
RHODY
CRITTER KITS
POLLINATOR
PALS
RHODE ISLAND
FISH & WILDLIFE
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WILDLIFE & SPORT FISH RESTORATION

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Rhode Island Division of Fish and Wildlife

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RHODE ISLAND FISH & WILDLIFE

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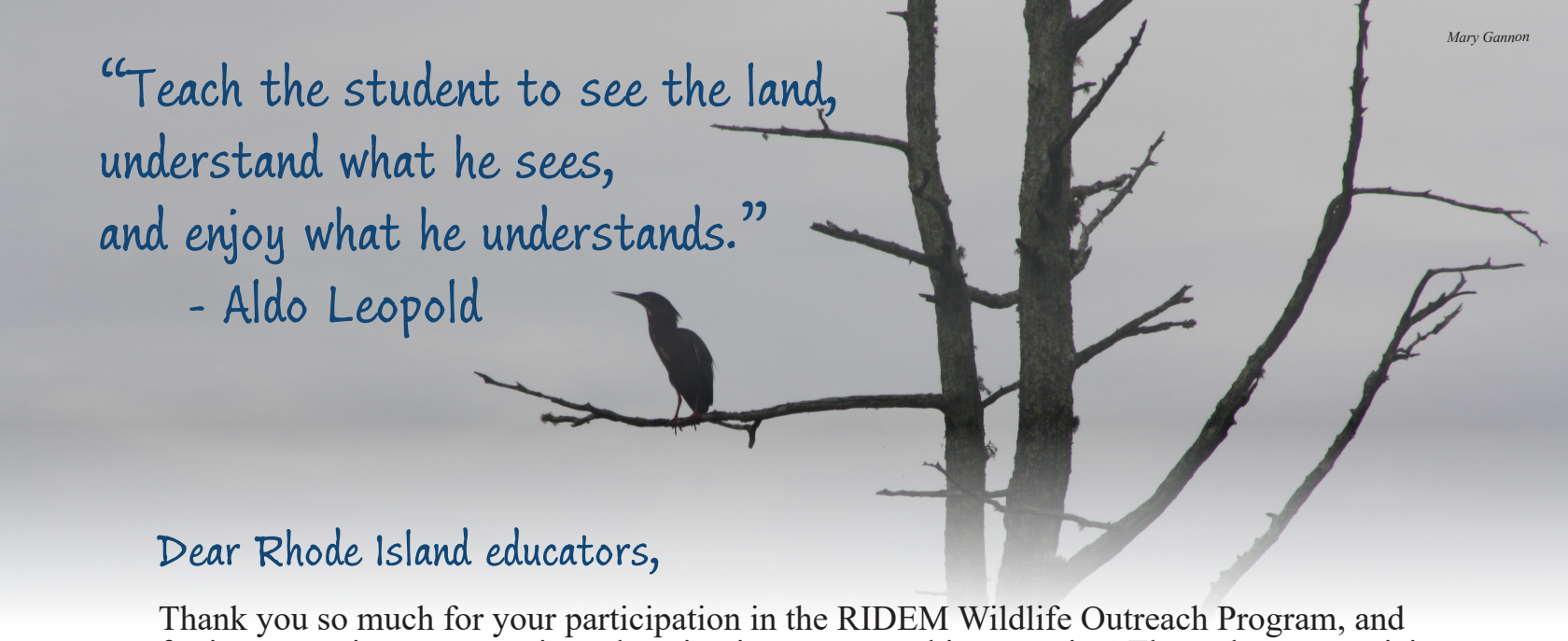
Cover: Dean Birch; Inside cover: Mike Stultz; Rhody Critter Kits logo by Nick Pires



Mary Gannon

"Teach the student to see the land,
understand what he sees,
and enjoy what he understands."
- Aldo Leopold

Dear Rhode Island educators,

Thank you so much for your participation in the RIDEM Wildlife Outreach Program, and for incorporating conservation education into your teaching practice! Through your participation in this program, you are nurturing the growth of our next generation of environmental stewards and advocating on behalf of Rhode Island's diverse and amazing wildlife. On behalf of our wild creatures, big and small, thank you.

The Wildlife Outreach Program has been growing in leaps and bounds since its inception in 2017. Coordinating this program has been the most enjoyable and rewarding whirlwind I could imagine. Most of our program participants have been elementary and middle school students, and the requests from teachers across the state keep rolling in. I am so happy that Rhode Island's educators are invested in connecting their students to the natural world right in their own backyards!

To meet this growing need and interest, the Wildlife Outreach Team has developed our very own Rhody Critter Kits. With the help of these kits, we will be able to reach more students each year, and provide teachers with the tools and resources they need to incorporate wildlife-focused lessons into their curriculum. The kits are not limited just to science lessons, but could be incorporated into art, reading, writing, and social studies as well. The wonderful thing about these kits is that you can tailor them to fit your individual class's needs. I hope you will get creative and have fun learning with the help of these kits!

When we create connections to nature in a memorable, enjoyable way, we inspire responsible stewardship and care. As educators, you are incredibly important cultivators of those connections. Keep up the good work!

Best wishes,
Mary Gannon

Wildlife Outreach Coordinator
Rhode Island Department of Environmental Management
Division of Fish and Wildlife

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Gabrielle DeMeillon

Hello wonderful educators!

We couldn't be more excited to introduce you to our Rhody Critter Kit Program! While we always enjoy visiting schools in person, there are only two of us, and so many students who deserve to learn about the interesting and important wildlife that inhabit our state.

Necessity drove us to create these kits, and thank goodness it did. We strive to reach every community in Rhode Island and have now created a fun and interactive way to do so! We all rely on the resources that nature provides and are all responsible for conserving it, no matter our age. Introducing these important concepts to students today will help shape caring and responsible individuals in the future.

The Rhody Critter Kits aim to encourage students to explore the natural world around them with an open mind and observational eye. The resources provided are designed to be adapted to individual class needs, so please use them however you see fit!

Since joining the RIDEM Fish & Wildlife Outreach Team, I have had the opportunity to share our conservation work with students across the state and see their eyes grow wide with inspiration. Seeing misinformation and fear turn into awe and curiosity is one of the greatest transformations to witness. Through these kits, I hope your students are able to learn and grow in the same way. After all, knowledge is the key to growth!

Thank you for sharing in the education of future conservationists through our Rhody Critter Kit Program and we hope you have fun!

Kind regards,
Gabrielle DeMeillon

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Division of Fish and Wildlife

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About Us


D. Birch

The Division of Fish and Wildlife (DFW) protects, restores, and manages the freshwater and wildlife resources of the state. We share management responsibility of more than 60,000 acres of land, including over 25 State Management Areas, and are responsible for thousands of species. We serve a wide and diverse segment of the public from outdoor recreationists (e.g., hunters, hikers, mountain bikers, wildlife watchers) to the general public (e.g., backyard birders, public concerned with nuisance wildlife, municipalities, legislators). In addition, we are responsible for the State's public hunter education programs and overseeing all hunting and trapping in the state. This includes setting seasons, size limits, hunting methods, and daily limits for the harvest of game species like white-tailed deer, wild turkey, waterfowl, and furbearers.

