LESSON 1

There is no such place as "Away"

(A Lesson Series about Litter)
Grade Band: High School (9-12)

LIVE LITTER FREE

photo by Evan Halleck

SERIES INTRO

This lesson series is anchored in the fundamental ecological principle of ecosystem interconnectedness, which offers a framework to support student inquiry into how human activity impacts the natural environment. The series also includes an assessment plan to check for student understanding at the culmination of the three lessons. The lesson series follows a trajectory centered on place-based learning, inquiry, and taking action: First, students define litter and explore the prevalence and impact of this phenomenon on a local ecosystem of their choosing. Second, students explore what happens to litter when it is properly and improperly disposed of and research how litter impacts different ecosystems. Third, using their litter survey findings, students identify a problem in their local context, research and draw inspiration from solutions others have implemented in the past, and determine a way to take action.

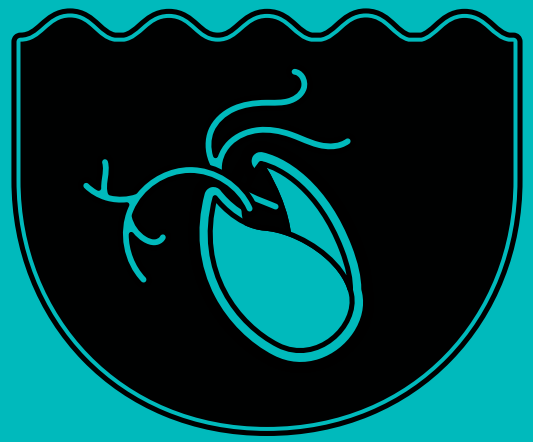
In Lesson 1, students explore litter as a concept and phenomenon. In addition, students engage in place-based learning by conducting a local litter survey and exploring human impacts on a local ecosystem. In Lesson 2, students explore what happens to litter, where it goes, and the impacts it has on different ecosystems. In Lesson 3, students identify a local litter problem, derive a solution, and take action.

Enduring Understanding(s):

This lesson supports student exploration of two questions: "What is litter? Where does it come from? Students learn how to conduct an ecosystem survey to gather data about litter. Using the data collected, students make maps of selected areas *(e.g., school yard, nearby park)* that indicates the location and type of all litter present. In addition, students will learn how to graph their data and create various data representations *(e.g., type of litter, % total)*. Students are encouraged to share their survey data – which is analogous to an ecosystem count – with other schools for comparison across diverse regions and to national statistics.

Lesson 1 Summary Description:

In this first of three lessons , we start with the complex problem of litter. Students are introduced to fundamentals of environmental stewardship *(i.e., conservation, ecosystem health, and sustainability)* through an examination of the definition and origins of litter. Students identify an area to explore, create a map of the area, and conduct an 'ecosystem count' to identify all of the litter in that area, including its location, in order to create a litter map. Students then examine the litter *(either directly or via photographic artifacts in cases where litter was not collected directly)*, describe its characteristics, create categories of increasing specificity *(e.g., plastics → water bottles),* hypothesize about its origins and identify features and trends in the litter location data as illustrated by the litter map. Finally, students will learn how to graph their data and create various data representations *(e.g., type of litter, % total)* illutsrating the types, quantity, and density of litter in the surveyed location.



Background Information for Teachers:

1. ***Ecosystems*** *(Kahn Academy)*
2. ***Litter*** *(Wikipedia)*: definitions, characteristics, prevalence in the environment, sources, effects on the biosphere
3. ***Litter*** *(Keep America Beautiful.org)*
4. ***Coastal Litter Survey*** *(A Duke of Edinburough Award project)*
5. ***The Litter Myth*** *(NPR, Throughline, the socio-political history of litter - fascinating!!)*

NGSS Standards: HS-ESS3-4 Earth and Human Activity. Students who demonstrate understanding can evaluate or refine a technological solution that reduces impacts of human activities on natural systems. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

DCI: ESS3.C – Human impacts on Earth Systems

HS-ESS3-4 Evidence Statement: Earth and Human Activity

Crosscutting Concept – Cause and Effect, Systems and System Models, Stability and Change

Science and Engineering Practices – Asking Questions and Defining Problems; Analyzing and Interpreting Data

OBJECTIVES

1. **Distinguish between natural and human-made features and objects in a geographical area.**

2. **Recognize and identify characteristics of litter and identify the characteristics that define it as litter** *(e.g., how is litter different from/the same as trash?)***.**

3. **Develop and execute a plan to gather data about the types and location of litter in a given geographical area** *(e.g. on school grounds or in a nearby local context)***.**

4. **Create a visual graphical representation of litter data to identify and convey features and patterns in the data** *(e.g. location, litter types, etc.)*

MATERIALS

1. **Tape measure** *(50m if possible)* **to serve as a transect line**

2. **Data collection sheet** *(modifiable to specific context needs)*

3. **One field notebook per group to take notes about litter location and description**

