Lesson: Flight Path to Solutions

Time Needed: 145-245 minutes

Lesson Summary	In this lesson, students investigate bird-building collisions in New York City through Science, Social Studies, and Art. After building background knowledge about why collisions happen and how light, glass, and urban geography play a role, students choose a content-area lens to research the problem more deeply, then collaboratively design and present evidence-based solutions. With the Social Studies track, students work as a team to draft a law based on potential gaps in existing legislation. In the Art track, students work collaboratively to create bird-safe window designs for your class or school.
Lesson Driving Question:	Why are there bird collisions in NYC and what can we do to make our cities safer for birds?
Materials Needed	Slides Other Materials: ● NYC Bird Collisions Choice Board ● Hope is a Thing With Feathers dashboard ● Chromebooks or other devices (ideally 1:1) ● Markers for Art choice board option if you're printing a copy of the NYC Bird Collisions Choice Board for students ● Optional: notecards for presentation
Teacher Preparation	1. Pre-load the interactive Hope is a Thing With Feathers dashboard and the NYC Bird Collisions Choice Board on Google Classroom or another online platform you use with students. a. Run through the dashboard yourself to get comfortable with its features and scrollbars. *b. **Note: It may also be helpful to separately add each of the Social Studies and Art research links to your chosen platform, which are embedded on pages 3, 4, and 7 of the NYC Bird Collisions Choice Board.* *i. This option enables students to use a handout and reference the sites without splitting their screens for research and typing simultaneously.* 2. Print copies of NYC Bird Collisions Choice Board for students as needed. a. It will likely be easier for students to create their Art window design if the worksheet is printed. b. You can also just print sections of the handout (i.e. just the Social Studies section, Rubric, etc.) as needed. 3. Charge devices prior to the lesson. 4. ***Optional: if the Choice Board feels like too much classroom management, you can choose just the one option you want to explore further (Social Studies or Art) to make it easier on the teacher end.*** *Other options:* *a. Split this into multiple days (with the Social Studies choice board option taking place on day 1 and Art taking place day 2).* *b. Connect with the Science, Social Studies, or Art teacher to implement the counterpart in their own classroom.* 5. *Optional: pre-assign heterogeneous groups for both the Social Studies and Art Choice Board options.*

Standards & Vocabulary

Aligned Science Standards:

- **5-PS1-3.** Make observations and measurements to identify materials based on their properties.
- **5-ESS3-1.** Obtain and combine information about ways individual communities use science ideas to protect Earth's resources and environment.
- **MS-LS1-8.** Gather and synthesize information that sensory receptors respond to stimuli, resulting in immediate behavior and/or storage as memories.
- **MS-LS2-2.** Construct an explanation that predicts patterns of interactions among organisms in a variety of ecosystems
- **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- **MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and protecting ecosystem stability.
- **MS-PS1-3.** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- **MS-PS2-1.** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
- **MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- **MS-PS4-1.** Develop a model and use mathematical representations to describe waves that includes frequency, wavelength, and how the amplitude of a wave is related to the energy in a wave.
- **MS-PS4-2.** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Aligned Social Studies Standards:

- **5:** The diverse geography of the Western Hemisphere has influenced human culture and settlement in distinct ways. Human communities in the Western Hemisphere have modified the physical environment:
    - **5.4a:** Physical maps reflect the varied climate zones, landforms, bodies of water, and natural resources of the Western Hemisphere.
    - **5.4b:** The Western Hemisphere can be divided into regions. Regions are areas that share common, identifiable characteristics such as physical, political, economic, or cultural features. Regions within the Western Hemisphere include: North America (Canada and the United States) Mesoamerica (Mexico and Central America) Caribbean South America
    - **5.4c:** The physical environment influences human population distribution, land use, and other forms of economic activity. Students will map the regions within the Western Hemisphere and locate major physical features within each region. Students will create a political map of the Western Hemisphere, noting which countries are in which region, and a political map of the United States showing the location of the states. Students will use physical, climate, and vegetation maps in combination with population density, land use, and resource distribution maps to discern patterns in human settlement and types of economic activity.
- **8.8c:** Pollution, population growth, the consumption of natural resources, clearing of land for human sustenance, and large-scale industrialization have put added stress on the global environment.
- **8.9e:** Constitutional issues involving the violation of civil liberties and the role of the federal government are a source of debate in American society.