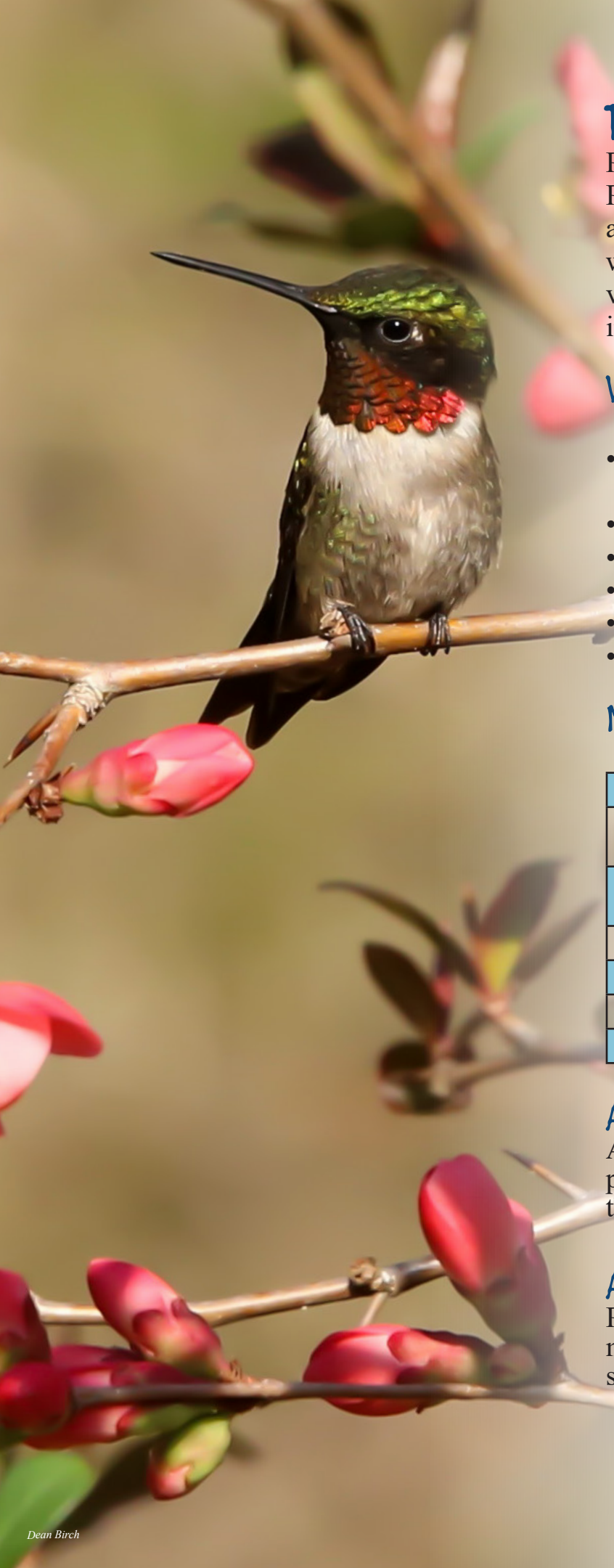
As part of a larger network of recreational opportunities in Rhode Island, hunting and fishing play an important role in connecting people with nature, supporting quality of life and family traditions, and attracting tourism. Anglers and hunters purchase around 70,000 licenses, permits, stamps, and tags each year and contribute more than $235 million to Rhode Island's economy. Revenue generated from license and permit sales support Rhode Island fish and wildlife conservation programs.


S. Petrarca

The DFW is primarily funded through the Federal Wildlife and Sport Fish Restoration Program (WSFR), which is administered through the U.S. Fish & Wildlife Service. This program uses taxes placed on firearms, ammunition, and archery equipment to help fund avian and mammalian research and conservation programs, habitat acquisition, and outreach and education programs.


C. Raithel

Annual appropriations for WSFR's State Wildlife Grants (SWG) Program provide an additional, smaller, yet less restricted pot of money that can be put toward conservation of all Species of Greatest Conservation Need (SGCN) as identified in the RI Wildlife Action Plan. The list of SGCN includes game and non-game species, and also provides much needed attention to amphibians, reptiles, and invertebrates. It is our goal to responsibly manage and steward our state's wildlife resources, safeguarding them in perpetuity.



Dean Birch

Pollinator Pals

Pollinators may be tiny, but they are powerful! Pollinators play a critical role in ecosystems and connect to all creatures. In this kit, students will learn about native pollinators, the conservation issues they face, and how we can all get involved in helping our pollinator pals!

What's included in this kit?

- Information about Rhode Island's pollinators and conservation work
- Interactive activities
- Sample lesson plans
- PowerPoints
- Photos and videos
- Natural artifacts

Next Generation Science Standards

LS1A	Structure and Function
LS2A	Interdependent Relationships in Ecosystems
LS2C	Ecosystem Dynamics, Functioning, and Resilience
LS4C	Adaptation
LS4D	Biodiversity and Humans
ESS3A	Natural Resources
ESS3C	Human Impacts on Earth Systems

Are you using this kit online only?

After using these materials in your classroom, please fill out our feedback form, available on the Rhody Critter Kits page.

Are you borrowing the physical kit?

Please be sure to fill out the feedback form and materials checklist (included in the bin) to ensure all items have been returned.

Kit Materials

Item	Talking Points
Wasp nest	Social wasps make their nests out of paper by chewing up wood fibers and mixing it with their saliva. This nest fragment is very delicate, and should be kept inside its container. Educators can take off the lid and hold the container while walking around the room. Please ask students to treat this artifact with care!
Laminated butterfly wings	Admire the beauty of butterfly wings preserved in a laminator! Easy to pass around and observe with a magnifying glass or microscope if you have one at school!
Am I Even a Bee?	This book follows a small solitary bee, Osmia, as she learns about the diversity of bee species.
What's Inside a Flower?	This beautiful book illustrates the anatomy of a flower and how pollination helps plants grow.
Field guides	These colorful field guides of butterflies, bees, and native plants are a great way to introduce students to the biodiversity all around them. Enjoy flipping through them for art inspiration or take them outside and see if you can identify any plants and insects!
Conservation Connections cards	Pollinators create many links in the food web. Use these cards for a fun food web activity in Lesson 1.
Which Pollinator Am I cards	Use these cards for an identity guessing game that reviews the adaptations and characteristics of different pollinator groups.
Bee Mythbusters cards	Bees are often misunderstood creatures! Use these cards to bust some common bee myths.
Laminated flower parts	Work together as a team to build a flower, using Velcro to stick the pieces together and learn the anatomy of a flower.
Miscellaneous laminated photos	These fun little cards are great to pass around to get the pollinator conversation started or to review.
Bee life cycle model	Follow the life cycle of a bee from egg to larva to pupa and adult.
Pollinator puppets	Use these little friends to illustrate learning, act out pollination, and just have fun! The monarch butterfly can be turned inside out using the zippers on the puppet, transforming from caterpillar to chrysalis to adult butterfly!


Spencer Hardy

Introduction: Pollinators are incredible!

Pollinators are animals that carry **pollen** from one flower to another so that those plants can produce seeds and fruits. This act of moving pollen around is called **pollination** and is a super important **ecosystem service**. There are many different species of pollinator from all corners of the animal kingdom, such as bees, flies, butterflies, moths, wasps, bats, birds, monkeys, lizards and many more!