4. **Butcher paper or equivalent** *(e.g. a large section of whiteboard.)* **on which to draw map. Alternatively, a map can be created using an online map-making app** *(e.g. National Geographic Mapmaker)* **or drawing software** *(e.g. Adobe Illustrator, Sketch-up for Web)*

5. **Trash grabber** *(NOTE: teachers should explain the dangers of picking up certain types of litter.* **Students should be aware that they SHOULD NOT TOUCH/PICK UP ANYTHING THAT COULD BE HARMFUL to them or others** *(e.g., needles, sharp objects, broken class)*. **Students should at a minimum wear gloves.**

6. **Bags - one per group to hold any litter appropriate for collection by students** *(e.g. pencil stubs, paper, plastic candy wrappers, etc.)*

7. **Cameras - one per group - to take image of litter not appropriate for collection by students** *(e.g. broken glass, anything that might be contaminated by bodily fluids (e.g. cigarette butts, syringes, etc.))*

8. **Stick-on flags, tape, or the like, for labeling all individual pieces of litter the students collect**

9. **Latex gloves to protect children's hands**

10. *(Optional)* **Magnifying glasses, scales, microscope, etc., to aid in examining individual pieces of litter.**

ENGAGE

1. **Teacher begins by posing an open-ended question for students to discuss:**
    a. *Write down 5 words or phrases that come to mind when you hear the word "litter." (~3 min)*
2. **Students individually write down at least 5 words/phrases in a science journal, class notebook etc.**
3. **Students share their words/phrases with a partner and explain why they chose them (~ 3 min)**
4. **Teacher asks for students to share their words/phrases with class - writes on board**
5. **Teacher then mediates a discussion of the resulting list(s). Potential follow up questions:**
    a. *What defines something as "litter?"*
    b. *How are trash (or garbage) and litter different? The same?*
    c. *Where might you find litter*

TEACHING PLAN

The suggestions provided in the boxes below follow the 5E lesson format.

EXPLORE

With teacher guidance, students identify an area to map ((e.g. a portion of the playground, a nearby park, etc.).

A Using direct measurements, field observation, and/or photographic/satellite images available online via Google Earth or the like, students identify major features of the selected area *(e.g. fence lines, playground equipment, plantings and ground coverings, etc)*. This can be done as a whole class or in small groups.

B Students use this data to create a scale map of the selected area. The map should be large enough to identify and differentiate the locations of individual pieces of litter. A map that allows for resolution of about a meter or less will suffice. The map should also contain grid lines to help with noting the location of litter *(see below)*. A piece of butcher paper that is a meter or more on the smallest dimension will suffice.

C Once the map is complete, students form groups *(3-4 students/ group)*. Each group will run a transect lines through the mapped area (one transect line per group, space transects out as evenly as possible in the mapped area. See: Information on laying transect lines. Review the transect line method of data collection prior to conducting the litter survey:

i. Transects are an ecological tool used by scientists to quantify the relative abundance of organisms in an area and to track changes over time. For the purposes of the litter survey, students will use this method to estimate the abundance of litter in a given area.

ii. Have the class decide the best way to lay the transects through the mapped area, determine how long they should be, and how often they should sample *(ie. every meter or half meter)* to most accurately monitor the site.

iii. Students walk the transect area and stop every meter *(or half meter, based on class specifications)* and record data on the data sheet. Students include 1 foot on each side of the transect line in the litter scan and data collection.

iv. Data collection/the litter survey should include 1 meter on each side/ perpendicular to the transect line. Have 2 group members walk the transect together, each person is responsible for surveying 1 meter perpendicular to the transect line. Another group member can record the data.

v. Students should determine how specific their designations will be as a class before starting the activity so everyone records the same type of data. It is recommended that students differentiate between types of plastics *(e.g., water bottle vs. candy wrapper)* and be as specific as possible when identifying the trash.

D Students record each type of litter as specifically as possible on the data sheet next to the appropriate transect marker. Each group should carry a sketch of the mapped area to note the locations of their finds and transfer that data to the classroom map afterward, during the Explain phase.

E For each piece of litter identified but not collected, students will record its location and description. Teacher may decide to direct students to take a photograph of it or describe it in writing.

