LESSON PLAN PACKET

Grades 6 to 12

Grades 6 to 12, ages 11 to 18

Ages 11 to 18. Real data, cause and effect, and argument from evidence.

> **Big idea:** Ecosystems are networks. Removing or adding one species changes others several steps away, and the data to see it is public.

This packet holds a 45-minute lesson, a reproducible student handout, and answer keys. It is built from the same data as the free games and tools on pollinatehappiness.com, a student-led project on Long Island where brothers Aidan and Ben Ellis have installed five native pollinator planters.

Lesson at a glance (45 minutes)

Time	Activity	What students do
0-3 min	**Warm-up question**	Write for one minute: can planting a shrub raise Lyme disease cases? Share one prediction.
3-18 min	**Cascade Stories**	Play one Cascade Story as a class. At each decision, discuss in pairs, vote, then read the feedback. Record the chain of effects.
18-30 min	**Investigate with the tools**	In small groups, use one tool for the school's zip code. Write a claim with at least two numbers as evidence.
30-37 min	**Who Got Here First? and Origin Stories**	Order invasive species by arrival year. Note which were introduced on purpose and why.
37-42 min	**Myth or Fact, Over/Under**	Play a quick round of Myth or Fact or Over/Under and read the source on any answer you missed.
42-45 min	**Exit ticket**	Answer the three exit-ticket questions on the handout.

Extensions (another day, or early finishers)

- **Project brief: design a planting:** Use the full Bloom Builder, the Native Plant Finder for the school's zip, and the planter bench guide to propose a real installation. Our own project started this way.
- **Project brief: fund it:** The student-funding guide covers youth grants, Eagle and Gold Award projects, and how to pitch a host site.

Learning objectives

By the end of the lesson, students will be able to:

1. Trace a cause-and-effect chain of at least three links from one introduced species to an effect elsewhere in the ecosystem.
2. Use community-science data from a site tool to make a claim about the school's zip code, support it with at least two numbers, and name one limitation of the data.

3. Explain, using at least two historical examples, why many invasive plants were introduced on purpose, and name a native alternative to one of them.

Materials and prep

Materials

- One device per student or per group of three, with internet access.
- Projector for the class Cascade Story.
- Student handout from this packet, one per student.
- Optional for the project briefs: the planter bench guide, the student-funding guide, and graph paper.

Before class

- Read the Cascade Story you plan to use and decide where to pause. The barberry story is the most local for Long Island.
- Run the Monarch Tracker, Garden Calendar, and Invasive Species tools for the school's zip code the day before, so you can spot surprising results.
- Remind students that tool results come from public observations and change daily. Have them note the date and radius they used.
- Print the handout and the answer keys in this packet.

Online activities (free, no sign-up)

- **Cascade Stories:** https://www.pollinatehappiness.com/games/cascade
- **Investigate with the tools:** https://www.pollinatehappiness.com/tools
- **Who Got Here First? and Origin Stories:** https://www.pollinatehappiness.com/games/timeline
- **Myth or Fact, Over/Under:** https://www.pollinatehappiness.com/games/myth-or-fact
- **Project brief: design a planting:** https://www.pollinatehappiness.com/guides/how-to-build-a-native-pollinator-planter-bench
- **Project brief: fund it:** https://www.pollinatehappiness.com/guides/how-students-can-fund-a-community-environmental-project
- **Answer keys (myths, timeline, pairs) (printable):** https://www.pollinatehappiness.com/educators/answer-keys
- **Invasive species library (printable):** https://www.pollinatehappiness.com/invasives
- **Native plant library (printable):** https://www.pollinatehappiness.com/natives

Vocabulary

Word	Meaning
Native species	A species that occurred in a region before European colonization, without human introduction.
Introduced species	A species moved by people, on purpose or by accident, to a region outside its native range.
Invasive species	An introduced species that spreads and causes harm to ecosystems, the economy, or human health.

Word	Meaning
Pollinator	An animal that moves pollen between flowers, allowing plants to reproduce.
Host plant	A plant that a particular insect's larvae must eat to develop. Specialists, like the monarch on milkweed, have very few.
Habitat	The area and conditions where an organism finds food, shelter, and space to reproduce.
Ecosystem	A community of living things interacting with each other and with their physical environment.
Trophic cascade	A chain of effects that moves through a food web when one species is added, removed, or changes in number.
Biodiversity	The variety of life in an area, from genes to species to ecosystems.
Research-grade observation	An iNaturalist record with a photo or sound, a date, a location, and a species ID agreed on by the community.

Discussion questions

Each question is followed by what a strong answer sounds like.