Most plants need a pollinator helper to reproduce, including foods that we like to eat such as strawberries, blueberries, and chocolate. The foods that require pollination also make up the majority of our Vitamin C and other nutrients, which means that pollinators are super important for keeping us healthy!

In addition to supporting human health, pollinators are also very important for maintaining healthy food webs in nature. Not only does animal pollination help most plants reproduce, the seeds and fruits produced by these animal-pollinated plants provide food for birds and mammals. These **herbivores** then become food for larger **carnivores**, which means that pollinators also help feed animals higher up the food chain!

Unfortunately, pollinator populations are in decline in many parts of the world due to threats such as habitat loss, disease spread, pesticide use, and climate change. But luckily, there are lots of people working to bring back our pollinators – and you could be one of them! In this Critter Kit, you will learn all about the incredible world of pollinators and how to help conserve them.

Read on to learn more about pollinators!

Pollinator Fun Facts

- The majority of pollinators are insects – over 200,000 species of them!
- Butterflies and flies can taste with their feet!
- Male bees and wasps don't have stingers!
- A hummingbird's wings beat 50 - 200 times per second!
- Some flowers smell like rotting meat to attract pollinators like blow flies and carrion beetles!

Spencer Hardy

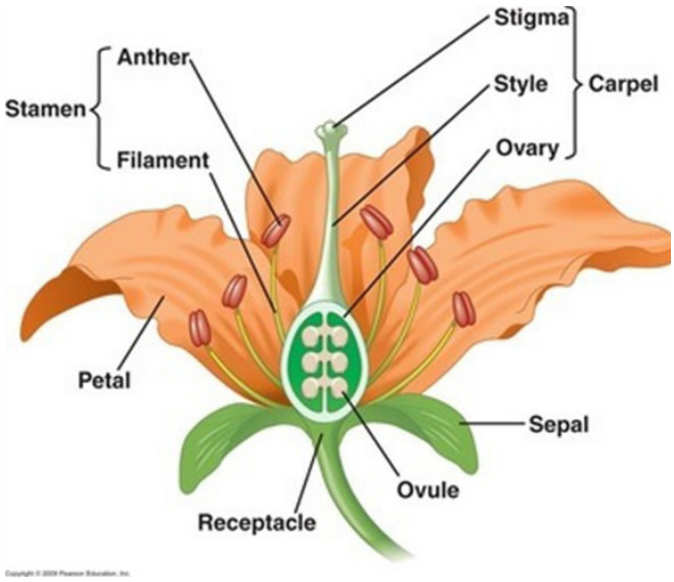
What is pollination?

Plants serve a vital purpose in the landscape. They provide both humans and other creatures with food, shelter, and clean air. This is why plant reproduction is so important! Plants use many different strategies to reproduce, though the majority of plants require a pollinator helper.

Flower Anatomy

There are many anatomical structures of a flower that assist in plant reproduction. The first structure that you can typically see on a flower are the flower's **petals**, which are soft coverings that surround the internal structures of the flower. These are usually brightly colored to attract potential pollinators. Below the petals are the **sepals** of the flower, which protect the petals and internal organs when the flower is a bud. The sepals and petals are both attached to the **receptacle**, which is the base of the flower stalk. Within the petals is the **carpel** (the female part of the flower) and the **stamen** (the male part of the flower).

The stamen is composed of two main parts: the **anther** and the **filament**. The filament is the stalk that both supports the anther and carries nutrients from the rest of the plant to the developing pollen. The anther is the bulbous portion of the stamen, which both produces and contains pollen. Once the anthers have produced enough pollen and the pollen has matured, the anther will burst open in a process called dehiscence. When this happens, the pollen becomes available to be picked up either by wind, water, or an animal to be transferred to another flower.



The carpel is composed of three main parts: the **stigma**, the **style**, and the **ovary**. The stigma is a sticky surface at the tip of the carpel where pollen gets stuck before germinating. When the pollen germinates, it grows a long, thin tube that travels down the style of the carpel. If the pollen belongs to different species of plant, the style

will block the growth of the pollen tube. If the pollen is from the same species, the pollen tube will eventually reach the ovary, which contains **ovules**. The ovule is the part of the plant that will eventually become a seed! When the pollen tube reaches an ovule, they fuse together and begin to swell until the ovule becomes a seed. Within this seed is an embryo (a baby plant), endosperm (nutrients to feed the embryo), and a seed coat (a hard outer covering to protect the embryo). After fertilization occurs, the ovary will also swell until it forms either a dry or fleshy fruit.

Plant Reproduction

Plants reproduce either asexually or sexually. Plants that reproduce asexually either do so through vegetative reproduction or apomixis. Vegetative reproduction is the process in which a new plant grows from a fragment of the parent plant or grows from a specialized reproductive structure, such as a tuber or bulb. Apomixis is the process in which plants are able to produce seeds without fertilization. Both of these processes result in new plants that are genetic clones of the parent plant. While asexual plants tend to mature faster, these populations can be left susceptible to diseases due to a lack of genetic diversity between individuals (i.e. they are all equally susceptible to diseases).

Most plants reproduce sexually, through either cross or self-pollination. Self-pollination is the process by which pollen from either the same flower or another flower from the same plant is transferred onto a flower's stigma. Cross-pollination is the process by which pollen from a flower is transferred onto the stigma of another flower from an entirely different plant within the same species. While self-pollination can limit genetic diversity, cross-pollination can lead to greater genetic diversity, because the genetic information of different plants is combined. Pollen transfer for both self and cross-pollinating plants can occur either through wind (anemophily), water (hydrophily), or animals (zoophily), depending on the plant species.

Most animal-pollinated plants attract potential pollinators with the promise of food (i.e. nectar and pollen). These flowers are designed to make it easy for animals to accidently rub up against the flower's anthers and get pollen stuck to their bodies when they visit the flower to drink nectar or gather pollen. The animal will then hopefully deposit the pollen onto another flower by rubbing against its stigma. Animals can assist with both self and cross-pollination, by either facilitating the transfer of pollen within a flower or between two flowers.

While some plants are generalists, which means they attract a wide diversity of pollinators, others are specialists and only attract a few pollinators that have specific, complimenting traits. These traits may be behavioral or anatomical. One example of a behavioral adaptation is "buzz pollination" or "sonication," in which a bee buzzes a flower at a certain frequency in order to release its pollen. Some plants, such as tomatoes, blueberries, cranberries, and eggplants, require this type of pollination for optimal reproduction, which only ~ 50% of bee species can perform (including bumblebees and large carpenter bees). An example of an anatomical adaptation is the evolution of nectar spurs in certain plants. Nectar spurs are long tubes attached to the receptacle of the plant that contain nectar. Therefore, in order to reach the nectar, a potential pollinator needs to have an extremely long tongue or beak.

Spencer Hardy

TYPE OF POLLINATION	PERCENTAGE OF PLANTS	KEY PLANT TRAITS	EXAMPLES
Zoophily	~85%	• Brightly colored petals • Nectar reward present • Large floral displays • Produce small amounts of pollen • Sticky pollen grains	• Forbs • Fruit trees • Flowering shrubs • Cacti
Anemophily	~10%	• No bright colors • No nectar • Small flowers • Produce large amounts of pollen • Pollen is lightweight and easily airborne	• Coniferous trees • Grasses • Oaks
Hydrophily	~2%	• No bright colors • No nectar • Small flowers • Produce large amounts of pollen • Pollen is lightweight and covered by waterproof mucilage	• Pond weeds • Seagrass

Why is animal pollination important?