EXPLAIN

Teacher engages students in a data-sharing discussion:

a. **When transect data collection is complete, students return to the classroom and enter their data into an excel sheet, google sheets, or other graphing software program**

b. **Students calculate the density of litter in the given area:**

D = n/2Lw

Where:

D = Density of litter per unit area

n = Number of pieces of litter seen on transect

L = Total length of transect

w = width of transect (1 side only) (in this case = 1m)

c. **Students explore data by type, quantity, density and make desirable graphs of data (e.g., pie chart of type of litter (% total), bar graph - density by type)**

d. **Each group adds their data (location and description) to the class map.**

Guiding questions to support data analysis and discussion include:

a. **What kind of litter is most common? Which type had the highest density?**

b. **What kind of litter is least common? Which type had the lowest density?**

c. **Within each general type (e.g., plastics), what were the most common specific types of litter (e.g., water bottles).**

d. **Is the litter evenly distributed or are there any locations where litter seems to be more common?**

e. **Where do you think various pieces of litter came from?**

f. **Do you recognize any patterns in the data? If so, what hypotheses do those patterns suggest?**

Guiding questions to support data analysis and discussion include:

a. **Litter is a waste product that has been discarded in an un desirable way, usually in a public location or a location used for a collective purpose.**

b. **Data about litter, such as counts, descriptions, and locations, can provide support for claims about where it may have come from, why it can be more readily found in one place rather than another, and its source (both in terms of the source of manufacture and the litterer).**

c. **Visual representations of data can often help scientists make connections, suggest hypotheses, and support claims.**

EVALUATE

(including student self-assessment opportunities)

1. **Students analyze their group data, class map data, and collective litter survey data** *(combining group data)***. Students explore patterns in data, and determine main findings.**

2. **Students** *(individually, in groups, or as a whole class)* **examine the class litter map and field notes to identify the following:**
   a. *Major features or patterns of interest in the data*
   b. *Locations of the most common type(s) of litter*
   c. *Descriptions of particular pieces of data*
   d. *Determine main findings from individual transect and class data*

3. **Data can be used to describe/illustrate an issue and then determine ways to reduce the impact of the issue. For example, say the class finds that plastic water bottles are the most common source of litter in the surveyed area. The identified issue could be that people are throwing their plastic water bottles on the ground. This can help start to brainstorm a solution** *(e.g., a solution could be placing recycle bins in the area or even better, promoting reusable water bottles)*

4. **Students revisit the opening question and express** *(verbally or in writing)* **how their ideas about litter have changed, identifying particular experiences** *(e.g. examining litter closely, creating and studying the litter map)* **that led to those changes.**

Closing Activity

1. **Teacher begins by posing an open-ended question for students to discuss:**
   a. Write down 5 words or phrases that come to mind when you hear the word "litter." *(~3 min)*

2. **Students individually write down at least 5 words/phrases in a science journal, class notebook etc.**

3. **Students share their words/phrases with a partner and explain why they chose them** *(~ 3 min)*

4. **Teacher asks for students to share their words/phrases with class - writes on board**

EXTEND / ELABORATE

Extend

1

Students listen to NPR Throughline: The Litter Myth and gain an understanding of the socio-political history of litter *(truly fascinating)*. Student then capture an oral history of litter by interviewing an older adult *(e.g., grandparent, relative, parent, community member)* about their experiences with litter and how trash and litter has evolved and increased in their lifetime.

Extend

2

Teacher provides instructions and support for students to carry out a similar litter count and produce another litter map for a location used for a different collective use. Students will compare and contrast the two maps and articulate claims about litter *(type, origins, etc.)* that might be supported by the data.

Extend

3

Teacher invites school custodial staff/groundskeepers to class to share their experiences with litter. With teacher assistance and supervision, students engage with custodial staff/groundskeeper to formulate a plan for more extensive long-range data collection about the types and location of litter. For example, students might decide to ask groundskeeping staff to save all litter they pick up for a week, keeping litter found at specific locations *(e.g. the parking lot, the pick-up area, the softball field, the snack area, etc.)* in separate bags/containers. Students could then examine the litter from each area to look for trends.

Elaborate

4

Teacher poses the following questions and mediates a discussion about them *(either in pairs, small groups, or whole class)*: What do you think happens to litter if it is not picked up and disposed of properly? Alternatively, what do you think might happen to litter if it is picked up and disposed of properly? Can some of the discarded items be re-used or recycled, or does all of it enter what is known as the waste stream?

DIFFERENTIATION PLANS

In this space, include notes about how you will differentiate your instruction to meet the needs of any individual students in your class who may need particular adaptations or accommodations

[note: the categories below are offered merely as planning guides; it is acknowledged that the categories are neither complete nor discreet].

Cognitive:

Linguistic:

Behavioral:

Affective:

Other:

LESSON 2

What's the Story with Litter?

(A Lesson Series about Litter)
Grade Band: High School (9-12)

LIKE LITTER FREE

photo by Evan Halleck

SERIES INTRO

This lesson series is anchored in the fundamental ecological principle of ecosystem interconnectedness, which offers a framework to support student inquiry into how human activity impacts the natural environment. The series also includes a summative assessment plan to check for student understanding at the culmination of the three lessons. The lesson series follows a trajectory centered on place-based learning, inquiry, and taking action: First, students define litter and explore the prevalence and impact of this phenomenon on a local ecosystem of their choosing. Second, students explore what happens to litter when it is properly and improperly disposed of and research how litter impacts different ecosystems. Third, using their litter survey findings, students identify a problem in their local context, research and draw inspiration from solutions others have implemented in the past, and determine a way to take action.

