Grow Eat Learn
Nourish Nova Scotia

Moth Gardens: Habitat for Midnight Pollinators

Learning & Activity Guide

by Ruth Lapp

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Chapter 1

Introduction to Moths

In this chapter we learn how to identify some key physical characteristics of moths, and how to distinguish a moth from other insects. We discover some of the clever ways moths have learned to avoid becoming prey and how moths contribute to maintaining a vibrant and healthy world.

1.1 Learning Outcomes

- Learn about where moths fit within the **scientific classification system** of the animal kingdom
- Understand key physical characteristics that allow for the **observation and identification** of moths in their natural settings.
- Become more aware of the **critical roles that moths play in natural ecosystems** and their contribution to food sustainability for humans.
- Learn about different **cultural perceptions** of moths, and how some cultures perceive moths in a positive light, while in other cultures moths have a negative reputation?

Find words in **bold orange** in the glossary section

1.2 What is a moth?

Moths belong to the same group of insects as butterflies. Their scientific name **Lepidoptera** (from Greek) means 'scaly winged', and refers to the microscopic, dust-like scales covering their wings.

While there are over 100,000 identified species of Lepidoptera in the world, new species continue to be discovered, and scientists estimate that globally there are 300,000 to 500,000 species of Lepidoptera. The vast majority of these are moths! [1]

Climate Connections

Growing & Processing Food

Moths are significant contributors to pollination, often times pollinating plants that other insects do not. Through their pollination of plants, moths help ensure plants are able to produce fruit that is food for other creatures (including humans), and the seeds for next year's crops

Habitat Creation & Biodiversity

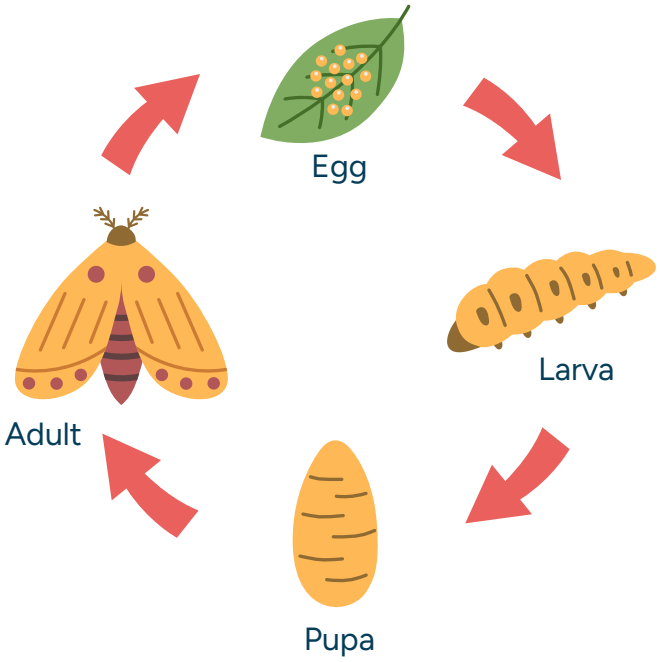
By increasing the biodiversity of our gardens we engage in habitat creation that supports ecosystem resiliency. This correlates directly with plant and animal species richness (the total number of different species in an environment) and the density of a particular species in a given area. Biodiversity ensures that an ecosystem can remain dynamic in the event of droughts, floods, or other extreme conditions.

Climate Justice

In cultures around the world moths are revered as sacred beings. Many Indigenous peoples practice the ethic of "All my relations" and consider all life as important and connected for the continuance of creation. In Western science we understand this ethic with biodiversity. When biodiversity declines, ecosystems lose the ability to support life and may even collapse.

1.2 What is a moth? (cont.)

During their lifetime, moths and butterflies undergo complete **metamorphosis** (see below), meaning each individual goes through four distinct stages: egg, **larva**/caterpillar, pupa/chrysalis/**cocoon**), and adult.



Throughout the larva stage, moths are very vulnerable to predation from birds, spiders, ants, lacewings and parasitic wasps. The larvae of some moth species have developed special tactics to help them avoid becoming prey. We will explore some of these tactics throughout this resource under the heading: How moths avoid becoming prey!

Compared to moth larva, most adult moths are short-lived (some adults live for just a few days). Some adult moths stay alive just long enough to mate and lay eggs.[2]

In the following pages, we will explore the significant contributions moths make to ecosystem resilience and economic prosperity for humans. While not an exhaustive exploration, our hope is this resource will pique your interest in these fascinating, mysterious and unsung heroes of the insect world.

Fascinating Fact

An **instar** is a developmental stage of the larva (caterpillar) between each molting, or shedding of its skin, to allow for growth. A caterpillar enters its first instar after hatching, and then goes through several more instars, each followed by a molt, until it reaches the final instar and is ready to **pupate**. The number of instars and the length of each instar can vary depending on the moth species, climate, and food availability.