Animal pollination is an essential ecosystem service that supports both healthy food webs and human food security. Almost 90% of flowering plants need an animal pollinator to reproduce, including wildflowers, flowering trees, crop plants, and cultivated garden plants. Plants are **producers**, which means that they are capable of turning the sun's energy into sugars through **photosynthesis**. By carrying out photosynthesis, plants convert carbon dioxide into oxygen, which is important for keeping our air clean and breathable.

Producers are also the first **trophic level** in the food chain and therefore are the main source of energy for all other trophic levels, whether they are consumed directly (herbivory) or indirectly (carnivory) by animals, including humans! As the main source of energy for all living things, plants are essential for maintaining healthy food webs. Therefore, animal pollinators are incredibly important as they contribute the majority of plant reproduction! Not only does animal pollination result in the production of more plants, it also is the method by which plants produce the seeds and fruits that are consumed by a multitude of creatures.

Approximately 75% of crops benefit in some way from animal pollination and about 10% depend fully on pollinators to produce the food that we eat. These foods include chocolate, coffee, avocados, almonds, bananas, mangos, strawberries, and many more. The food crops amount to about 30% of global food production and the majority of human Vitamin C, Vitamin A, and calcium intake. The crop services that animal pollinators provide contribute between $157 and 515 billion to the global economy per year - and pollinators do it for free! Though managed European honeybees (*Apis mellifera*) are used extensively for crop pollination since they are easily managed and transported by humans, they are not always the most efficient pollinator for all crop species. Therefore, it's important that healthy, diverse populations of wild pollinators are supported and protected to maintain a sustainable, efficient food system.


Spencer Hardy

Who are the pollinators?

Any critter that comes up close and personal with a flower has the potential to be a pollinator! However, there are some organisms that interact with flowers more closely and more frequently than others either because of their specific anatomical and behavioral traits. Though **insects** are considered the most important pollinators, there are plenty of other flower-visiting animals who help contribute to this ecosystem service.

Bees

Bees belong to an order of insects called **Hymenoptera**, which includes wasps, ants, and sawflies. Like other hymenopterans, these insects have two pairs of membranous wings and only the females have a stinger.

Bees can be found in every part of the world, except for Antarctica. There are an estimated 20,000 bee species worldwide and 4,000 species in North America. Rhode Island is home to approximately 250 species, which occupy a variety of ecosystems including meadows, riparian areas, woodlands, orchards, coastal areas, and urban and suburban areas. Most bees are solitary, meaning that they don't have a queen or make honey. While both honeybees and bumblebees are social bees, honeybees are not native in North America and are primarily a managed, livestock species in this country. The only wild, native social bees in North America are bumblebees and only 12 bumblebee species are historically native to Rhode Island.

Wild bees live in a variety of different nest types, depending on the species. Approximately 30% of native bees are cavity nesters, meaning that they make nests in pre-existing cavities (e.g. hollow stems, rock crevices, and abandoned beetle holes). Approximately 70% of native bees are ground nesters, meaning that they make their nests by burrowing in bare soil. Bumblebees make their nests either underground (e.g. abandoned rodent burrows), in tree hollows, or other protected areas (e.g. tussocky grasses and brush piles).

Bees are some of the most important pollinators because they consume plant material (pollen and nectar) at every stage of their lifecycle and therefore visit flowers regularly!

To learn more about Rhode Island's bees, check out the Wild Bees fact sheet from the RI Division of Fish and Wildlife!


USFWS

Syrphid (Flower) Flies

Syrphid flies, also known as "flower" flies, belong to an order of insects called **Diptera**, which are two-winged insects that have special anatomy that makes them excellent, agile fliers. This order includes groups such as mosquitoes, horseflies, crane flies, and robber flies. Unlike some other fly species, syrphid flies feed primarily on nectar as adults and do not bite humans or other mammals.

There are over 6,000 species of syrphid fly worldwide and in North America there are an estimated 850 species of syrphid fly. In Northeastern North America, there are about 400 species of syrphid fly that come in a wide range of sizes and colors. Many are quite beautiful, with brightly colored spots and stripes that often mimic the patterns found on bees and wasps. This type of mimicry is called Batesian Mimicry, in which the flies mimic protective coloration in order to trick potential predators into thinking that they have a stinger (even though they do not).

As **larvae**, flower flies feed on either decaying plant and animal material or feed on other insects, like aphids and thrips. As adults, the flies feed on nectar and pollen from a wide variety of flowers, though they seem to prefer white and yellow flowers. When they visit these flowers, pollen gets stuck to their hairs which allows them to carry out pollination. Next to bees, syrphid flies are considered one of the most important pollinator groups and contribute to the pollination of many wild and cultivated plants.

Beetles

Beetles belong to a very large and diverse order of insects called **Coleoptera**, which all have hardened front wings. Beetles fall into many different groups in terms of their life histories, including herbivores, carnivores, scavengers, fungus feeders, and parasites. Species can also be either **nocturnal** or **diurnal**.

Beetles comprise approximately 40% of all insect species and are found almost everywhere on Earth. There are over 350,000 species of beetles currently described worldwide, however there are over one million species estimated to exist. North America is home to over 30,000 species of beetle, many of which visit flowers.Beetles are present in the fossil record millions of years before bees and butterflies, which means they were likely one of the first insect groups to ever visit flowers. Therefore, they are key players in some of the earliest known pollinator-plant relationships.


USFWS

Though they don't have the anatomical structures to actively collect pollen, flower-visiting beetles do eat pollen which means their bodies usually get covered in it. This allows them to transport the pollen from flower to flower. Some beetles also eat other plant material besides pollen, like the leaves and petals of flowers, which is why many beetle-pollinated plants tend to have thicker flowers. Some beetle pollinated plants include water lilies, spicebush, and pawpaws.

Moths and Butterflies

Moths and butterflies belong to an order of insects called **Lepidoptera** which, with the exception of a few wingless moths, all have two pairs of "scaly wings" covered in microscopic, dust-like scales. Butterflies are typically brighter in coloration than moths and are found exclusively during the day, while moths are usually active at night and have more muted coloration. Butterflies also have antennae that end in a club shape, while moths have either tapered or fanned antennae.

There are about 300,000 species of lepidopterans worldwide and North America is home to about 12,000 species of moth and 750 species of butterfly. In Northeastern North America, there are about 1,500 species of moth and 100 species of butterfly. In addition to feeding on the nectar of flowers, many butterflies and moths require host plants. A host plant is where a female lepidopteran will lay her eggs and is the first food the hatched caterpillars will eat. Therefore, host plants are super important for butterflies and moths to complete their lifecycles. One of the best-known examples of a butterfly-host plant association, is the relationship between Monarch Butterflies and milkweeds. Milkweeds not only provide a place for female Monarchs to lay their eggs and feed Monarch caterpillars, but they also imbibe the caterpillars with a toxin that makes them poisonous to bird and mammal predators. Other examples of important host plants include grasses like little bluestem and Indiangrass, which are used by skipper butterflies, and oaks, which support hairstreak butterflies and silk moths. In Rhode Island, the Frosted Elfin is one of our rarest butterflies and relies on yellow wild indigo and wild lupine as host plants.