Aligned Art Standards:

- **VA:Cr1.1.5a:** Combine ideas to generate an innovative idea for artmaking.
- **VA:Cr1.2.5a:** Identify and demonstrate diverse strategies for artistic investigation to choose an approach for beginning a work of art.
- **VA:Cr1.1.6.a:** Collaboratively exchange concepts and different points of view to generate innovative ideas for creating art.

- **VA:Cr1.2.6a:** Use brainstorming to formulate an artistic investigation of personally relevant content for creating art.
- **VA:Cr1.2.7a:** Develop criteria to guide making a work of art or design to meet an identified goal.
- **VA:Cr1.2.8a:** Collaboratively shape an artistic investigation of an aspect of present-day life by using a contemporary practice of art and design.
- **VA:Cr2.2.8:** Explain environmental implications of conservation, care, and clean-up of art materials, tools, and equipment; and demonstrate self-regulation in applying the understandings in the art classroom.
- **VA:Cr3.1.8a:** Apply relevant criteria to examine, reflect on, and plan revisions for a work of art or design in progress.
- **VA:Pr5.1.8a:** Collaboratively prepare and present selected theme-based artwork for display, and formulate exhibition narratives for the viewer.
- **VA:Cn10.1.8a:** Make art collaboratively to reflect on and reinforce positive aspects of group identity.
- **VA:Cn11.2.8a:** Identify and explore careers in which innovation and creative problem-solving skills are fundamental to success.

Aligned Engineering Design Standards:

- **MS-ETS1-1:** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- **MS-ETS1-2:** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- **MS-ETS1-3:** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- **MS-ETS1-4:** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Vocabulary

1. **Absorption:** Absorption of light occurs when light is soaked up by a material, converting it into other forms of energy (usually heat).
2. **Amplitude:** The height of a wave. When you change the amplitude of a light wave, you're changing how bright the light is (higher amplitudes are brighter lights, lower amplitudes are dimmer lights).
3. **Atlantic Flyway:** A major north-south migratory route for birds along the eastern coast of North America, passing directly through New York City.
4. **Biodiversity:** The variety of species in an ecosystem. Migratory bird species are essential to global biodiversity, and they make up the majority of birds killed in collisions.
5. **Bird collision:** When a bird strikes a building, window, or other human-made structure, often fatally. Bird collisions are a leading anthropogenic cause of bird mortality in urban areas.
6. **Bird-safe design:** Architectural and engineering solutions that help prevent bird collisions. Examples include UV-patterned glass, external screens, and reduced interior and exterior nighttime lighting.
7. **Citizen science:** Scientific research conducted in part by the public. dBird is an example of citizen science: it allows community members to report and track bird collision data.
8. **Crest:** The highest point of a wave. Higher amplitude waves have higher crests.
9. **Design criteria and constraints:** The standards a solution must meet (criteria) and the limits within which it must work (constraints), both central to engineering design.
10. **Ecosystem services:** Benefits that healthy bird populations provide to humans and ecosystems, such as pest control, seed dispersal, and pollination.
11. **Electromagnetic (EM) Spectrum:** The complete range of electromagnetic radiation, which includes all forms of light, placed in order of increasing frequency.
12. **Iterative design:** A process of testing, evaluating, and improving a solution through repeated cycles of refinement.
13. **Light pollution:** Excessive or misdirected artificial light at night that disorients nocturnal and

migratory animals, often drawing birds toward lit buildings.