Luna Moth Life Cycle (video)

Some adult moths have a **proboscis**, an elongated sucking mouth part that is typically tubular and flexible. A proboscis allows a moth to drink nectar from flowers. However, not all moths have a proboscis, which means they do not eat as adults. These moths rely on energy that is stored in their bodies from the moment they emerged from their cocoon.

1.3 How to Identify a Moth

You might think that moths are not as beautiful or interesting as their butterfly cousins. However, many moths are exquisite and have intriguing natural histories. The Luna moth (*Actias luna*)—an ethereal beauty—is a large silkworm moth, and the most well known member of the Saturniidae family, native to Nova Scotia.

Luna moth (*Actias luna)*. Photo 582646604, (c) anneirwin, some rights reserved (CC BY-NC).

Luna moths are **nocturnal**, meaning they are active at night. This is why we often do not see them. The Luna moth adult does not have a mouth-part, and does not eat as as an adult.

How Moths Avoid Becoming Prey

Camouflage

Camouflage is a colour pattern that allows animals to blend into their habitat.

Moth larva are often the same colour as the plant material upon which they are feeding. Common coloration are greens, greys, and browns. Some larva also have body markings that help them blend into their surroundings.

Many adult moths also use colour and pattern camouflage to make it difficult to see them against the colour and texture of the flowers, leaves, bark, or even lichens they are resting on. Check out the Slant lined moth or mayapple moth profile.

Crypsis

Some moths take camouflage a step further—**Crypsis**. They not only use colour and patterns to help them evade their predators, but actually mimic the very plant structures they are on. For example, moths such as the White-Striped Black Moth (see profile pages) from the Geometridae family (or loopers) often mimic small sticks, so they look like a part of the branch they are on.

Crypsis, like the word cryptic, comes from the Ancient Greek word krúpsis, meaning “hiding, concealment”. The word mimicry also comes from the same ancient word.

1.3 How to Identify a Moth (cont.)

Learning to tell a moth apart from a butterfly (or even from some wasps) can be challenging. The following three characteristics can assist in differentiating a moth from a butterfly.

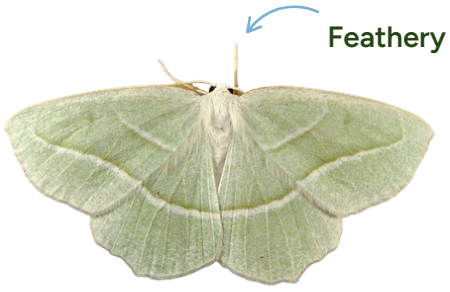
1. **In general, butterflies fly during the day and moths fly at night**. However, some moths like the *Ctenucha virginica* fly mostly during the day, which makes telling moths and butterflies apart even more confusing.

2. Another way to tell the difference between a moth and a butterfly is by the **shape and style of their antennae**. Butterflies have clubbed antennae, and moths have feathered or comb-like antennae.[3]

3. A third distinguishing characteristic is **wing posture**. While resting, butterflies tend to hold their wings vertically while most moths rest with their wings laid flat. But, as with many examples in nature, there are always exceptions to the rule!

For more information on distinguishing characteristics check out the awesome resources in the reference section (4 and 5).

Pale Beauty Moth



https://www.inaturalist.ca/taxa/81681-Campaea-perlata

Red Admiral Butterfly

https://www.inaturalist.ca/taxa/49133-Vanessa-atalanta

Nourish Resource Features

Use this Moth ID Guide (either printed or on a tablet) to observe and identify which moths live near you.

How Moths Avoid Becoming Prey

Wearing a Disguise

While not as common as the first two forms of camouflage, at least one moth species puts on a costume to fool its prey. The larva of the Wavy-Lined Emerald Moth (*Synchlora aerata*), also known as the Camouflaged Looper, attaches fragments of flower petals it has chewed to its body using silk threads it spins. When the petal pieces wither, or if the larva moves to another flower species, it will replace its disguise with a fresh costume. (see profile)

Scary Horns

Soft and slow moving moth larva are fat and protein snack-sacks, critical for song bird reproduction. Some moth larva have evolved body parts to try and frighten predators. The family of moths known as sphingidae or sphinx moths are equipped with horn-like appendages on their tail-end. (profile hummingbird moth)

Sphinx moth caterpillar with horn

1.4 Moth Ecology

Moths live on every continent on Earth except Antarctica. They inhabit a range of diverse terrestrial ecosystems—from tropical rainforests to mountainous regions, temperate and boreal forests to grasslands and deserts. There is even one known species of aquatic moth (*Acentria ephemerella*). Some moths have even adapted to live in human-created environments such as your clothes closet or your pantry.

"Moths are involved in a tapestry of relationships that are indispensable to the ecosystems around us."

– Shane Sater[6]

Moths matter! If moths were to become extinct it would be catastrophic for the environment. Moths provide many ecological goods and services for humans and are indispensable to the well-being of countless animals and plants! Moths are considered to be co-evolutionary players in shaping the nature of plant and animal communities.