1. **In the barberry story, list every link between the shrub and a Lyme case.**
   Strong answer: Birds spread berries into woods; deer avoid barberry so it forms thickets; thickets stay humid; ticks survive and mice nest there; more infected ticks contact people.
2. **Why does an insect that is harmless in its native range become a serious pest here?**
   Strong answer: Its natural predators, parasites, and diseases did not come with it, and local trees did not evolve defenses against it.
3. **Your tool result shows fewer monarch reports this year than last. What are two possible explanations, and how could you tell them apart?**
   Strong answer: A real decline, or fewer people observing. Compare with other species' report counts or with longer-term data before drawing a conclusion.
4. **Why would invasive species reported within 10 km differ from those within 50 km?**
   Strong answer: A larger area includes more habitat types and more observers, and some invaders are still spreading, so they appear at the edges first.
5. **Most invasive plants on the timeline were planted on purpose. What did people believe at the time?**
   Strong answer: That they were attractive, useful for erosion control, hedges, or wildlife food. Gives at least one real example, like barberry or multiflora rose.
6. **Pick a myth you or a classmate believed. What evidence changed your mind?**
   Strong answer: States the myth, the correction, and the source cited in the game, such as ragweed rather than goldenrod causing hay fever.
7. **If the school planted a pollinator garden, what data would you collect to show it worked?**
   Strong answer: Before-and-after counts of pollinator visits, iNaturalist observations at the site, bloom months covered, and a plan for repeat measurements.

8. **Who should pay to control an invasive species: the seller, the landowner, or the public? Argue one side.**
   Strong answer: Takes a position and supports it with evidence about costs, who benefits, and who caused the spread.

Standards touchpoints

- NGSS MS-LS2-1, MS-LS2-2, MS-LS2-4, MS-LS2-5 (interdependence, ecosystem dynamics, biodiversity)
- NGSS MS-ESS3-3 (human impacts on the environment)
- NGSS HS-LS2-6, HS-LS2-7 (ecosystem stability and change; solutions to human impact)
- NGSS HS-LS4-5, HS-LS4-6 (environmental change and biodiversity)

Informal mapping to the Next Generation Science Standards; not a formal alignment. New York State's P-12 Science Learning Standards are built on the same framework; check your district's curriculum for exact codes.

STUDENT HANDOUT | free to copy

Following the Chain

Name _____ **Date** _____

Use the Cascade Story and one data tool. Write in complete sentences and cite numbers where you can.

1. Draw the cause-and-effect chain from the Cascade Story as boxes and arrows. Include at least four links.

2. Tool used, zip code, radius, and date:

3. Claim: what does the data show? Evidence: give at least two numbers. Limitation: what could make the data misleading?

4. Name one invasive species that was introduced on purpose. Why was it brought here, and what native plant could replace it?

EXIT TICKET

Define trophic cascade in your own words.

Give one reason community-science data might undercount a species.

Which myth or fact surprised you most, and why?

Answer keys

Games that draw random questions list the full pool they draw from. Games built live from local data or random recordings have no fixed key, so the teaching point is given instead. A printable set of all keys is at https://www.pollinatehappiness.com/educators/answer-keys.

Cascade Stories

Each decision has one choice the game marks as the wise answer. The wise answer is listed for every question.

The Hedge and the Tick

1. **What happens to the barberry's berries over the next few winters?**
   Wise answer: Birds eat them and drop seeds in the woods next door. Within a decade there are barberry seedlings scattered through the understory, and the deer that browse everything else leave them alone.
2. **What does a dense, humid barberry thicket do to the ground beneath it?**
   Wise answer: It shades the soil and keeps it moist, creating a humid microclimate. Barberry leafs out early and grows dense. The air under it stays humid, which matters to the next character in this story.
3. **What did researchers in Connecticut find when they compared barberry thickets with native shrub areas?**
   Wise answer: Several times more Lyme-infected ticks in the barberry. Humid thickets keep ticks alive; mice thrive in the cover; more ticks feed on more mice; more ticks end up infected.
4. **Which action reduces tick risk the most?**
   Wise answer: Remove the barberry and replant native shrubs like blueberry, bayberry, and winterberry. The same Connecticut studies found that clearing barberry cut tick numbers by more than half within a year. Native shrubs are open and drier underneath, and they feed birds and insects too.
5. **What comes back first, and why does it matter?**
   Wise answer: Native wildflowers and shrub seedlings the deer had suppressed, if deer are managed too. Barberry removal works best alongside deer management and replanting. Otherwise deer eat the recovery and the barberry seed bank returns.