14. **Migration:** The seasonal movement of birds (and other animals) between breeding and wintering grounds, often passing through cities like NYC along the Atlantic Flyway.
15. **Nanometers:** A unit of measurement. We use nanometers to measure different wavelengths of Visible Light, UV light, and X-Rays on the EM spectrum.
16. **Reflection:** The bouncing back of light (or sound waves) off a surface. Birds see the sky and trees reflected in glass and fly toward it.
17. **Tetrachromacy:** The possession of four types of cone cells (red, blue, green, and UV) in the eye. Organisms with tetrachromacy are called tetrachromats.
18. **Transmission:** The passing of light through a material. Glass that transmits UV light can appear as an invisible barrier to birds.
19. **Transparent:** An object that can be seen through easily. Examples include glass, air, and clear plastic water bottles.
20. **Trichromacy:** The possession of three types of cone cells (red, blue, and green) in the eye. Organisms with trichromacy are called trichromats.
21. **Trough:** The lowest point of a wave. Higher amplitude waves have deeper troughs.
22. **Ultraviolet (UV) Light:** A form of EM light with wavelengths between 10-400 nm. UV light is why we need sunscreen. As birds are tetrachromats, they can see some wavelengths of UV light.
23. **Visible Light:** EM radiation that can be perceived by the human eye. Visible light ranges from 400-700 nm in wavelength.
24. **Wavelength:** The distance between two crests or troughs of a wave; different wavelengths of light are perceived differently by birds and humans.

Formative Assessment/Check for Understanding

Assessment Options:

1. Group discussions.
2. Notes from research on the choice board.
3. Choice board solution and group work.
4. Jigsaw presentations.
5. Head-Hands-Heart-Feet Reflection.
6. One-on-one check-ins.

Scaffolds & Supports

Scaffolds & Supports:

- Pre-teach vocabulary.
- Run through the Hope is a Thing With Feathers dashboard and associated prompts as a class, rather than students exploring on their own.
- Assign heterogenous groups for the choice board.
- Provide sentence starters and/or

Extension/Side Hike Ideas

English Language Arts:

- Research a real piece of bird-safe legislation (such as NYC Local Law 15 or the Migratory Bird Treaty Act) and write a persuasive op-ed or letter to a council member arguing for stronger protections, using dBird and NYC Bird Alliance data as evidence.
- Analyze two competing opinion pieces on urban development and wildlife protection. For each, identify the author's claims and rhetorical strategies, then write a synthesis response.

Math:

- Express key collision statistics in scientific notation (estimated U.S. bird deaths ~1×10^9, NYC mortality estimates, Atlantic Flyway migration numbers) and calculate what percentage of NYC building glass would need treatment to meaningfully reduce collisions.

flashcards for presentations as needed.
- Use visual anchor charts with labeled diagrams of wave behavior and bird flyways.
- Optional group roles for choice board.

For Enrichment:

- Science: Conduct a controlled experiment, testing different window-treatment materials for light transmittance and reflectance using a light meter or phone sensor app.
- Social Studies: Research and map NYC neighborhoods with the highest collision rates against socioeconomic and land-use data. Think about who bears the greatest burden of bird loss.
  - ***Note: dBird is crowd-sourced and presence-only data. More reports are made in areas where there are more people to find collision victims and where there are more people who know about dBird. As a result, the data is spatially skewed and buildings that have the highest number of collision observation reports in dBird don't necessarily have the highest collision rates.*
- Art: Enter the Cornell bird-friendly student art contest or present students' window design proposal at a Board of Education meeting.
  - ***Note: not all glass is equally dangerous! For example, the majority of collisions occur on the bottom stories of buildings, so retrofits and legislation typically prioritize those areas to have the greatest impact.*
- Analyze Hope is a Thing With Feathers collision data over time, differentiate by species of bird, graph collected data, express totals in scientific notation, and/or write a short data narrative explaining what the numbers mean for bird populations.
  - ***Note: collision data over time is a feature in Hope is a Thing With Feathers, not dBird. The number of reports made to dBird tend to increase from year to year but this is likely more reflective of an increase in awareness of both collisions and dBird.*

Engineering Design:

- Using the NYC Bird Alliance's bird-friendly building design guidelines, calculate the ratio of glass to total facade area for your school, then redesign the facade to meet bird-safe thresholds while maximizing both cost and natural light for occupant well-being.
  - Iterate on the building design based on peer feedback and simulated light transmission data, documenting each design cycle and explaining improvements.