Some flowering plants have flowers that can only be pollinated by moths. For example, the hummingbird hawkmoth has a proboscis longer than the rest of its body, allowing this moth to reach nectar at the base of narrowly tubular flowers, and has a "knee-bend" that facilitates entry into the flowers.

Moth larva are indispensable food for birds when raising their young.

"Most song birds in North America are primarily insectivores, particularly during that all-important nesting period, with seeds and berries only supplementing their diet. Their nestlings are unable to digest seeds at all".

– The Nature of Oaks by Doug Tallamy

A rare species of evening primrose found in the Antioch Dunes in the San Francisco Bay Area is in a critical state due to a drastic decline in the local hawkmoth population, the primrose's pollinator.

In Chapter 2 we will explore in more detail some of the roles moths play in maintaining healthy ecosystems and supporting human economies.[7]

How Moths Avoid Becoming Prey

Hairy Bodies & Toxic Bristles

The word "caterpillar" comes from Latin and means "hairy cat". Some moth larva have hairy bodies, such as the well-known "Wooly bear" or the Isabella Tiger Moth (*Pyrrharctia isabella*) (see profile). While the Wooly bear is considered safe to handle, if handled roughly, its bristles can break off and cause skin irritation. Be aware, other bristly caterpillars can be toxic.

Tiger Moth (*Pyrrharctia isabella*)

Building a Safe Space

Leafrollers or leaftiers include many different species of moths whose larvae roll, fold or tie together leaves of trees, shrubs or perennials. This helps them avoid being seen. These larva feed from within this safe space.

There are many other ways moths have evolved to avoid being eaten by prey. While these tactics have helped moths survive, there are no foolproof methods, and moths (especially larva) are eaten by the higher members in the trophic level of ecosystem. This is how moths contribute to the foodweb.

1.5 Moths in Human Cultures

Moths are not only important to the scientific community, they appear in various cultural expressions. Different societies and cultures have many ways of thinking and feeling about moths.

In our modern Western society moths are often considered to be pests that spoil your flour, eat your favourite wool sweater, or continuously fly into your porch light. The moths that people most often hear about in the media are those considered to be destructive to agricultural crops or other economically significant landscapes. Because moths are generally nocturnal, they may invoke a sense of fear or loathing that is associated with the dark. People rarely have the same feelings towards butterflies.

But not all cultural traditions view moths in such a negative light. In some traditional cultures in China, people consider moths to be returning spirits of their ancestors. In this context, moths are highly revered and protected.[16]

Because of their complex and transformative life cycle (metamorphosis) moths and their cousin butterflies have come to represent resurrection or reincarnation in some spiritual traditions and religions. In this context they are signs of renewal and hope!

Moths belong within the Mi'kmaq concept of Netukulimk, which "respects and honours the interconnectedness of all things—land, animals, water, human beings, plants, customs, and laws—and the sustainability and cycles of life."[17]

1.6 Discussion Questions

- What is one way that moths have adapted to their natural surroundings to help them avoid becoming prey? Are there other insects or animals you are aware of that have evolved similar ways of avoiding becoming prey?
- What are some features that set moths apart from other insects?
- If you were to write a story or make art about a moth, what kind of character or features would you depict and why?

The Art of Moths

Throughout history moths have been the inspiration of paintings, literature, and have even been thematic in films, like the Japanese cult classic Mothra.[18]

In Australia, cave paintings indicate that moths are the oldest archaeological evidence of insect foods on stone artefacts in the world.

Scan here to learn more

The painting, the "Great Peacock Moth" by Vincent van Gogh (1890) expresses the artists inspiration of moth metamorphosis, which "he believed symbolized people's capacity for transformation."[19]

Contemporary and award-winning charcoal and mixed media artist Traci Wright Martin considers moths to be important to her artistic practice: "The moth has become my symbol for underrepresentation," particularly when it comes to the representation of women artists in art history.[20]

Moths make their way into literature. Examples in English literature include Virginia Wolfe's essay (and book by the same title) The Death of the Moth, as well as Sharon English's Canadian novel, Night in the World.

Chapter 2

Moths are Important, Naturally!

In Chapter 1, we briefly touched upon how moths contribute to vibrant ecosystems. In this chapter we explore in greater detail why healthy moth populations are key to ensuring a biodiverse world. We address some of the unique threats moths currently face, and consider ways to mitigate the threats to moths.

2.1 Learning Outcomes

- Learn why **biodiversity is critically important** to stable and functioning ecosystems. Learn why biodiversity is at risk of decline.
- Learn how **biodiversity impacts human food systems**. Understand the Food Web.

2.2 Biodiversity

Biological diversity—or **biodiversity**—refers to the variety of life on Earth, in all its forms! Biodiversity ranges from genes and bacteria to entire ecosystems such as forests or coral reefs. Moths are a part of this beautiful tapestry of life on Planet Earth, and moths have important roles to play in earth's viability.