The Beetle and the Trout Stream

1. **Why does a beetle that is harmless in Asia become a killer here?**
   Wise answer: Asian ash trees evolved with it and have chemical defenses; North American ash did not. Our ash trees never met this beetle, so they have no defense, and the beetle's natural enemies stayed behind in Asia.
2. **How does the larva kill the tree?**
   Wise answer: It tunnels S-shaped galleries under the bark, cutting the pipes that carry water and sugar. The tree starves from the top down. Woodpeckers strip the bark hunting larvae, the crown thins, and in two to four years the ash is dead.
3. **What happens to the stream?**
   Wise answer: It warms by several degrees in summer. Shade is temperature control. A few degrees is the difference between water brook trout can breathe in and water they cannot.
4. **What else did the ash provide besides shade?**
   Wise answer: Leaves that fed stream insects, and dozens of insect species that live only on ash. Ash leaf litter breaks down quickly and feeds the aquatic insects trout eat. And about 40 insect species in the Northeast eat nothing but ash; they go extinct locally with the trees.
5. **Which choice keeps the stream cold?**
   Wise answer: Have an arborist treat it with a trunk injection every two to three years, and plant other native shade trees beside it now. Treatment protects a healthy ash for as long as the beetle pressure lasts, and the young oaks

and sycamores will be ready to take over the shade.

The Garden That Stopped the Migration

1. **What is it?**
   Wise answer: Tropical milkweed, a non-native annual.It is easy to grow and monarchs will lay eggs on it, which is exactly why it is popular and exactly why it is a problem.
2. **What does fresh milkweed in late September signal to a monarch?**
   Wise answer: Keep breeding here instead of migrating. Some of the last generation break diapause and lay eggs instead of storing fat for Mexico. Those late caterpillars rarely survive, and the adults miss the window to leave.
3. **Why does native milkweed limit OE while tropical milkweed concentrates it?**
   Wise answer: Native milkweed dies back every year, which clears the spores; tropical milkweed keeps the same leaves for months, so spores pile up. Every extra generation breeding on the same leaves raises the spore load. Monarchs on year-round tropical milkweed in the South carry OE at several times the rate of migrants.
4. **What should the family do this week?**
   Wise answer: Cut the tropical milkweed to the ground now, and plant native milkweed for next year.Cutting it removes the false signal and the spore load. Common, swamp, and butterfly milkweed go dormant on schedule and host monarchs just as well.
5. **What does the fall garden do now?**
   Wise answer: Feeds the migrants on their way to Mexico, then goes dormant and lets them leave.That is a garden working with the migration instead of against it.

Investigate with the tools

Results are live and change daily, so there is no fixed key. Look for claims backed by specific numbers, a stated date and radius, and at least one limitation (observer effort, season, radius, misidentification).

Who Got Here First?

Arrival order with the year and how each species arrived. Origin Stories draws random trivia from the species profiles, so it has no fixed key; the game cites the profile after each answer.

Year	Species	How it arrived
1756	Norway maple	Sold by John Bartram in Philadelphia
1784	Tree-of-heaven	Planted in Philadelphia as a shade tree
1806	Japanese honeysuckle	Introduced through a Long Island nursery
1810	Purple loosestrife	Arrived in ship ballast on the Northeast coast
1816	Chinese and Japanese wisteria	Imported for porch arbors
1830	Autumn olive	Introduced as an ornamental
1860	Oriental bittersweet	Imported for autumn decorations
1866	Multiflora rose	Imported as rose rootstock
1867	Japanese knotweed	Growing in American gardens, one plant sent straight from Japan
1868	Garlic mustard	First recorded on Long Island as a potherb
1869	Spongy moth (formerly gypsy moth)	Escapes from a silk breeder's window in Massachusetts

Year	Species	How it arrived
1870	Porcelain berry	Planted for its speckled berries
1875	Japanese barberry	Seeds arrive at the Arnold Arboretum
1876	Kudzu	Shown at the Philadelphia Centennial Exposition
1908	Callery (Bradford) pear	Grown from Chinese seed at the Arnold Arboretum
1919	Japanese stiltgrass	Spills from porcelain packing crates in Tennessee
1930	Mile-a-minute weed	Arrives in a holly seed shipment to Pennsylvania
1951	Hemlock woolly adelgid	Found in Virginia on imported hemlocks
1996	Asian longhorned beetle	Discovered in Brooklyn maples
1998	Brown marmorated stink bug	Collected in Allentown, Pennsylvania
2002	Emerald ash borer	Found killing ash near Detroit
2014	Spotted lanternfly	Hatches from stone shipment in Berks County

Myth or Fact

The game draws fifteen cards from this pool.