Butterflies and moths do not feed on or collect pollen from flowers, but they do visit flowers to feed on nectar. When they visit these flowers, they get pollen stuck to their bodies which allows them to transport it to other flowers and assist in pollination. Moths are good pollinators of several night-blooming species, such as evening primrose and honeysuckle.


Spencer Hardy

Wasps

Like bees, wasps fall into the order of insects called **Hymenoptera**. Wasps are typically hairless or sparsely bristled with slender bodies and narrow waists, however they can vary in size, coloration, nest type, and sociality.

There are over 700,000 species of wasp worldwide and ~18,000 in North America (north of Mexico). However, most wasps are small-bodied and don't live in colonies, so they are not readily recognized as wasps by the public. Many of these species are also currently undescribed, which means that they don't have formal names yet. The three main groups of wasps are solitary wasps, social wasps, and parasitic wasps. Solitary wasps make their nests in either underground burrows, hollow stems, or nests constructed out of mud, which is where a female solitary wasp lays her eggs and raises her offspring alone. Social wasps utilize a task-partitioning caste system, similar to honeybees or bumblebees, in which a queen and workers live together in a colony. These wasps live in annual nests made out of paper, which they construct using chewed up wood fibers mixed with their saliva. Unlike solitary or social wasps, cuckoo and parasitic wasps do not care for their own young. Cuckoo wasps lay their eggs in the nests of other wasps or bees and parasitoid wasps lay their eggs either on or in a host species so that when the eggs hatch, the larvae will have an immediate food source.

Though wasp larvae (young wasps) are carnivorous, adult wasps feed on nectar from flowering plants and other sugary substances. When they visit flowers to drink nectar, they often get pollen stuck to their bodies which allows them to facilitate pollination. Wasps are particularly efficient pollinators of some milkweed and orchid species.

Birds

Globally, there are approximately 2,000 species of birds that are nectivorous, meaning that they feed on nectar, and about half of those species are considered pollinators. In order to digest nectar, birds require a special enzyme called sucrase, which only certain birds have. These nectivorous birds can be found on almost all continents except Europe and Antarctica and include groups such as hummingbirds, sunbirds, honeyeaters, and brush-tongued parrots.


Creative Commons:BlueRidgeKitties

There are over 50 species of bird that visit flowers in North America, the majority of which are hummingbirds. The Ruby Throated Hummingbird is the only hummingbird species that nests in the Northeastern United States, though others can be found in small numbers in the autumn during bird migration season. Hummingbirds feed primarily on nectar and can drink up to two times their weight in nectar each day. Though nectar is their main source of energy, they also feed sparingly on insects for protein.

Hummingbirds have slender beaks and long, tube-like tongues, which allow them to reach deep down into flowers to drink nectar. When a hummingbird visits a flower, pollen gets stuck to its bill and feathers and then gets carried to the next flower that the bird visits. Hummingbird-pollinated flowers tend to have long, tubular flowers and are often red, pink, yellow, or orange, which are attractive colors to hummingbirds. Some of these hummingbird-pollinated plants include red cardinal flower, trumpet honeysuckle, and red columbine.

Mammals

There are many species of mammal that assist in pollination worldwide, though most of them are tropical species. These mammal pollinators include bats, lemurs, sugar gliders, honey possums, and mice. The world's largest pollinator is the black and white ruffed lemur, which pollinates a tree called the traveler's palm. The most successful mammal pollinators are those that can fly because they are able to spread pollen to more flowers.

Bats are particularly important pollinators and are responsible for the pollination of approximately 528 plant species worldwide. In the Northeastern United States, the only native bat species are insectivores, and therefore do not visit flowers. However, in the Southern United States there are three species of nectivorous bats: the Mexican long-tongued bat, the lesser long-nosed bat, and the greater long-nosed bat. These bats can also be found throughout Mexico and inhabit desert, open woodland, and scrub habitats. They are particularly good pollinators of agave and cacti, which tend to have large, pale flowers that open at night when the bats are active. When they visit these flowers to drink nectar or eat pollen, the pollen gets stuck to their fur and then gets carried to the next flower.

Reptiles

Most reptiles are carnivores, but some also supplement their diet with vegetation, nectar, and pollen. Reptile pollination is a relatively new discovery, with the first observation occurring in 1977. Since then, over 40 species of lizard and gecko have been observed visiting flowers and transporting pollen.

Most pollinating reptiles are found on arid island habitats, which may lack freshwater sources during the warmest months of the year. This may explain why these island reptiles resort to drinking flower nectar. In North America, there are no known pollinator relationships between reptiles and plants.

When reptiles visit flowers to drink nectar or eat pollen, the pollen grains get stuck to their scales and then get transported to other flowers. Lizard and gecko-pollinated flowers tend to have orange-colored nectar, which has been found to be an important visual signal to help reptiles recognize the presence of a food reward. For some flowers, reptiles are their primary pollinator, such as a species of liana (long-stemmed, woody vine) that is endemic to the mountain forest of Mauritius and is pollinated almost exclusively by the blue-tailed day gecko.


Spencer Hardy

How do I help protect pollinators?

Despite their importance, most pollinators have very simple needs! Once we have a good understanding of what pollinators need to survive and what factors may be threatening their survival, we can better protect them and the services they provide for future generations. Luckily, there are so many easy ways to help support and protect pollinators on your property and in your community!

Basic Needs of Pollinators

Food

In order to survive, pollinators need to eat! Most pollinator species feed on the nectar of flowering plants and many also feed on the pollen. For bees, pollen is an especially important food source for their developing larvae because it is very protein rich. Some pollinator species also feed on the vegetal parts of plants, such as the leaves, stem, and petals, at different stages of development. For example, many butterflies and moths require host plants to lay their eggs on, which become the first food for the caterpillars that hatch from those eggs.

The plants that animal pollinators depend on for food are usually closely **co-evolved** with specific pollinator species. This is why regional, native plants (and not non-native plants or species **cultivars**) are the best food resources for native pollinators. Seasonality is an important factor in pollinator food sources. Different pollinators become active at different times of the year, and many are active for several months. Therefore, to maintain a steady flow of food resources, there should be nectar and pollen-rich flowers blooming from early spring until late autumn. It's also important that these food sources are not too fragmented or spread out, since some pollinators (like solitary bees) have a very short flight range – sometimes less than half a mile!


Tom Potter

Shelter

Animal pollinators vary in their habitat requirements. Many pollinators, such as flies, butterflies, and moths, are content finding periodic shelter under tree bark, in the foliage of trees and shrubs, or in leaf litter. However, some pollinators, such as bees and wasps, live in nests where they store food and raise their babies. Habitat features such as patches of bare ground, brush piles, tussocky grasses, plants with hollow or pithy stems, rock piles, and old stumps and logs can provide these nesting pollinators with the materials to build their homes.

In the winter, many hibernating pollinators depend on leaf cover to protect them from the cold weather and potential predators. Depending on the species, moths and butterflies will either lay their eggs on fallen leaves, will overwinter in the leaves in camouflaged cocoons and chrysalises, or will hide in the leaves as caterpillars to wait out the cold. Leaves also provide an extra blanket of protection against the cold for queen bumblebees and beetles, which overwinter in shallow soils.