Biodiverse plants and animals

Humans depend on biodiversity for many things including food, clean water, medicine, a stable climate, economic growth, among others. It goes without saying, we cannot live without biodiversity.[9]

But biodiversity is in decline around the world, with approximately 1 million species at risk of extinction. (10) And, we are losing many species to extinction before we even have the opportunity to learn who they are. This is especially true of insects!

> "At its most essential, biodiversity improves the stability and resilience of an ecosystem. The more complex an ecosystem—the more abundant and variable its life and resources—the more likely it is that some of its species will have the ability to withstand stressors like drought, disease, or a changing climate."
>
> – Courtney Lindwall [8]

2.2 Biodiversity (cont.)

Why is biodiversity declining?

According to the United Nations, the number one cause of biodiversity loss is human alteration of land. The intensification of industrial agriculture and urbanization are major contributors to ecosystem degradation and habitat loss. However, climate change is increasingly having a deleterious effect on ecosystems and biodiversity.

Many moths are currently at risk of decline. It is important that we become aware of what the risk factors are, so that we can take action to support moth well-being.

Insect Diversity

Insects make up the largest proportion of animal diversity and biomass on the planet and play a central role in the global Foodweb. It is critical that we understand what is happening to them and try to protect them.

A recent scientific study from Canada shows that one-fifth of pollinators in North America are at risk of extinction. Most plants, including many important agricultural crops, depend on pollination to reproduce.[11]

Climate Change

Climate change refers to the long-term shift in temperature and weather patterns, at both local/regional levels and globally. While climate change is caused by many factors, increased CO_2 from burning fossil fuels and the destruction of forests is a major contributor.

Climate change influences the health of ecosystems, affecting shifts in the distribution of plants, viruses, animals, and even human settlements. When ecosystems are degraded, their benefits for human well-being (ecological goods and services) are also jeopardized.

Moths and many other insect species are disappearing rapidly, with climate change being a major contributing factor.

Habitat Destruction

Habitat destruction is when a natural environment is made unusable for its native plant and animal species, causing them to die or move.

Loss of habitat leads to reduced biodiversity and even species extinction. Humans are the primary driver of this phenomenon, with activities like agriculture, urbanization, deforestation, mining, and dredging of waterways. When the natural environment is degraded or destroyed, this can eliminate sources of food, water, shelter, and spaces that wildlife needs to survive.

By preserving wild spaces in our yards (eg. not mowing every space) and planting native plants in our gardens we can provide food and shelter for moths through their whole lifecycle.

2.2 Biodiversity (cont.)

Pesticides

According to the Pesticide Atlas, pesticide use has increased by 80% since 1990. This increase in use has caused a 30% decline in field birds and butterflies.

Additionally, pesticides are also responsible for an estimated 11,000 human fatalities and the poisoning of 385 million people every year. In large part, the increase in pesticide use is driven by the global intensification of agriculture.[12]

Insecticides can directly target juvenile and adult Lepidoptera and cause lethal effects. Furthermore, insecticides can also cause sublethal effects or act as a repellent to moths.[13]

Along with insecticides, the increase in use of herbicides and fungicides also impacts moths, destroying their food sources and shelter.

By growing food in our gardens organically, or supporting farmers who do not use pesticides on their crops, we can help moths and many other creatures.

Light Pollution

Nocturnal animals sleep during the day and are active at night. Light pollution radically alters their nighttime environment by turning night into day.[14]

Not surprisingly, artificial lights disorient moths, and research has found this can impair finding mates, evading predators, and pollinating plants.[15]

By turning off outdoor lights at night, we can help moths not become disoriented or make them easier prey for bats.

Tension with agriculture and forestry industries:

BTK (Bacillus thuringiensis var. kurstaki) is an insecticide that is used extensively in agriculture and industrial forestry to control crop pests such as cabbage moths, tomato worms and spruce budworm. While considered safe to humans and other creatures, BTK targets the larval stage of **ALL** lepidoptera (butterflies and moths) that come into contact with foliage sprayed with BTK. When the larva ingest the leaves that are covered with the toxin they die.

As we have learned, moth larva are indispensable food for many birds while raising their young. Many other creatures including parasitoid wasps, frogs and toads, trout, and even mammals such as red squirrels also depend on moth larva to provide essential protein and fats in their diets.

Hold on, good news is coming!

2.3 Pollination

Ecosystem goods and services

"Pollinators are declining worldwide, and this has raised concerns for a parallel decline in the essential pollination service they provide to both crops and wild plants."[21]

While much attention has been given to the role of bees and butterflies in pollination services, moths are also important pollinators. Because of the sheer number of moth species in the world compared to the number of butterfly species, moths pollinate more plants than butterflies.

While moths themselves do not consume pollen for food like bees, many adult moths are **nectarivores**. As they move from flower to flower seeking nectar to eat, they inadvertently move pollen from flower to flower and increase seed viability.