In Lesson 1, students explore litter as a concept and phenomenon. In addition, students will engage in place-based learning by conducting a local litter survey and exploring human impacts on a local ecosystem. In Lesson 2, students explore what happens to litter, where it goes, and the impacts it has on different ecosystems. In Lesson 3, students identify a local litter problem, derive a solution, and take action.

Lesson 2 Enduring Understanding(s):

This lesson supports student exploration of two questions: “What happens to litter when we throw it away? How does litter impact ecosystems? Students examine the litter they collected and/or documented in lesson 1, identifying, to the extent possible, what it is made of and how ameleable it is to reuse or recycling, and identify possible pathways it might take in the waste stream.

Lesson 2 Summary Description:

This second of three lessons builds on lesson one in the series. In this lesson, students select a particular component *(or components)* of their litter collection - or litter they want to learn more about *(e.g. fishing line or single-use plastic water bottles)* to research further. For example, students might decide to examine the impact of cigarette butts (the most littered item in the world) on birds or other wildlife, the impact of organic litter decomposition on lakes, streams, and waterways, or the impact of fishing line on fishes and marine mammals. Students then create a narrative storyline from the perspective of the littered object, taking the position of the litter in order to explicate various events and possibilities in the path of the littered object, from point of manufacture to point of improper discard, to eventual degradation, landfill containment, or reprocessing.

Background Information for Teachers:

Writer's Workshop

NOTE: Because most high schools have adopted the three course model of NGSS (Physics, Chemistry, Biology), teachers in specific disciplines can tailor the lesson to their disciplinary needs. To assist with this specific NGSS Performance Expectations are identified below by discipline (though this is not an exhaustive list). For example, a biology teacher could have students explore the impact of litter on marine life and biodiversity. A chemistry teacher could focus on the molecular structure of different recycled materials, what happens when plastics are recycled etc.) Variations on this lesson are included below.

HS-ESS3-4 Earth and Human Activity. Students who demonstrate understanding can evaluate or refine a technological solution that reduces impacts of human activities on natural systems. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics: Students who demonstrate understanding can design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity

HS-PS2-6 Motion and Stability: Forces and Interactions Students who demonstrate understanding can communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

ESS3.C Human Impacts on Earth Systems

HS-ESS3-4 Evidence Statement: Earth and Human Activity (Earth Science)

HS-LS2-7 Evidence Statement Ecosystems: Interactions, Energy, and Dynamics (Life Science, Biology)

HS-PS2-6 Motion and Stability: Forces and Interactions (Chemistry, Physical Science)

Crosscutting Concepts: Cause and Effect, Systems and System Models, Stability and Change. *New technologies can have deep impacts on society and the environment, including some that were not anticipated.*

Science and Engineering Practices (SEPs) – *Analyzing and Interpreting Data; Using Mathematical and Computational Thinking, Constructing Explanations and Designing Solutions*

OBJECTIVES

1. **Identify aspects of the material composition of litter *(what it is made of)*, where it goes when properly and improperly disposed of, and its impact on natural ecosystems.**

2. **Investigate the impact of specific types of litter on biotic components of ecosystems**

3. **Demonstrate an understanding of the “cradle-to-grave” pathway of litter through the medium of story or narrative.**

MATERIALS

1. A collection of litter *(from Lesson 1 in the series)*
2. A field notebook about the location of litter and its description *(from Lesson 1)*.
3. A litter map *(from Lesson 1)*
4. Access to age-appropriate research materials *(e.g. school library resources or internet access)*

TEACHING PLAN

The suggestions provided in the boxes below follow the 5E lesson format.

ENGAGE

Teacher begins by posing open-ended questions for students to discuss *(~5+ minutes):*

a. *What do you think happens to litter if no one picks it up?*
b. *What do you think happens to litter if it's picked up and put in a trash can or recycling bin?*
c. *How do you think litter might affect the ecosystem or living things?*

Teacher then asks students to create a number of possible responses to those questions that capture their thinking about litter. *(10-15 minutes)*

Teacher then mediates a discussion of student responses, suggesting possible resources students could use to explore what happens to litter under various circumstances, and how it affects ecosystems in general.

Teacher then introduces the lesson's major task: Create a story from the perspective of a piece of litter in which the piece of litter describes the pathway it and litter like it takes from cradle to grave *(i.e. from manufacture to decomposition)*. Depending on the disciplinary focus of the class, each story should contain evidence required for the specific discipline *(e.g., molecular structure for chemistry)* listed in the Explore and Evaluate sections, below.

For example, a story could begin with the manufacture of a plastic bottle, the most commonly littered object in the world. In this story, the cigarette butt looks forward to a life of helpfulness as a device meant to shield humans from some of the dangerous components of toxic cigarette smoke. Composed of cellulose acetate plastic, it is designed to withstand heat and rough handling *(Chemistry: include evidence of molecular structure in the design)*. After it is made, it is installed on the end of a cigarette and packaged with 19 others just like it.