Threats to Pollinators

Habitat Loss

One of the biggest threats to pollinators is land use change due to increased **urbanization** or agricultural intensification. This type of land use change can lead to habitat loss and habitat fragmentation, meaning that insects may not have access to suitable areas for nesting, laying eggs, or foraging for food.

Parasites and Diseases

In the United States, the spread of parasites and disease is prevalent in both managed honeybees and commercially raised butterflies because they are usually kept and transported across the country in high densities. Unfortunately, these parasites and diseases can also spread to wild bees and butterflies when these insects visit the same flowers. Another major conduit of pollinator pathogens is the improper use of hummingbird feeders. Sugar water is a perfect breeding ground for molds and bacteria and can infect hummingbirds and other birds visiting the feeder.


Mary Gannon

Pesticide Use

The ingredients in chemical **insecticides, herbicides,** and **fungicides,** including the ones you can buy at the hardware store, can harm pollinators in a variety of ways. They can alter insect behavior, which might make it harder for them to collect food and care for their larvae (sublethal effect) and can also kill insects outright (lethal effect). Herbicides can also harm pollinators by reducing the number of flowers in the landscape, which reduces the amount of food that they have access to.

Climate Change

Climate change can affect pollinators by altering the emergence time of both flowers and the animal pollinators themselves. This means that when insects emerge from hibernation and hummingbirds return from their migration in the spring, there may not be enough flowers for them to forage on because the flowers may have either already withered or not bloomed yet.

Everyday Ways to Help Pollinators

- Turn off your lights at night to help nocturnal pollinators (such as moths, beetles, and bats) which can become disoriented by artificial lights.
- If you have a hummingbird feeder, clean it every 1-2 days by scrubbing it out with hot water and soap to avoid the growth of mold and bacteria, which can kill hummingbirds. Red dye and chemical flavorings are not healthy for hummingbirds, so avoid the brightly colored commercial nectars! Sugar water is okay in a pinch, but the best food for hummingbirds are flowers!
- Advocate for the insect pollinators in your community by talking to friends, family, and fellow community members about the importance of pollinators and encouraging them to consider pollinator needs in their landscaping choices.
- If possible and accessible, join a local Community Supported Agriculture (CSA) initiative or try to purchase local, seasonal, organic produce.
- Become a community scientist (also sometimes referred to as "citizen scientist") by joining a community science project that focuses on native pollinators, like the Rhode Island Wild Bee Observer!
- Support organizations that are helping to conserve bees and other pollinators.
- Vote for the pollinators by supporting initiatives that take action to protect insect pollinators and other wildlife, both locally and nationally.

In the Classroom

- Be cautious about store-bought butterfly kits as the caterpillars that are included in these kits are prone to diseases, parasites, and harmful fungi, and therefore should not be released into the wild where these pathogens may spread to wild butterfly populations.
- Take a field trip to a local wildlife refuge, arboretum, or botanical garden to learn about native plants and pollinators in your area.
- Start a school pollinator garden!

Improving Pollinator Habitat

- Consider mulching with compost or leaves instead of wood chips to make the ground more accessible for ground-nesting bees.
- Plant RI native plants that have hollow, pithy stems that cavity-nesting bees can use for nests, such as native raspberries and Joe-Pye weedsPlant RI and encourage native grasses, such as little bluestem (*Schizachyrium scoparium*) or Indiangrass (*Sorghastrum nutans*), which are host plants for skipper butterflies and provide bumblebees with nesting and overwintering habitat.
- Leave piles of twigs, branches, or logs on your property for cavity-nesting bees, wood-boring bees, and bumblebees.
- Leave the leaves and dried, perennial stems in the fall to provide cover and protection for overwintering insects by either leaving a thin layer of leaves on your lawn, spreading raked leaves over your vegetable and garden beds, or piling them around ornamental trees and shrubs.
- Plant and encourage native butterfly host plants like milkweeds, lupines, and grasses.

Improving Pollinator Food Availability

- Allow RI native wildflowers to grow on your lawn, such as wild violets (*Viola lanceolata* and *Viola pedata*) and asters (*Eurybia divaricata* and *Eurybia spectabilis*).

- If you are a gardener or landscaper, consider growing RI native flowers, trees, and shrubs that are visited by bees and other pollinators. Try to avoid the cultivars of those species, which are not as accessible or nutritious for insect pollinators. Plant a diversity of flowers that bloom through the seasons!

- If you are growing food for yourself or your community, consider planting RI native food plants frequented by insect floral visitors, such as summer grape (*Vitis aestivalis*), low and highbush blueberries (*Vaccinium angustifolium* and *Vaccinium corymbosum*), American plum trees (*Prunus americana*), and black cherry trees (*Prunus serotina*).

- If you don't have a garden, fill a window box or flowerpots with RI native flowers, such as violets, wild strawberries, goldenrods, and milkweeds.

- Avoid using weedkillers and insect sprays in your garden and on your lawn, as these can limit the availability of flowers available for floral visitors to feed on and/or can poison the nectar and pollen that pollinators collect, which may kill or impair these insects and potentially their offspring.

- Plant hummingbird plants like red cardinal flower (*Lobelia cardinalis*) and red columbine (*Aquilegia canadensis*).

- Remove invasive plants like bittersweet, garlic mustard, and dog-strangling vine, which can outcompete and choke out native plants that are beneficial for insect pollinators.

Conservation Work in Rhode Island: The RI Pollinator Atlas

What is the Rhode Island Pollinator Atlas?

In 2021, RIDEM Division of Fish and Wildlife caught the "buzz" on pollinators and launched an exciting new initiative called the Rhode Island Pollinator Atlas. The Pollinator Atlas is an effort to inventory Rhode Island's pollinating insects and to gather data that will inform future conservation plans to protect our insect pollinators. Conducting an inventory of our pollinators helps us to determine which species need our help, how their populations are doing, which habitats are most important to our pollinators, and what activities are threatening their survival. All of this information will help us build management plans to promote and protect current and future pollinator populations. launch of two community science projects: The Rhode Island Bumblebee Survey (RIBS) and the Rhode Island Wild Bee Observer.

What is the Rhode Island Bumblebee Survey?

Though Rhode Island is historically home to about 12 species of bumblebee, preliminary surveys undertaken by Dr. Howard Ginsberg and Dr. Steven Alm's research groups at the University of Rhode Island (2014-2021) revealed that almost half of these species may have disappeared from the state. Given their declines both in Rhode Island and throughout the country, it's important that we determine the status and distribution of Rhode Island's bumblebees, as well as the floral species and habitats associated with these species, so that we can better protect them. To do this, the RIBS project is engaging community scientists to document bumblebee species and their habitats around the state.

In Spring 2022, RIDEM launched the pilot season of RIBS with a small group of volunteers, but the project will be open to public participation in both Spring 2023 and 2024. All you need to participate is a love of nature, a smartphone, a lunchbox, and an insect net! Information about how to participate will be announced through both DEM's newsletter and on their social media channels in Spring 2023.

What is Rhode Island Wild Bee Observer?