Technology:

- Explore another simulation (3BB) made by the same author who created Hope is a Thing With Feathers. 3BB is an interactive data visualization tool that helps us understand the scale of the 3 billion birds lost since 1970.
- Take a bird walk and collect and input data at or near school, logged to either of the below citizen science databases based on your goal:
  - dBird for birding checklists or bird collisions
  - MerlinBirdID for bird ID

Field Trip and Event Extension:

- Go on a scavenger hunt to identify bird-safe and non-bird-safe glass features within the school building and neighborhood.
- Join NYC Bird Alliance's Light's Out Initiative.

Green Careers Connection:

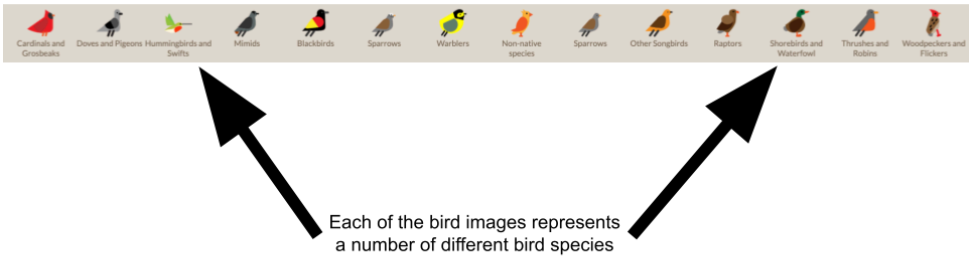
- **Ornithologist:** A scientist who studies bird behavior, ecology, and conservation, and may advise on bird-safe building policy.
- **GIS Analyst:** A specialist who uses mapping software to analyze spatial data, such as collision hotspots and migration corridors.
- **Sustainable Architect:** An architect who designs buildings with minimal environmental impact, incorporating features like bird-safe glass and green roofs.

Lesson Plan: Steps

Engage

45 Minutes

1. Briefly discuss the Science Fact of the Day with the class.
2. Pass out or have students virtually open the NYC Bird Collisions Choice Board and read the overview out loud as a class.
3. Open the interactive Hope is a Thing With Feathers dashboard on the board for everyone to see.
    a. Run through the dashboard as a class:
        i. Hover over the different bird icons at the top of the dashboard, having students read aloud what group of birds each icon represents:



        ii. Talk about the different visualization tools on the site:
            1. Map
            2. Monthly Collision Graph
        iii. ***Note: There's also a scrollbar on the bottom of the page, to see explanations and the full graph images so be sure to model both scrollbars for the class.*
        iv. ***Note: When you hover over an* icon*, it gives you all the information you need. When you click on an* icon*, it isolates that information. Therefore, tell students it's best if they hover over an* icon*.*
4. Give students 10-15 minutes to explore the dashboard on their own in google classroom or other platform and answer the prompts in Part 1 of their NYC Bird Collisions Choice Board.
5. Regroup as a class and ask 4-5 students to share their findings.
    a. Key to discuss: some of the birds dying on NYC sidewalks are mid-journey on routes stretching from Northern Canada to Argentina. NYC is a single dangerous waypoint in a dual-hemispheric journey thousands of miles long.
6. Survey the class to ask if they've ever seen or heard bird collisions in NYC.
7. Use the Slides 3-4 to explain key facts about bird migration and the Atlantic Flyway as a geographic corridor.
8. Explain that to understand *why* glass kills birds, students need to understand how light behaves. Walk through Slides 5-9 to use energy and waves as a means of understanding the biology of bird collisions. Key points below, with vocabulary highlighted in bold:
    a. Birds see more than we do:
        i. Humans are **trichromats** (3 cone types: red, green, blue), seeing light in the 400–700 **nm** range (**visible light** range).
        ii. Birds are **tetrachromats** (4 cone types), also detecting **UV light** down to ~200 **nm** in addition to