Moths are particularly important pollinators because many are active after dark (nocturnal). One study found that "nocturnal moths visit more plant species than day active bees do (quite a feat considering the super pollinator status of bees), highlighting their importance in pollen transport."[22]

As with other pollinators, moths co-evolved with native plants, such that both moths and plants exhibit characteristics that are adapted to each other. "The flowers of some plants open in the evening and become more fragrant at night, luring in moths, which depend on the scent to find food (and mates). These flowers also tend to be white or pale in colour to reflect moonlight, allowing them to be seen at a distance by nocturnal pollinators."[23]

Fascinating Fact

Moths don't have noses but they can smell...

"All over the body of a moth are thousands of finely tuned smell and taste receptors. These come in the form of scales, bristles and pits found on moths' feet, mouthparts and antennae. These receptors help moths find food, detect fungal diseases and parasites and find mates. A male moth can even smell a female more than seven miles away!" [28]

Nourish Resource Features

Native Pollinator Plant ID Guide

Learn how identify Native pollinator plants using this plant ID guide.

2.3 Pollination (cont.)

Moths are also superb pollinators thanks to their fat bodies and hairy underbellies. With all of these characteristics, pollen transport by moths plays an important role in facilitating genetic diversity in plant communities across landscapes. Adult moths tend to move much longer distances between patches of plants than bees, which forage around a specific nest location. These larger flight ranges mean moths take pollen further afield.[24]

Declines in moth populations, combined with a growing understanding of their importance for pollination, highlight the need to include these nocturnal pollinators in pollinator conservation efforts.

2.4 Food web

There are a lot of caterpillars and they "represent the largest biomass of any group of herbivorous animals." [25] A healthy ecosystem is a dynamic ecosystem. This means that ecosystems are always in flux but overall, there is a tendency towards balance and stability. When a healthy ecosystem is impacted by a disturbance such as a storm, an infestation, or fire, it can generally bounce back or repair itself. This is known as ecosystem resiliency.

Ecosystem resiliency is directly related to biodiversity. The plants, animals, and fungi that are native to a particular ecological system are all interconnected and interdependent. This interdependency is sometimes conceptualized as the food web—but a more accurate term would be the life web.

2.5 Discussion Questions

- Why are moths important to a secure and sustainable food system?
- What are some ways we can help boost moth populations that may be in decline in the area we live?
- When thinking about the food web, where do see yourself fitting in? Can you make a diagram of this?

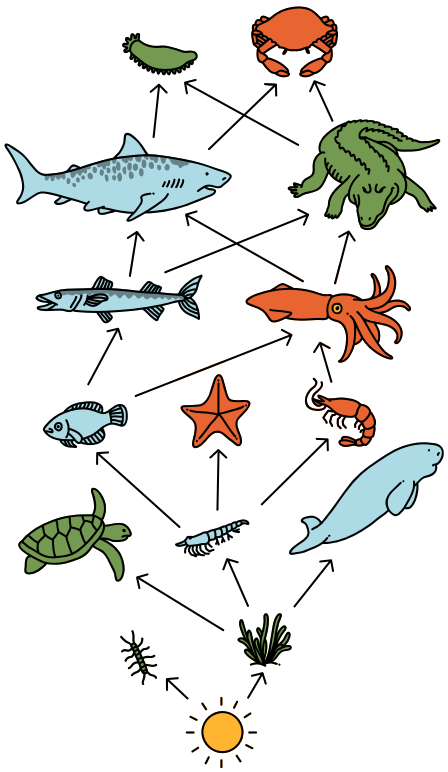
What is a Food Web?

A food web is a visual way of understanding all the links among biotic and abiotic elements in an ecosystem—essentially it shows who eats who or what!

There are many different kinds of ecosystems—therefore there are also many different kinds of food webs.

All food webs are powered by the sun. Plants capture the sun's energy through photosynthesis. When plants are eaten the sun's energy is transferred to a higher trophic level.

Below is a simple diagram of an aquatic food web.



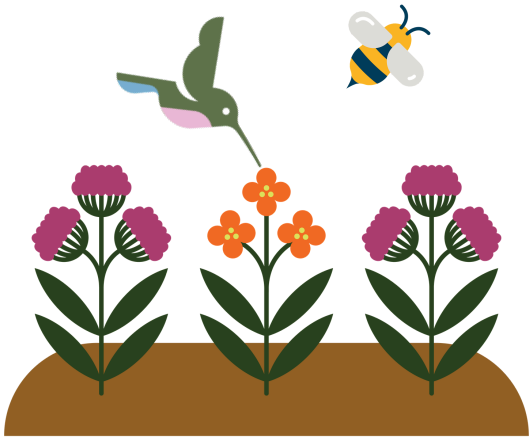
Chapter 3

Take Action for Moths!