The Rhode Island Wild Bee Observer is a data collection effort that invites the public to submit their observations of bees from anywhere in the state through the popular wildlife observation website and phone app, iNaturalist. The observations submitted through RI Wild Bee Observer will help improve our understanding of where Rhode Island's ~ 250 bee species occur throughout the state. You don't even have to find a rare bee species to participate! Observations of all species, both common and rare, are welcome. This information is essential for the effective conservation and management of these important insect pollinator species. To participate and learn more about this exciting community science effort, visit the "Report Wildlife Observations" page on the RIDEM website.

Vocabulary

Carnivore – An animal that eats the flesh of other animals

Climate change – A change in global or regional climate patterns, attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels

Co-evolution – The process in which closely associated species influence each other's traits

Coleoptera – An order of insects that comprises beetles and weevils with hardened front wings, forming the largest order of animals on the earth

Cultivar – A plant variety or strain that has been produced through selective breeding for desired traits

Diptera – A large order of insects that comprises the two-winged or "true" flies, which have reduced hind wings that form club-shaped balancing organs called halteres

Diurnal – Active primarily in the daytime

Ecosystem service – The many and varied benefits to humans provided by the natural environment and from healthy ecosystems, such as pollination, decomposition, and water filtration

Endemic – A native plant or animal that is restricted to a single place

Fungicide – A pesticide (usually chemical) that kills or prevents the growth of fungi and their spores

Herbicide – A pesticide (usually chemical) that kills or prevents the growth of plants

Herbivore – An animal that eats plant material

Hymenoptera – A large order of insects that comprises wasps, bees, ants, and sawflies which all have four transparent wings

Insect – Any animal of the class Insecta, comprising small, air-breathing arthropods with bodies divided into three parts (head, thorax, and abdomen) and three pairs of segmented legs

Insecticide – A pesticide (usually chemical) that kills or alters the behavior of insects

Insectivore – An animal that eats primarily insects

Larvae – The immature form of an insect that greatly differs from the adult; phase between egg and pupa

Lepidoptera – An order of insects that comprises moths and butterflies, which all have four large scale-covered wings and larvae that are caterpillars

Mammal – Any animal of the class Mammalia, comprising warm-blooded vertebrate animals of a distinguished by the possession of hair or fur and the secretion of milk by females for the nourishment of their young

Nectivore – An animal that feeds on nectar

Nocturnal – Primarily active during the nighttime

Photosynthesis – The process by which green plants use sunlight to synthesize foods from carbon dioxide and water, generating oxygen as a byproduct

Pollen – A fine powdery substance discharged from the male part of a flower consisting of microscopic grains that contain a male gamete that can fertilize a female ovule

Pollinator – Any animal that carries pollen from the male stamen to the female stigma of the same or another flower

Pollination – The process in which pollen grains are transferred from the male anther of a flower to the female stigma of the same or another flower

Producers – Any organism that carries out the process of photosynthesis

Trophic level – A position within a food chain or food web that is occupied by a group of organisms based on their feeding behavior


Mary Gannon

Quick Links

RIDEM Wildlife Observation Reporting
Learn how you can report wild bee observations (and other wildlife observations!) to the Rhode Island Division of Fish and Wildlife.
http://www.dem.ri.gov/reportwildlife

RIDEM Wasp Response Guide
Learn about coexisting with these often misunderstood and underappreciated insects!
https://dem.ri.gov/sites/g/files/xkgbur861/files/2022-08/wasp-response-guide.pdf

RIDEM Wild Bees Fact Sheet
Learn about some of RI's most common wild bee species!
https://dem.ri.gov/sites/g/files/xkgbur861/files/2022-07/bees.pdf

Xerces Society
An amazing resource to explore more about local and global insect research and conservation, and ways you can hep in your own community, backyard, or garden!
xerces.org

URI Master Gardener Gardening Resource Library
Free resources on native plants for pollinators, school gardens, and so much more!
https://web.uri.edu/mastergardener/gardening-resources/

Native Plant Trust: Go Botany
An online treasure trove of information on New England's native plants!
https://gobotany.nativeplanttrust.org/


Spencer Hardy

Lesson 1: The Power of Pollination

Theme
Pollination supports life on all levels of the food chain.

Learning Objectives
Students will understand the process of pollination and its ecological importance.

Corresponding Activities for this Lesson
- Conservation Connections
- Busy Bees, Busy Blooms

Materials
-
- Lesson 1 PowerPoint
- Book: What's Inside a Flower?
- Conservation Connections cards
- String
- Laminated flower parts and labels
- Felt backing for flower assembly

Lesson

1. **Explain to students that today we will be learning about the role of pollination and how biologists at the RIDEM Division of Fish and Wildlife are helping protect the animals that play a huge part in the process.**

2. **Read through the *What's Inside a Flower?* book.**
    - Review flower parts by having students piece the laminated flower parts together.
    - Hand out the pieces to students and have them come to the front of the classroom one by one to Velcro their flower part to the felt backing. Once organized, quiz students on the functions of each part. For very young students, you can limit flower anatomy to the four broader terms, listed here, and can go more in depth with older students. There's a lot of new words here! You can review all of the flower parts using the animated diagram in the PowerPoint.
        - ***Sepals***: protect the ovary
        - ***Petals***: attract pollinators with bright colors
        - ***Pistil***: female parts made up of the sticky **stigma** which collects pollen, the **style**, which leads down into the **ovary** where new seeds are made.
        - ***Stamen***: male parts made up of the **filament** which supports the **anther** which creates and holds pollen.

3. **Ask students if anyone gets especially sneezy in the spring or fall?** This is due to pollen, a yellow powder that helps a plant make new seeds (which grow into new plants) and sometimes gets into our noses and causes allergies.

4. **Ask students how the pollen moves from one flower to another. Explain there there are some plants that use wind and water, but most plants need an animal to help spread the pollen, also known as a pollinator!**
    - Ask students to names some pollinators: bees, butterflies, moths, bats, birds, beetles, ants and even mice
    - Describe how when pollinators move from flower to flower, they accidentally knock against the stamen and pollen gets stuck on their fur or feathers.

5. **What brings pollinators to flowers? Do they pollinate on purpose?**
    - Color and smell attract pollinators to the flowers, letting them know that there is tasty nectar to drink and pollen to eat. Pollinators are looking for food, and accidentally spread the pollen while they are snacking!
    - ***Play the Busy Bees, Busy Blooms game from Project WILD to illustrate the concept of pollination.***

6. **Explain that when we think about plants and animals, we can't think about just one at a time, we have to think of how they all fit together, like pieces of a puzzle. If one piece is missing, the puzzle will never be complete.**
    - Pollinators are especially important because they help create new plants, and plants are able to make their own energy, unlike other living things. Herbivores have to eat plants to get energy. Then, when carnivores eat herbivores, the energy goes into their bodies! Plants also create oxygen, which we all need to breathe, so we want lots of pollinators to help create lots of energy and oxygen for our planet!

7. **Wrap up with the Conservation Connections Activity.**

Lesson 2: Meet the Pollinators!

Theme

Pollinators can come in many different shapes and sizes but all of them are equally important.

Learning Objectives

In this short lesson, students will learn about the different species of pollinators that can occur in Rhode Island and around the world.