Statement	Answer	Why
Goldenrod causes fall hay fever.	**MYTH**	Goldenrod pollen is heavy and insect-carried. Ragweed, blooming unseen at the same time, is the culprit.
Butterfly bush is one of the best plants for butterflies.	**MYTH**	It feeds adults nectar but hosts no caterpillars, so it produces no butterflies. Sweet pepperbush and Joe Pye weed do both.
Tropical milkweed is fine to plant in New York because frost kills it.	**MYTH**	It stays green into fall and can delay monarch migration and concentrate the OE parasite. Plant common, swamp, or butterfly milkweed instead.
Most native bees do not live in hives.	**FACT**	About 70 percent nest alone in the ground and most of the rest in hollow stems. Honey bees, the hive builders, are not native.
Cutting down a tree-of-heaven gets rid of it.	**MYTH**	Cutting triggers dozens of root suckers, and treating the stump does not kill the roots. The standing tree needs a systemic herbicide in mid to late summer, then cutting about a month later, then follow-up on sprouts.
Monarch caterpillars can only eat milkweed.	**FACT**	Milkweed is their sole host plant. No milkweed, no monarchs.
Spotted lanternflies can bite and sting.	**MYTH**	They are planthoppers with sucking mouthparts for plant sap. They cannot bite or sting people.
Leaving dead stems and leaves in the garden over winter helps pollinators.	**FACT**	Hollow stems house small bees, leaf litter shelters butterfly pupae, and seed heads feed goldfinches. Cut back in April.

Statement	Answer	Why
Japanese barberry thickets hold more Lyme-carrying ticks than native shrubs.	**FACT**	Studies in Connecticut found several times more infected ticks in barberry stands. Removing it is tick control.
Double-flowered coneflowers feed pollinators as well as the wild type.	**MYTH**	The extra petals usually replace the nectar-bearing disk florets. In Mt. Cuba Center's coneflower trial, doubles drew fewer pollinators than single-flowered types.
Earthworms are native to Long Island.	**MYTH**	Glaciers removed native earthworms; every worm here is introduced. The Asian jumping worm is the destructive one.
Oaks support more caterpillar species than any other North American plant.	**FACT**	Over 500 species in the Northeast, which is what feeds nesting songbirds.
Pheromone traps are a good way to control Japanese beetles.	**MYTH**	They attract more beetles than they catch. Knock beetles into soapy water instead.
Hummingbirds are the main pollinators of cardinal flower.	**FACT**	Bees cannot see red well; ruby-throated hummingbirds carry cardinal flower pollen on their foreheads.
You should collect milkweed seed from nature preserves to spread the plant.	**MYTH**	Never collect in preserves or parks. Collect from your own garden, or buy local-ecotype seed.
Violets in a lawn are a weed with no wildlife value.	**MYTH**	Violets are the only host plant for fritillary butterflies. Leave them.
The Asian longhorned beetle has been wiped out everywhere on Long Island.	**MYTH**	Not yet. Islip was declared free of it in 2011 and Brooklyn and Queens in 2019, but when USDA lifted 7.4 square miles of quarantine in July 2026, the other parts of Nassau and Suffolk stayed under quarantine. Keep reporting.
Bumble bees die in winter except the queens.	**FACT**	Only mated queens overwinter, in leaf litter and loose soil. Spring flowers like blueberry and redbud feed them when they emerge.
Milkweed sap is harmless to touch.	**MYTH**	The latex can irritate skin and is dangerous in the eyes. Wash your hands after handling.
Most invasive plants arrived by accident.	**MYTH**	Most were planted on purpose: as ornamentals, erosion control, hedges, or wildlife food. Tree-of-heaven, barberry, multiflora rose, and autumn olive were all promoted.

Over/Under

The answer is over if the real value is above the line.