Because we know that moths are a critical part of healthy ecosystems and understand that many moth species are in decline due to human caused threats, the next question we can ask is, how can we protect moths? This chapter lays out activities that help protect moth populations everywhere there are moths!

3.1 Learning Outcomes

- Learn how to use simple, in-the-field tools (eg. magnifying glass) to help identify moths and develop documentation skills by keeping a journal.
- Be able to access online citizen science tools, such as iNaturalist, in order to become part of a wide community of citizen-based conservationists.
- Learn to design a species-specific habitat - Moth Garden - and why native plants are important for moth conservation.



Habitat Creation & Biodiversity

How to Take Action for Moths

- Observe, Identify, and Document
- Protect Moth Habitat: Conservation
- Create Moth Habitat: Gardening for Moths

3.2 Observe and identify, and document moths

Basics for observation and documenting

Use a hand-held magnifying glass to look at the details of a moth (and other insects). **What do you see? Draw what you see.** Keep a journal of your drawings and observations. Sample questions to ask yourself and record in your journal:

- What was the date when you observed the moth?
- What time of day did you see the moth?
- What was the location (geographical) where you saw the moth?
- Was the moth on a specific plant?
- What stage of its life cycle? Observing moths as adults is much easier than when they are eggs, larvae or pupa/cocoon.

Create a moth sheet

Use a white cotton sheet hung up on a clothesline (pegged at the ground level to keep from flapping), with a light to attract moths and other nocturnal insects.

- Wait until dark.
- Shine a light (preferably an ultraviolet black-light) on the sheet so that most of the sheet is lit up. Different species of moths fly at different times of the night. The moths (and other flying insects) will be attracted to the light and land on the sheet.
- Once there are a number of species present, you can examine them more closely.
- Use your hand-held magnifying glass to look at the details of the moth.
- Record your observations in your journal.
- Take pictures if you have a camera or phone.
- **Important!!** With kids, this activity should be done with the supervision of an adult. Don't leave your trap up when done. Gently remove the moths from the sheet, turn off the light and let them continue on with their flying and foraging.

There are some good tips in this short video.[29]

3.2 Observe and identify, and document moths (cont.)

Become a Citizen Scientist

- Share your observations, findings and questions.
- Upload your photos to a nature identification app and learn more about the species in your trap or that you have observed with your magnifying glass.
- Join a group such as iNature Canada.

Consider joining iNaturalist, where you can learn what others are observing in your area and help create a species database. The app will also help identify what creatures and plants you are finding!

learn more

Nourish Resource Features

Check out these resources to learn how to spot local pollinators

Bug Bingo

Moth ID Guide

3.3 Protect moth habitat

- Learn about the habitat requirements of moths that are in your neighbourhood or county. You may also want to contact your local government officials to tell them why protecting moth habitat and biodiversity is important to you, and to your regional ecosystem.
- Learn what plant foods moths need, especially in their larval stage, which is a moth's longest life-stage. We often think of planting gardens for pollinating insects—such as butterflies and bees— when they are in their adult stage, perhaps because that's when these insects are most appealing to us humans. But all species of Lepidoptera spend most of their lives as larva, and during this stage they require a lot of food! In their larval stage some butterflies and moths are 'specialists' and only eat specific plants, lichens or fungi, while others are known as generalists and may eat many different plants. **If you want to support the life cycle of moths, learn what plants are important for all stages of their life.**
- Choose one species of moth that you are interested in learning more about. Do more research on this moth and write your findings in your journal.

3.4 Create Moth Habitat: Plant a Pollinator Garden for Moths

- Design a moth garden using native plants. Moths have evolved with the plants that are native to your ecoystem.
- Select plants that moths require throughout their whole life cycle.
- To avoid creating a dead zone, remember to include plants that feed both larvae and adults.
- Start small. Select one one species of moth that you are interested in supporting, and design a garden with this specific moth in mind. You can expand your moth selection each year by adding new plants for each new moth species.
- Choose at least **three plant species** for each season of the year that moths require food (larva, adults) and shelter during the time the lay eggs and pupate.
- Determine where you are going to obtain these plants. You might want to start some from seed, or you might want to purchase plants at a plant nursery. Do not dig up wild plants to transplant in your garden. Your garden is about creating NEW habitat! If purchasing plants, ask the nursery if their plants have been exposed to pesticides, especially Neonicotinoids.
- Research what the growing requirements are for your plants. e.g. full sun or partial shade, moisture etc.
- Draw a design of where your plants will be situated in your garden. Make sure they have enough space to grow, and that they get the sun (or shade) they need.

3.5 Discussion Questions

- Why are native species of plants important to include in pollinator garden designs?
- When is the best time of the day to view moths, and what are some ways to see moths?
- When creating a moth garden, why is it important not to transplant plants from the wild into your garden?

3.6 Sample garden for the Hummingbird Moth



3-season Nectar Plants for Great for Moths:
Wild bee balm (*Monarda fistulosa*, swamp milkweed (*Asclepias incarnata*),American fly-honeysuckle (*Lonicera canadensis*).