After weeks in the dark sitting on a shelf in a convenience store, someone removes it, sets the cigarette on fire, and begins pulling toxic smoke through it *(Chemistry: combustion)*! The cigarette butt finds this to be a terrible experience, even though it's the very task it is designed for, because all manor of dangerous chemicals become trapped in it. After a few minutes, and much to its dismay, the smoker is in a hurry when the bus arrives and, finding no trashcan handy *(even though there's one not three meters away!)* flicks the butt unceremoniously into a gutter near a rainstorm grate where the next rainstorm carries it, now laden with toxic chemicals, toward the sea.

Ending 1 might be a description of a group of volunteer middle-schoolers finding it in the sand and picking it up for proper disposal. In this ending, the story continues with a description of the butt's journey to its final resting place: a landfill. Ending 2 might be a description of how a seagull finds it and, thinking it food, swallows it, where it harms the seagull's digestive tract *(Biology: biodiversity)*, or *(believe it or not!)* winds up in the nest of a finch, where its cocktail of toxic chemicals dissuades pests from invading the nest but also potentially harms the baby birds. This story ends, ultimately, with the bird nest falling into disuse and all the organic materials *(twigs, leave matter)* being reclaimed by nature, leaving the cellulose acetate to linger, lonely and forlorn, for decades *(Biology: Human impacts on ecosystems)*

EXPLORE PT.1

To initiate the Explore phase, the teacher helps students *(individually or in pairs)* revisit the list(s) they created in the Engage phase, examine the litter they found in Lesson 1, and based on those considerations, choose a piece of litter about which to to create a story *(Note: for disciplinary needs, teachers may choose to have students focus on particular types of litter such as plastics)*

With teacher guidance, students then explore resources - in print at the school library and/or online - to inform their stories about the origins and outcomes of litter, in particular the type of litter they chose to write about. The list of parameters for each story *(see below and in the Evaluate section)* is designed to provide useful structure for student research.

The table below provides potential variations on the focus and direction of the story based on discipline-specific needs. Students should explore and provide evidence of specific aspects of litter *(e.g., molecular structure, what happens when it is recycled etc)* as appropriate to their class disciplinary needs and directed by the teacher.

Explore pt.2

Discipline	NGSS: Discipline Specific Performance Expectations	Examples
Biology/Life Sciences	**HS-LS2-7 Evidence Statement Ecosystems: Interactions, Energy, and Dynamics** Students who demonstrate understanding can design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity	Students focus their story on the biological impacts of their litter *(e.g., on marine biodiversity, ecosystem dynamics, reproduction, food availability)* a. *Marine Plastics* b. *Biological impacts of chemical leaching* c. *Marine life and plastics*
Chemistry	**HS-PS2-6 Motion and Stability: Forces and Interactions** Students who demonstrate understanding can communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.	Students describe the molecular structure and material composition of litter *(e.g., aluminum, plastics), explore the recycling process, combustion (what happens when trash is burned)* etc. a. *Everyday Polymers Lesson* b. *Recycling process* c. *Chemical leaching*

EXPLORE PT.3

The teacher may decide to start by having students brainstorm and outline their stories, and then structure the Explore phase as a series of research projects intended to inform the writers about information needed to create a story that accurately captures what happens to litter at each stage of the story outline.

Alternatively, the teacher may decide to have students research the origins and outcomes of litter first, using the story parameter list as a guide, and then brainstorm and outline their stories.

Each story should contain or address the following parameters:

A What the piece of litter is made of and how it was made

B *The circumstances by which it came to be discarded improperly and thus became litter*

C What typically happens to similar litter

D How similar litter might affect wildlife or the environment

E What happened *(or will happen)* to the particular piece of litter *(e.g. will it find its way into the belly of a sea creature or the nest of a bird? Will its chemicals leach into a stream and contaminate the food chain?)*

F *Optional:* Teacher requires that each story contains two potential endings: (i) a happy ending in which the litter finds its way into a waste stream that minimizes its impact on the environment, and (ii) a troubling ending in which the litter finds its way into a waste stream that causes harm to wildlife or the environment.

EXPLAIN

As the teacher engages students in a writer's workshop approach to the development of their stories, students take part in discussions about content-accuracy in particular. *(More info about the writer's workshop approach here, or here, or here)*. Specifically, teacher supports students to support the plausibility of the events and occurrences in their stories by citing source material.