Corresponding Activities for this Lesson

- Which Pollinator Am I?
- Bee Mythbusters
- Build a Bee craft

Materials

- Bee Myth Cards
- Which Pollinator Am I Cards
- Bee Craft Supplies (egg cartons, markers, scissors, construction paper)

Lesson

1. **Ask students if they can name some pollinators, reviewing what they learned in the Lesson 1 discussion.**
    - Animals that pollinate include bees, wasps, birds, bats, butterflies, moths, ants, beetles, and even mice!

2. **Ask students if they can think of any adaptations of pollinators. What might help these critters be good at spreading pollen from flower to flower?**
    - Examples: Wings to fly from flower to flower, fuzz, fur, or feathers that pollen can stick to, small size so they can easily land on flowers, long tongues to reach flower nectar, spceial hairs on bees' legs that trap pollen into "baskets"

3. **Play the "Which Pollinator Am I?" game to get students talking about adaptations and learning the names of different pollinators.**

4. **After playing the game, you could also follow up with the Bee Mythbusters activity to do a deep dive on bees and hopefully dispel any fears of these often misunderstood insects.**
    - Review the anatomy of a bee with the Build a Bee craft. Written instructions are included in this packet, and also in the Creature Crafts video in the YouTube playlist linked on the Pollinator Pals page.

Lesson 3: How Can I Help Pollinators?

Theme

Pollinators are important providers of ecosystem services to humans, and need our help! There are several threats to pollinators that can be combated by simple actions everyone can accomplish.

Learning Objectives

Students will review the ways that pollinators help humans through ecosystem services. Students will learn about the threats to pollinators and simple actions we all can take to help them. Students will also learn about community science opportunities through the RIDEM Divsion of Fish and Wildlife's Wild Bee Observer survey.

Corresponding Activities for this Lesson

- Pollinator Protectors Gallery Walk
- Pollinator PSA

Materials

- Large pieces of paper
- Markers, crayons, colored pencils
- Plant and pollinator field guides

Lesson

1. **This lesson will be presented through a gallery walk in place of a PowerPoint.**
    - Set up the gallery walk by placing 5 large pieces of paper around the room. On each piece of paper, write the follow questions (feel free to come up with your own, as well):
        - How do pollinators help humans?
        - What are some things that may harm pollinators?
        - Why should humans protect pollionators?
        - How can you help pollinators?
        - What are some cool facts you know about pollinators?
    - Explain to students that there are 5 pieces of paper around the room with questions for them to answer about pollinators. Pass out markers and disperse students or groups around the room. Give students about 2 minutes per question,

making sure to give them a warning before time is up. It is okay if they don't get to all of the questions, they will have a chance to participate in the final discussion.
- Give students about 10-15 minutes total to walk around the room independently and write their thoughts on each piece of paper. They can also add some doodles to illustrate their thoughts! This can alternatively be done in small groups with a leader writing a single answer for their group. Encourage students to come up with their own ideas, and that answers can be anonymous. Once the time is up, gather back together as a group and discuss all of the answers.
- When the time is up, collect the markers and give students a couple of minutes to walk back through and read the answers from other classmates, ask them to think about what stands out to them. Gather students back together and begin a big group discussion.

2. **Did anything stand out to you from these answers? Did you strongly agree/ disagree with any of these answers?** This is a great time to let students express themselves. Encourage students to share their thoughts, and have a respectful discussion.

3. **How do pollinators help humans?** Explain to students that when a wild animal or habitat helps people in some way, that is called an ecosystem service. The most important ecosystem service pollinators provide is pollination of crops. Some pollinators (wasps) also provide crop pest control because they act as predators of these pesky pests.

4. **What are some things that might harm pollinators?** Review students' answers, and add any that might be missing. Here are some details to share about the main threats to pollinators.
   - *Habitat loss:* All wild creatures face this threat! It's tough to live in a habitat that is broken up into tiny pieces by roads, parking lots, and buildings. A lot of people think that pollinators just need flowers in the summer, but they need good habitat all year round, including shelter. Most neighborhoods and cities don't have space where pollinators can find good shelter. Leaf piles, brush piles, hollow dead flower stems and tree stumps or logs are usually cleaned up right away. However, these are some of the best places for bees, wasps, butterflies, and moths to shelter for the winter!
   - *Lack of nutritious food:* Most pollinators will visit any flower they can find, but not all flowers provide the best nutrition or bloom at different times in the season so that there's enough food to go around all the time. Flowers in most of our yards and gardens are not native to Rhode Island, and don't provide our pollinators with the best nutrition. Many butterflies and moths only eat one or two native plants in particular, called host plants. The best known example is the monarch butterfly caterpillar and native milkweed, but the same concept applies to most butterfly and moth species in Rhode Island.
   - *Chemicals:* Pesticides are chemicals that people apply to their gardens or crops to kill particular pest insects that are causing problems. Unfortunately, pesticides can kill pollinators too, even if people spraying them don't mean to! Herbicides kill weeds, but can also kill native plants if sprayed on them, which shrinks the local food source for pollinators.

- *Disease:* Did you know that honeybees are not native to North America? They are actually from Europe! Beekeepers take care of hives of these non-native honeybees, but if they aren't careful, the honeybees can get sick and then spread the illness to native wild bees. Wooden "bug hotels" are often marketed for bees and other insects to find shelter during the winter, but if not properly cleaned out, they can harbor harmful diseases and make the next bug tenants sick.
- *Invasive plants:* Invasive plants are not native to Rhode Island, but have arrived here from other parts of the world. Even though they aren't from here, they grow well in our local climate, and have a tendency to take over. When invasive plants crowd out native plants, that reduces food sources for pollinators, especially if they are hoping to find their host plants in an area.

5. Why should humans protect pollinators?
Without pollinators, humans would be very hungry! Pollinators are also food for other wild animals, and help a wide variety of plants to grow. A diverse and healthy ecosystem is important for everyone on the planet! Pollinators are also beautiful and fascinating, and deserve to be protected!

6. How can you help pollinators?
- Plant a pollinator garden with native plants.
- Create shelter for pollinators by making small brush piles with sticks, leaving the leaves on the ground in the fall, and leaving dead plant stalks up all winter. If you decide to put up a bug hotel, make sure to clean it out and refresh the materials so pollinators don't get sick.
- Don't use chemicals in your yard. Instead, opt for natural pest and weed control options
- Learn how to identify invasive plants and remove them from your yard, city park, or community garden.
- If you're going to be a beekeeper, make sure your bees are healthy.

7. Explain to students that there's another really cool way they can help Rhode Island's pollinators as community scientists through the Rhode Island Wild Bee Observer survey!
- A community scientist is anyone who has an interest in science. They do not have to work as a scientist professionally. Community scientists can be grown-ups or kids; they sign up to help out professional scientists with different projects by collecting information. The more people out collecting information, the more scientists can learn and share with the community!
- The Rhode Island Wild Bee Observer survey is an easy way to help bees in our state. All you have to do is take a photo of any bee you see in Rhode Island, submit through the iNaturalist app, and it goes straight to RIDEM's Pollinator Entomologist.
- This is a GREAT way to get your students outdoors and making science observations right at school! For detailed instructions, check out the first link on the quick links page in this packet (RIDEM Wildlife Observation Reporting).

8. What are some cool facts yo know about pollinators? This is a great opportunity for students to share what they have learned about pollinators, and review the unit as a whole!

9. Wrap up this lesson with the Pollinator PSA activity.