Hummingbird Moth



3-season Host Plants for Larva (spot for eggs and early food):
Common snowberry (*Symphoricarpos albus*), high-bush cranberry (*Viburnum opulus var. americanum*), and Northern wild raisin (*Viburnum cassinoides*).

Leaf Layer:
Hummingbird moths "pupate in a weak cocoon spun amongst fallen leaves" (Ref. Caterpillars of eastern North America).

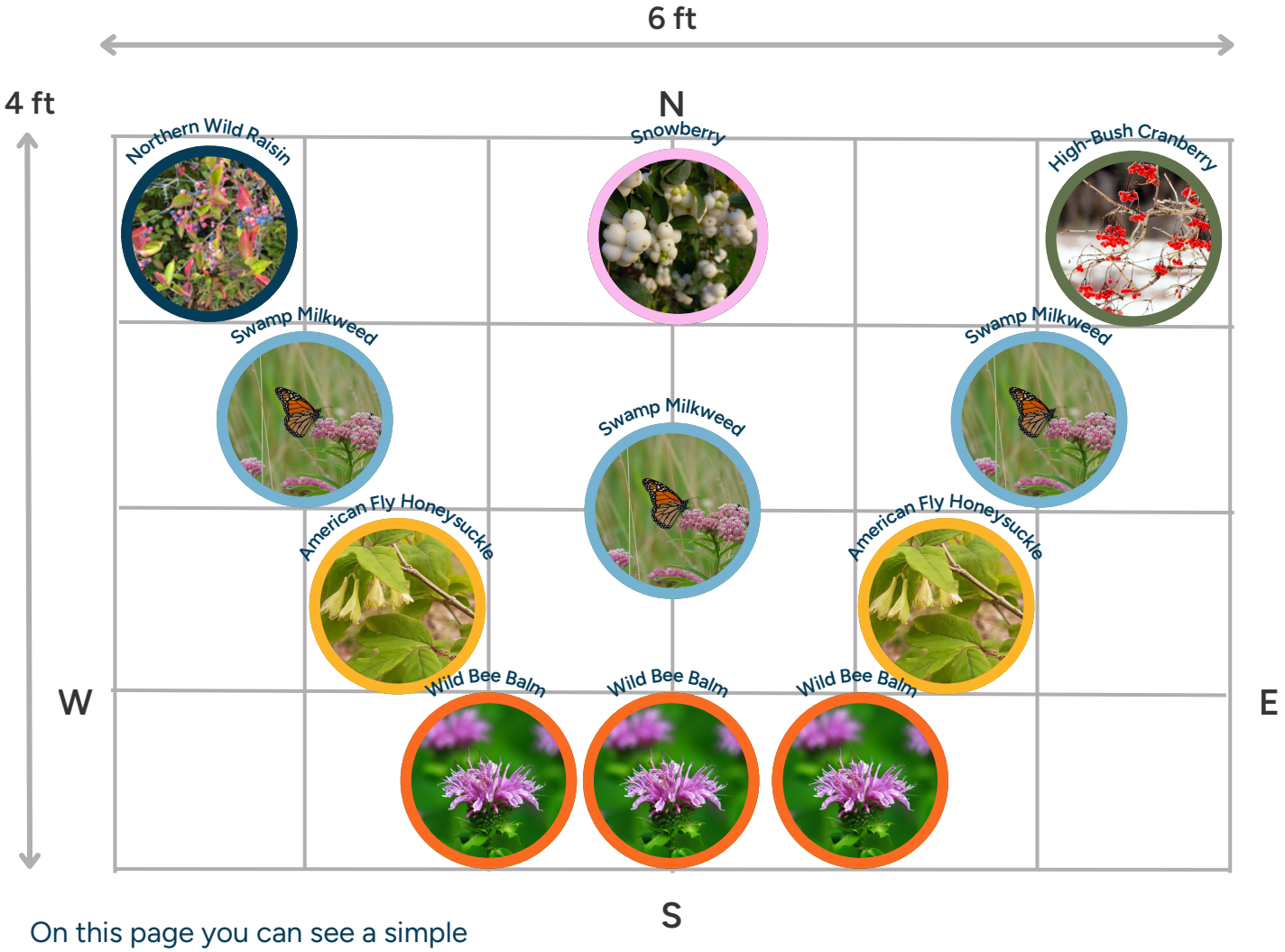
"Leave the leaves!"

Nourish Resource Features

Want to plant a garden for moths? Check out this guide to planting a pollinator garden for tips and rules of thumb

Pollinator Garden Planting Guide

3.6 Sample garden for the Hummingbird Moth (cont.)



On this page you can see a simple garden design for the Hummingbird Moth. The plants selected support the moth through all life stages. The layout shows estimated spacing between plants for optimal growth. Plants are positioned according to their growth height, with taller plants in the back and shorter in the front, so that they all receive ample sunlight. While this diagram shows a rectangular/grid layout, you may make your garden any shape, and follow the general rules of this garden design. You may also include other plants that your own research indicates are suitable for a hummingbird moth's food and shelter requirements.