Question	Real value	Line	Answer
Caterpillar species hosted by oaks in the Northeast	**534 species**	300	Over
Seeds one purple loosestrife plant can make in a year	**2,000,000 seeds**	500,000	Over
Milkweed floss collected by schoolchildren in WWII	**11,000,000 pounds**	5,000,000	Over
Year tree-of-heaven was introduced to Philadelphia	**1784**	1850	Under
Year spotted lanternfly was first found in the U.S.	**2014**	2010	Over

Question	Real value	Line	Answer
Trees removed in Brooklyn and Queens to eradicate the Asian longhorned beetle	**5,208 trees**	2,000	Over
Pollen grains one ragweed plant releases in a season	**1,000,000,000 grains**	100,000,000	Over
Insect species recorded visiting common milkweed flowers	**450 species**	200	Over
Wild bee species recorded in New York State (Cornell count, 2015)	**416 species**	250	Over
Caterpillars a chickadee pair needs to raise one brood	**7,500 caterpillars**	2,000	Over
Depth a kudzu root can reach	**12 feet**	6	Over
Distance a wild geranium flings its seeds	**30 feet**	10	Over
Seeds a single tree-of-heaven can produce in a year	**300,000 seeds**	50,000	Over
Year of the first commercial harvest of cultivated highbush blueberries	**1916**	1850	Over
Caterpillars in one spongy moth egg mass	**750 caterpillars**	200	Over
Average last spring frost in Syosset, NY (day of April)	**April 18**	10	Over
Years a Japanese knotweed rhizome fragment can regrow from	**20 years dormant**	5	Over
Monarch sightings reported within 25 km of Syosset in 2025	**164 sightings**	100	Over

Project briefs: design it and fund it (extensions)

No answer key. A strong proposal names a real site and host, lists native species with bloom months covering April through October, includes a milkweed, gives a budget, and names a funding source and a care plan.

Visit a real planter

Pollinate Happiness has five native pollinator planters on Long Island. Most of each planting is native perennials; the art museum's sensory planter and the high school planter also include some non-invasive ornamentals. All are at public or publicly accessible sites; check each site's hours before a visit. Bloom usually peaks July through September.

Wawapek Preserve

Cold Spring Harbor, NY 11724 | Suffolk County

Installed June 2021. Host: North Shore Land Alliance. Wawapek Preserve is open to the public from dawn to dusk. Park in the small lot off Shore Road and follow the meadow trail.

Field-trip sheet: https://www.pollinatehappiness.com/installations/wawapek/field-trip

Hicksville Public Library

169 Jerusalem Avenue, Hicksville, NY 11801 | Nassau County

Installed October 4, 2023. Host: Hicksville Public Library. The planter is in the front garden facing Jerusalem Avenue and can be seen any time the grounds are open.

Field-trip sheet: https://www.pollinatehappiness.com/installations/hicksville-library/field-trip

Theodore Roosevelt Sanctuary & Audubon Center

134 Cove Road, Oyster Bay, NY 11771 | Nassau County

Installed November 23, 2024. Host: Audubon New York. The sanctuary grounds and trails are open daily; the center building has posted hours.

Field-trip sheet:
https://www.pollinatehappiness.com/installations/theodore-roosevelt-sanctuary-audubon-center/field-trip

Nassau County Museum of Art

1 Museum Drive, Roslyn Harbor, NY 11576 | Nassau County

Installed Fall 2025. Host: Nassau County Museum of Art. The sensory planter is on the patio near the Manes Center; the nest boxes are along the meadow edge of the William Cullen Bryant Preserve.

Field-trip sheet: https://www.pollinatehappiness.com/installations/nassau-county-museum-of-art/field-trip

Syosset High School *(newest)*

70 South Woods Road, Syosset, NY 11791 | Nassau County

Installed September 28, 2026. Host: Syosset High School Environmental Club. The planter is at the front of the school beside the red Syosset High School sign on South Woods Road, visible from the sidewalk without entering the campus.

Field-trip sheet: https://www.pollinatehappiness.com/installations/syosset-high-school/field-trip

> **Field-trip sheets:** Each planter has a printable field-trip sheet at pollinatehappiness.com/installations/<slug>/field-trip with the address and host, what is planted, a look-for checklist that changes with the month, a five-question student worksheet, and a QR code back to the planter page.

Credit and sharing

You may copy and share this packet for classroom use. If you adapt it, please keep the credit line below.

How to cite

> Ellis, A., & Ellis, B. (2026). *Pollinate Happiness: native pollinator planters and tools for Long Island*. Retrieved from https://www.pollinatehappiness.com

For a specific species profile, add the page title and URL. For tool results, add the zip code, radius, and the date you retrieved them, since they change daily. Underlying observations should be credited to iNaturalist and its contributors; weather data to Open-Meteo.

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About Pollinate Happiness

Pollinate Happiness is a student-led project founded in 2021 by brothers Aidan and Ben Ellis, who started it in 5th and 6th grade. They have installed five native pollinator planters on Long Island and built free games and zip-code tools from public data so any class can use them.

Questions, corrections, or a request for a grade-specific version:
https://www.pollinatehappiness.com/contact

All activities by grade band: https://www.pollinatehappiness.com/educators