Target explanations *(guided by the storylines produced in the Explore phase)*:

a. *Students accurately address each of the parameters in the list.*

b. *Students refer to viable source material to support the accu racy of facts and plausibility of scenarios in their storylines.*

EVALUATE

(including student self-assessment opportunities)

The evaluation of content mastery takes place in the context of a series of writer's workshops *(see Explore phase, above)* in which individuals or teams of writers support each other in the creation of narrative pieces. Alternatively, or afterward, the teacher and students may decide to hold a writer's showcase, in which students are given the opportunity to share their work to a wider audience *(e.g. peers, students from other classes or grades, family and community members)*

Each story should contain or address the following parameters:

A What the piece of litter is made of and how it was made

B *The circumstances by which it came to be discarded improperly and thus became litter*

C What typically happens to similar litter

D How similar litter might affect wildlife or the environment

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EXTEND / ELABORATE

Extend

1

Students combine their stories into a class volume *(e.g. "The Life and Times of Litter; Collected Works of Dr. Swanson's Sixth Grade Science Class")*. With scheduling and outreach help from the teacher, students visit public officials to present them with copies of their works and, using the stories as a starting point, exchange ideas about what to do to combat the problems associated with litter.

Extend

2

Students create graphic novel versions of their stories.

Elaborate

3

Students combine aspects of several stories to write and produce a screenplay. With help from the fine arts and/or drama teacher, students present their play to the school and community as part of an Earth Day celebration, which occurs on April 22 each year.

DIFFERENTIATION PLANS

In this space, include notes about how you will differentiate your instruction to meet the needs of any individual students in your class who may need particular adaptations or accommodations

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Linguistic:

Behavioral:

Affective:

Other:

LESSON 3

Time to Take Action

(A Lesson Series about Litter)
Grade Band: High School (9-12)