Pollinator Plants We're Planting Together

Glossary of Terms

Antennae: sensory appendage on the heads of insects

Biotic and abiotic elements: in all ecosystems, biotic elements are any living organisms that affects another organism. Abiotic elements are the non-living physical and chemical components in the ecosystem that affect living organisms.

Chrysalis: refers to an exposed pupa (not within a cocoon)

Cocoon: a soft casing enclosing a moth pupa.

Coevolution: influences exerted by interacting organisms over time that cause morphological change to one or both organisms.

Diurnal: active during the day

Ecological Goods and Services: the many life-sustaining benefits we receive from nature—clean air and water, fertile soil for crop production, pollination, and flood control. These ecosystem services are important to environmental and human health and well-being.

Ecosystem Resiliency: a healthy ecosystem is a dynamic ecosystem. This means that ecosystems are always in flux but overall, there is a tendency towards balance and stability. When a healthy ecosystem is impacted by a disturbance such as a storm, an infestation, or fire, ecosystem resiliency means it can generally bounce back or repair itself.

Food Web: a complex network of connections between plants, animals and other organisms that eat—and are eaten by—each other. Food webs show how energy flows through an ecosystem.

Instar: the larval stage between molts. Most moths have between four and seven instars. Each instar can differ significantly in form, size and duration.

Keystone species: a species of plant, animal, fungus or microbe that has a disproportionately large effect on its natural environment relative to its abundance.

Larva: the immature, wingless, feeding stage of insects.

Metamorphosis: a profound change in form from one stage to the next in the life of an organism.

Glossary of Terms (con't)

Native/ Indigenous: originating naturally in a particular place or region.

Nectarivore: any animal that derives all or most of its nutrient requirements from the sugar-rich nectar of flowering plants.

Nocturnal: active at night.

Pollinator: an insect or other animal that pollinates a flowering plant.

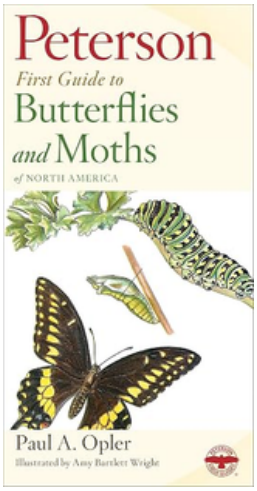
Proboscis: the elongated, protruding mouth parts of insects, adapted for feeding.

Pupa (pupae - plural): the third and non-feeding stage of a moth's life cycle, between the larva and adult, when a moth completes its final transformation. This transformation usually occurs within a protective cocoon. Pupate is the verb form of this process of transformation.

Thorax: the middle division of the body of an insect where the wings and legs are attached.

Trophic level: the position an organism occupies in a food web. Within a food web, a succession of organisms that eat other organisms and may, in turn, be eaten themselves **(Wikipedia)**

Umbelliferous: a family of herbaceous plants and shrubs, typically having hollow stems, divided or compound leaves, and flowers in umbels: includes fennel, dill, parsley, and carrot.



Field guides are fun for observing and identifying what's growing and living around you.

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Agriculture 11

Society and environment connections

- Compare the risks and benefits to society and the environment of production while maintaining health, preventing pests and diseases, and supply and demand (AG-14).

Designing an investigation

- Identify questions to investigate that include economy, environment, culture,
- and social aspects (AG-24). (https://curriculum.novascotia.ca/sites/default/files/documents/outcomes-indicators-files/Agriculture%20Agrifood%2011%20Outcomes%20%282015%29.pdf)

Learning outcomes for Agriculture 11 Foundational Outcomes

- Investigate and explain abiotic and biotic factors that influence agriculture (AG-01).

AP Environmental Science 12

- The AP Environmental Science course is designed to engage students with the scientific principles, concepts, and methodologies required to understand the interrelationships within the natural world. The course requires that students identify and analyze natural and human-made environmental problems, evaluate the relative risks associated with these problems, and examine alternative solutions for resolving or preventing them. Environmental science is interdisciplinary, embracing topics from geology, biology, environmental studies, environmental science, chemistry, and geography.

Netukulimk 12

- Netukulimk 12 explores environmental science concepts through the guiding principle of Etuaptmumk (Two-Eyed Seeing). Etuaptmumk refers to learning with the strengths of both the Mi'kmaw and western knowledge systems for the benefit of all. Through Wskitqamu guided learning, learners will gain an appreciation of interconnectiveness as they question the world around them, make observations, gather information, and reflect on decisions and actions. The core values of Netukulimk (Responsibility, Reciprocity, Relationship, and Respect) will guide the exploration of environments locally, throughout Mi'kma'ki, and globally. Learners will explore land, water, and global systems through four modules.