	visible light, giving them richer, more complex visual perception. b. Light waves and what they do to glass: i. **Amplitude** = brightness ii. **Wavelength** = color and energy 1. Shorter **wavelengths** carry more energy iii. Glass **transmits** most **visible light** (appears see-through) but **reflects** some **wavelengths** of light as well. c. Daytime collision causes: i. **Transparency**: clear glass looks like open air to a bird flying toward it. ii. **Reflection**: glass mirrors sky, clouds, and trees. Birds read the reflection as a continuation of their flight path and fly straight into it. d. Causes of nighttime collisions: i. Artificial light at night disorients migratory birds and often exposes them to predators and other threats. ii. Most songbirds navigate by starlight and Earth's magnetic field. iii. Birds circle light sources, exhaust themselves, then crash into nearby glass they cannot detect.
Explore GUIDE NEW LEARNING *60-100 Minutes*	1. Explain to the class that students will be creating a solution to these bird collisions. They can choose to solve this either through Social Studies and Civic Action, or through Art and Design. In both, they'll be independently researching, synthesizing their research as a group, and working collaboratively to create a solution. a. Tell students to choose how they want to solve the problem. If they want to solve it through Social Studies, they can go to the left side of the room. If they want to solve it through Art, they can go to the right side of the room. From there, they can create their group of 4. *i. Optional: split students into assigned heterogeneous groups of 4.* 2. Tell the class that **although this is a group project, every student should answer every question on their own worksheet** within their chosen content area (Social Studies or Art). 3. Students should complete research independently. Then, all students in a group will analyze the research together prior to creating a solution. *a. **Note: each group needs to check in with the teacher prior to creating their solution, so plan for a check-in with each group accordingly.* *b. **Note: the Art choice board section involves students first creating their own design, then sharing with the group, and ultimately creating a team design that incorporates ideas from each group member. This is a great chance to check in with these groups and ensure everyone is participating.*

Explain  *40-100 Minutes*	1. Regroup as a class so each group gets a chance to share their work with a larger audience. Discuss as a class what makes a quality presentation: stage presence! This includes: a. Eye contact. b. Loud speaking voice and proper pronunciation. c. Energy that matches the tone you're trying to achieve. d. Notecards for support if needed. *i. Optional: give groups a chance to prepare for their presentation with these supports/goals in mind.* 2. During presentations: a. Make sure everyone in the group gets a chance to talk! i. For the Social Studies groups, students can share the process that went into the creation of their draft bill or they can alternate which sentences of the bill to read aloud to the class. b. Each group should present for ~5 minutes. c. While groups are presenting, the audience should take notes using the prompts on pages 11-12 of the NYC Bird Collisions Choice Board. *d. Optional: Leave time for a Q&A for each group.* 3. Conduct a whole-class debrief, discussing the different solutions, if it's possible to combine ideas from different content areas into a stronger solution, etc. 4. Students independently complete the Head-Hands-Heart-Feet Reflection on page 13 of the NYC Bird Collisions Choice Board. *a. Optional: post responses on a class action board or share with a NYC council member.* 5. Take time to have a one-on-one check-in with each student to see if they can explain the content expectations on the Rubric on page 14 of the NYC Bird Collisions Choice Board. *a. **Note: The rubric has a Science, Social Studies, and Art standard. As students chose either the Social Studies or Art path, only 2 of the 3 standards on the rubric apply to these check-ins.*