of native milkweeds, and should be conscientious to raise and sell plants that minimize use of pesticides harmful to pollinators. The Xerces Society *provides a guide* to common garden products which contain neonicotinoids.

Educational Institutions

Schools and universities can and do play a key role in developing public awareness and engagement in monarch conservation. Many of the most valuable research and public resources for monarch conservation have come from university-based programs across the country. New Jersey's educational institutions can become more involved in monarch population monitoring and public outreach regarding pollinator protection.

While universities play an important role in saving the monarchs, these are not the only educational institutions that can help—schools at any level of education can make a positive impact. K-12 education is crucial for raising public awareness and encouraging conservation mindsets for the future. Monarch protection can be incorporated into education for students of any age: elementary school children can rear captive monarchs to observe their life cycle, junior high students can learn how to plant monarch gardens at home or on school property, and high schoolers can participate in citizen science through population monitoring tagging initiatives.

The New Jersey School-Age Care Coalition (NJSACC) offers a guide to *"Schoolyard Ecology;"* it focuses on the environmental and educational benefits of creating butterfly gardens at schools. To help institutions and individuals start their gardens with native plants, the *Pinelands Preservation Alliance* (PPA), The Native Plant Society of New Jersey, and other nonprofit and educational sources provide *resources on native plants* and companies that sell them. Schools can broadcast their monarch conservation efforts by certifying their gardens as monarch waystations through the Monarch Watch *Monarch Waystation Program.*

Participation in citizen science provides an excellent hands-on learning experience for students. Volunteering to track migrating monarchs with the *Monarch Monitoring Project* in Cape May during the fall migration, for example, would provide students with a unique and enjoyable opportunity to contribute to meaningful citizen science research.

Educators can learn about various opportunities to incorporate wildlife gardening and monarch education into their schools through the *Outdoor Classroom Network* hosted by the NJDEP's State Environmental Education Directory (SEED).

Nonprofits

Nonprofits can play an important role in monarch conservation. Environmental nonprofits, naturally (and many do), but also any other nonprofit with property and/or an interest in furthering education, volunteerism or other helpful aspects of fostering monarchs. Faith-based organizations, garden clubs, and scouts are just a few examples.

Individuals

Individuals also can have a crucial impact on the fate of monarch butterflies. From volunteering with citizen science efforts to changing lawn care practices, there are many ways to help monarchs, a few of which are detailed below. Monarch Watch has also launched a *"Bring Back the Monarchs"* campaign, providing a wealth of advice for individuals and groups about how to get involved in reviving the dwindling monarch population.

Habitat Creation and Enhancement

Individuals owning or managing property can create pollinator gardens and encourage native wildflower growth. Companies that sell native milkweed and nectar plants can be found on the *Pinelands Preservation Alliance* website. The Pollinator Partnership has also created a *helpful list* of plants good for monarch gardening.

Those interested in creating monarch gardens should consider participating in the National Wildlife Federation's *"Butterfly Heroes"* program, which provides participants with a starter kit of seeds for milkweed or native nectar plants and offers tips on how to start a monarch garden. The Monarch Watch "*Monarch Waystation Program*" offers the opportunity to certify one's monarch garden as a monarch waystation.

Oftentimes simply doing less work to manicure lawns can provide immediate benefits to pollinators and a wealth of other wildlife. Anyone who cares for a yard of any size can encourage butterflies to visit their property by leaving portions of the yard un-mowed, or by avoiding mowing during bloom season. These practices will allow wildflowers to grow and provide a vital food source off of which pollinators can nectar.

Another element of habitat enhancement is keeping pollinator habitat free of harmful pesticides. It is recommended that pesticide use on property be eliminated or reduced wherever possible. Glyphosate, the active ingredient in certain herbicides, should be avoided in and around potential habitat for monarchs, especially during summer breeding season when the butterflies and their larvae may be present. Neonicotinoid pesticides also pose a potential risk, and the systemic nature of these pesticides makes them pervasive and potentially threatening if used on plants at any point during the life of the plant. Groups such as the Xerces Society *have created guides* to neonicotinoid-containing products, that consumers may use to better inform their buying habits. Awareness of neonicotinoids is also important when purchasing seeds and plants, as any plant exposed to neonicotinoids retains the contaminant throughout its life. Retailers such as Home Depot, Lowe's, and BJ's Wholesale Club are beginning to either phase out buying plants exposed to neonicotinoids, or label contaminated plants as potentially harmful to pollinators.[20, 21]

A good way to find seeds unlikely to have been treated with neonicotinoids is by looking for non-treated seeds through local "seed swap" groups. Sites such as *PlantSwap.net* help connect individuals who may have plants or seeds they would like to swap for other plants or seeds. Seed

[20] Lyons Hardcastle, Jessica. "Home Depot to Require Neonicotinoids Labeling." *Environmental Leader*. Business Sector Media LLC, 1 July 2014. Web. 22 June 2016.
[21] Reuters, Thomson. "Lowe's to Phase out Neonics, Nursery Plants Grown with Pesticide." *CBCnews*. CBC/Radio Canada, 10 Apr. 2015. Web. 22 June 2016.

exchanges are also commonly held by local gardening groups. The last Saturday in January is annual "National Seed Swap Day," inspiring many swaps to prepare for the impending growing season.

Those who do not manage land but wish to contribute to conservation efforts may consider donating money or supplies to local conservation efforts, or to any number of the monarch conservation organizations mentioned in this report.

Volunteer Opportunities

Anyone can volunteer in monarch conservation and monarch monitoring efforts. The largest citizen science monitoring program in New Jersey is the *Monarch Monitoring Project* in Cape May County. Individuals can also purchase monarch tagging kits from Monarch Watch as a part of their *widespread monitoring program*.

People can also stay connected with monarch efforts by participating in photo sharing sites, such as that hosted by *Butterflies and Moths of North America (BAMONA)*. Tracking milkweed sightings can also provide useful insight into monarch habitat availability: a forum set up by iNaturalist encourages citizens to document *The Milkweeds of the National Park Service* to create a database of monarch habitat on public lands. Unofficial monitoring methods such as this allow an individual to engage with their environment and contribute to citizen science efforts.

There are a variety of other ways one can be involved with observation and monitoring efforts. Parks and forests engaged in monarch habitat restoration may measure the success of their efforts based on observed changes in pollinator populations, and often appreciate efforts of volunteers in observing the butterfly population and habitat quality of the parks. The growing trend of parks and communities forming their own monarch or pollinator gardens provides additional opportunities—individuals can also volunteer their efforts in the planting and maintenance of these gardens.

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Through a variety of efforts by many, New Jersey can do its part to help the monarch butterfly rebound so that it may continue to do its important pollinating work, brighten the landscape, and amaze with its phenomenal treks across the continent.