LIVE LITTER FREE

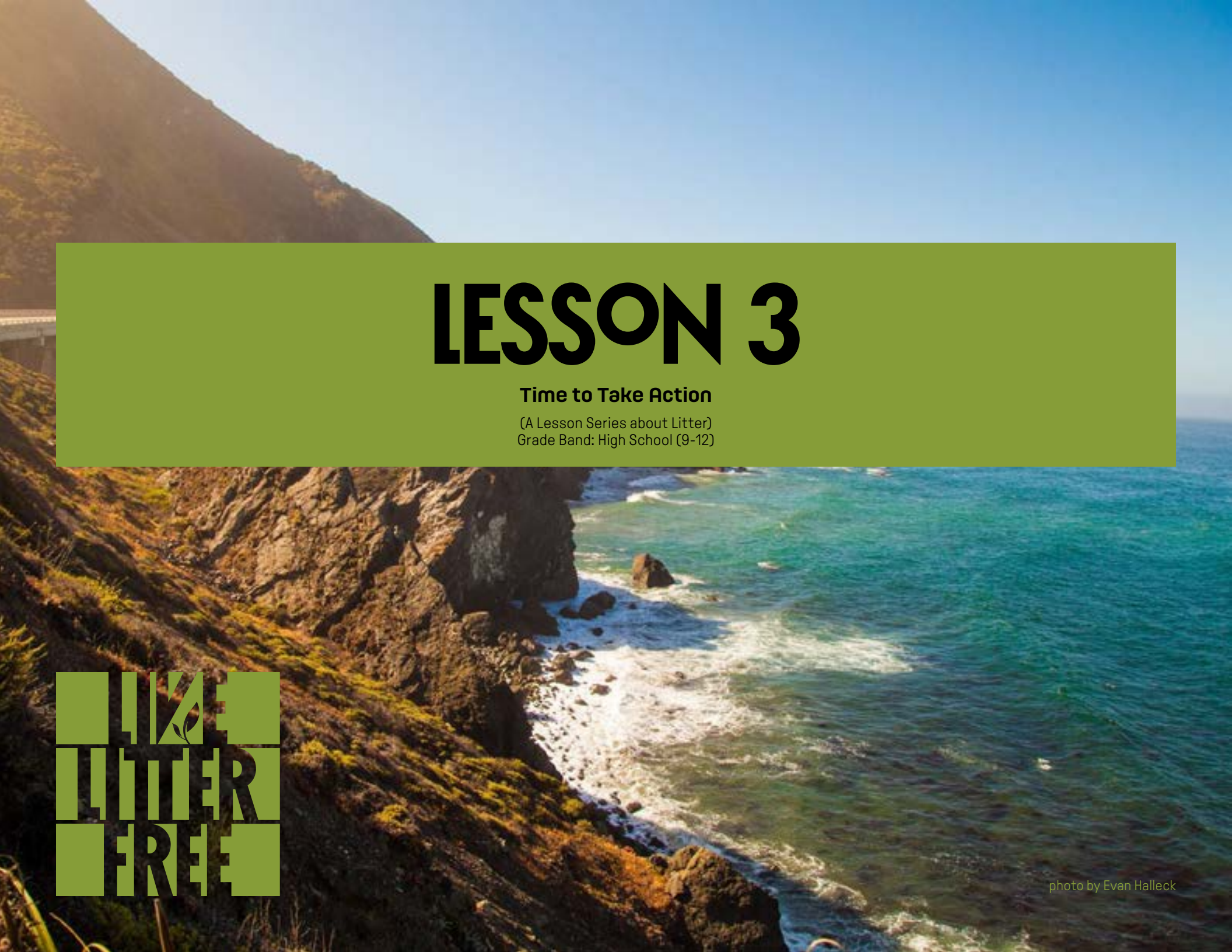

photo by Evan Halleck

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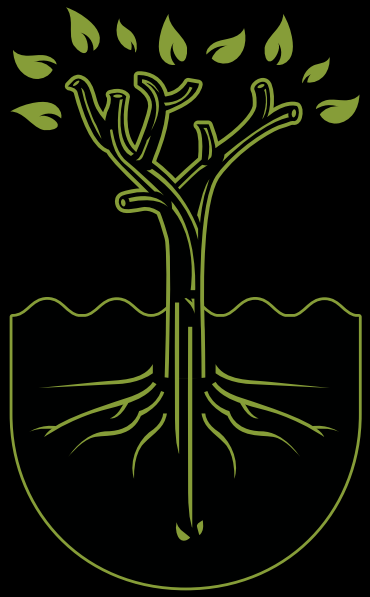
Lesson 3 Enduring Understanding(s):

This lesson supports student exploration of the essential question: "What can individuals do to combat the problems associated with litter? Based on the litter maps they made in lesson 1 and the facts about litter and its impacts they learned about in lesson 2, students plan and carry out a potential solution to a local litter problem.

Lesson 3 Summary Description:

This third in the series of three lessons engages students in experiential place-based learning. Using their litter survey data to identify a specific litter problem, students conduct research to derive a potential solution, and then implement, test, and refine their solution. Throughout this lesson, students engage in the engineering design process. First, students revisit their Litter Map and survey data analysis/findings to identify a specific litter problem they want to address, along with any constraints they might face. Second, students conduct research to find approaches that have been used to solve similar problems in other contexts, both locally, nationally, and globally. Third, students brainstorm how to adopt or adapt one or more of these possible solutions to address the local problem they identified in step 1. Students then create a detailed plan of action, create/build a prototype or model *(if their proposed solution requires it)*. Finally students test their approach and/or prototype, evaluate its effectiveness, and improve on their proposed solution.



Background Information for Teachers:

The NGSS Engineering and Design Process

1. **Engineering Design Process:** Teaching Engineering
2. **The NGSS Engineering and Design Process**
3. **Zero Waste/Reducing Footprint**

NGSS Standards: HS-ESS3-4 Earth and Human Activity. Students who demonstrate understanding can evaluate or refine a technological solution that reduces impacts of human activities on natural systems *(NOTE: This lesson centers on analyzing evidence and investigating the nature of the impact of consumption on Earth's systems)*. When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts *(HS-ESS3-4)*. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. *(HS-ESS3-4)*. HS-ETS1-1: Engineering Design. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants HS-ETS1-3: Engineering Design. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

HS-ESS3.C Human Impacts on Earth Systems *(Earth Science)*

HS-ETS1.B Developing Possible Solutions *(Engineering Design)*

HS-ESS3-4 Evidence Statement: Human Activity and Earth Systems

HS-ETSI-1: Evidence Statement: Engineering Design

HS-ETS1-3 Evidence Statement: Engineering Design

Crosscutting Concepts: Stability and Change, Scale *(taking action at local/community broader (e.g., national) levels))*, Influence of science, engineering, and technology on society and the natural world. *All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.New technologies can have deep impacts on society and the environment, including some that were not anticipated.*

Science and Engineering Practices (SEPs): Using Mathematical and Computational Thinking; Analyzing and Interpreting Data; Constructing Explanations and Designing Solutions; Obtain/Evaluate/Communicate Information

OBJECTIVES

1. Identify and characterize a specific problem of litter based on the litter survey they conducted in Lesson 1

2. Research solutions at local, national, and global scales that have been or are currently employed and use these ideas as inspiration to address their own problem.

3. Derive and implement a solution/plan of action that addresses the identified local litter problem.

4. Outline steps to take action at the state or national level.

MATERIALS

1. Litter map from lesson 1
2. Other materials TBD by the potential solutions the students identify (see below)

TEACHING PLAN

The suggestions provided in the boxes below follow the 5E lesson format.

ENGAGE

Teacher begins by asking students to revisit and review the class litter map from Lesson 1. Working in groups, students look for patterns, make observations, and ask questions about their litter survey data. Students use their class data and litter map to describe/illustrate an issue and then determine ways to reduce the impact of the issue. For example, say the class finds that plastic water bottles are the most common source of litter in the surveyed area. The identified issue could be that people are throwing their plastic water bottles on the ground. This can help start to brainstorm a solution *(e.g., a solution could be placing recycle bins in the area or even better, promoting reusable water bottles)*

The teacher then mediates a classwide discussion about some of the patterns and observations students made. After the review, the teacher poses the following open-ended questions for students to discuss *(~10+ minutes)*:

a. What patterns did you notice in the data? What are the main findings?
b. Based on our litter map and graphs of our litter data, what do you think are the biggest litter problems we face in our local context?
c. How does the litter map and data collected information support your idea(s)? What evidence backs up your ideas?
d. Do you know of other places that face similar problems?
e. Do you know of other places that have implemented solutions to similar problems?

Teacher then asks students to create a number of possible responses to those questions that capture their thinking about the biggest litter problems they see in their local context. Teacher then mediates a discussion of student responses with the goal of identifying a specific problem for the class to address.Teacher then engages students in the Engineering Design Process to identify and test out a solution:

a. Identify a range of possible solutions
b. Conduct research to inform decision-making about which possible solution is most viable
c. Develop a plan of action
d. Implement the solution, and test its effectiveness by collecting relevant data
e. Improve the solution in whatever way the data suggests would be most effective.

Explore

Resources useful to inform steps 1-4, below, will depend on the specific problems students identify. Examples of online resources include - but are certainly not limited to - the following (these are provided merely as examples):

Zero Waste/Reducing Footprint (practical ways to reduce waste)

Can I Recycle That?

Sharing: The New Recycling!

The Cleanest Line

Recycling Is Broken. Now What? *(creative corporate solutions to litter/trash)*

Perfect Storm Hits U.S. Recycling *(original recycling efforts/solutions to litter in Berkeley, CA)*

A Floating Device Created to Capture Ocean Plastics

Step 1: Identify Problem and/or Need

In step 1, the teacher helps students, either as a whole class or in small groups, identify a problem or need to explore further. The driving question directing this exploration includes:

a. *Based on the information displayed in our litter map, what do you think are the biggest litter problems we face in our local context?*

Step 2: Research Viable Solutions

In step 2, students research different solutions that have been or are currently implemented locally, nationally, and globally. The teacher helps students, either as a whole class or in small groups, decide which among a number of potential solutions is the most viable for addressing their identified problem. The driving questions directing this part of the exploration include:

a. *What solutions have been used to address problems of litter similar to the one we identified?*
b. *In what ways do those solutions address the context in which they were used?*
c. *How is our local context similar to the contexts in which they were used? How does it differ?*
d. *Can you justify your responses to part c, above, using infor mation from the litter map?*

Step 3: Identify and Create a Specific Solution

In step 3, the teacher helps students, either as a whole class or in small groups, identify in detail the steps that need to be taken in order to create/ build and implement the solution identified in step 2. The driving questions directing this part of the exploration include:

a. *What solutions have been used to address problems of litter similar to the one we identified?*
b. *In what ways do those solutions address the context in which they were used?*
c. *How is our local context similar to the contexts in which they were used? How does it differ?*
d. *Can you justify your responses to part c, above, using infor mation from the litter map?*
e. *What features of the solution under consideration seem doable? Why?*
f. What features of the solution under consideration seem challeng ing? Why?
g. What changes might we make to address those challenges?

EXPLAIN

The teacher engages with students in each of the four steps in the Explore phase, above, helping mediate discussion toward target explanations implied by each of the four steps. Because of the stepwise nature, the teacher should not proceed from one step to the next until students have internalized the reasoning behind each of the steps. Specifically:

Step 1

Students make connections between the local context and other contexts.

Step 2

Students make reasonable claims about potential solutions, using evidence to support their claims.

Step 3

Students develop viable plans of action appropriate in scope and scale.

Step 4

Students engage in appropriate data collection and analysis and leverage that analysis in reasonable ways to improve their solutions.

EVALUATE

(including student self-assessment opportunities)

Evaluation centers on the *NGSS Engineering Design Process:* problem identification and characterization followed by solution development, implementation, testing, and improvement. See also: Teaching Engineering website

The teacher may decide to have students, either individually or in groups, produce an artifact *(e.g. a drawing or a piece of writing)* to illustrate understanding of particular aspects of the engineering design process by describing how they operationalized that process as they developed, implemented, and improved their solution.

Alternatively - or afterward - the teacher might decide to have the students present their solution and describe each step of the engineering design process they engaged in to a wider audience *(e.g. peers, students from other classes or grades, family and community members)*.

EXTEND / ELABORATE

Extend

1 Students expand implementation of their solution to other similar sites, such as other schools, or other public places with similar litter problems. For example, students could focus on shifting individual behavior and choices *(e.g., stop using single use plastic; create a school wide 'no single use plastic challenge')*

Elaborate

2 Students explore how they can address the issue on a larger scale. For example, students could create an online "Awareness Campaign" about their project and use appropriate social media tools *(e.g. Twitter, Instagram)* to showcase their solutions and encourage others to join in. In addition, students could contact city and/or national policymakers and advocate for change.

DIFFERENTIATION PLANS

In this space, include notes about how you will differentiate your instruction to meet the needs of any individual students in your class who may need particular adaptations or accommodations

[note: the categories below are offered merely as planning guides; it is acknowledged that the categories are neither complete nor discreet].

Cognitive:

Linguistic:

Behavioral:

Affective:

Other: