

LESSON**Ecology Disrupted: A Change in Any Ecosystem Factor, Living or Non-Living, Can Unexpectedly Disrupt the Ecosystem**

The Baltimore study is reviewed in the context of ecological relationships to show how daily activities can change ecosystem components, which disrupt the normal functions of an ecosystem resulting in environmental issues.

What We Are Hoping For: Learning Goals

- Abiotic and Biotic Factors
- Water
- Runoff
- Human Impact
 - A, B, C
- Nature of Science
 - A-E
- Data Representation
 - A, B, C

Learning Goals:

- An ecosystem is made up of living organisms (biotic factors) and non-living (abiotic) factors that are interconnected
- A change in any factor, living or non-living can affect the entire system
- Our daily life can change abiotic factors
- Changing abiotic factors (e.g. adding salt to roads) can disrupt water supplies and other important parts of an ecosystem
- Data can be collected to learn about ecosystems (we can study ecosystems)
- People can use what they have learned from studying ecosystems to develop solutions for human caused disruptions.

CHECKLIST**Ecology Disrupted: A Change in Any Ecosystem Factor, Living or Non-Living, Can Unexpectedly Disrupt the Ecosystem**

In this lesson, students will:

- Discuss ecosystems, abiotic, and biotic factors in the context of Baltimore streams. **(5 min)**
- Watch *Science Bulletins* and complete the *Science Bulletins* graphic organizers in *Ecology Disrupted* section in the Investigation Booklet. **(50 min)**
- Discuss findings from the *Science Bulletins*. **(10 min)**
 - Discuss the consequences to ecosystems of changing abiotic factors like salt, light, and temperature.
 - Discuss the role of daily life in changing abiotic factors and impacting ecosystems.
 - Discuss possible solutions for each of the environmental issues.
 - Discuss the role of data in scientific investigations.
- Complete and discuss the *Final Thoughts* section of the Investigation Booklet. **(25 min)**

(Times indicated are approximate.)

1. Discuss ecosystems, abiotic, and biotic factors in the context of Baltimore streams. (5 min)**Biotic and Abiotic Factors**

Discuss biotic and abiotic factors in the context of salt and the Baltimore streams.

- A. Introduce the ecological principles of biotic and abiotic factors
- B. Connect the principles to this case study about Baltimore streams.

Discussion**Key Idea: Ecosystems have a natural balance of abiotic and biotic factors.**

Question: What is the definition of an ecosystem?

Answer: An ecosystem is an area that includes all the interconnected living (biotic) and non-living (abiotic) components.

Question: In science we call living things biotic factors and the non-living things abiotic factors. What are some abiotic and biotic factors in the Baltimore stream ecosystem?

Answer: Biotic: fish, plants, algae, bacteria

Abiotic: salt, water, rocks, sediment, trash

Ecosystems need a balance of both types of factors to be healthy. The ecosystems that we have been exploring are the fresh waterways around a city – in this case the city of Baltimore.

2. Complete the graphic organizer for *Winter Roads Make Salty Streams*. (5 min)**Winter Roads Make Salty Streams Graphic Organizer**

This exercise should familiarize the students with the graphic organizers.

Recall the Ecology Disrupted curriculum learning goals:

- Human daily life can disrupt ecological function leading to environmental issues.
- Scientists can collect data to investigate human impact local ecology.

Before the students begin watching the Bulletins, ask them to complete the graphic organizer for *Winter Roads Make Salty Streams* without watching the Bulletin. This exercise should familiarize the students with the graphic organizers.

While watching the Bulletins they will complete a graphic organizer with the following questions:

1. What abiotic factor(s) have people changed and what is the impact on the biotic factors in the ecosystem?
2. What is the evidence/data for your conclusion?
3. How has daily life contributed to this change and how is it affected?
4. What are possible solutions?

Solutions Background: Alternatives to salt

Calcium Magnesium Acetate (CMA) is a combination of dolomitic limestone (a very common rock), and acetic acid (vinegar) is a viable alternative to road salt. It was developed in 1987 and has since been extensively tested. Scientists have found that it is significantly less harmful for the environment than salt and it works well in temperatures as low as 23° F. Unfortunately, it is much more expensive than road salt. One way to combat the cost is to mix 20% CMA with 80% salt, which is more effective at melting ice than either substance alone, and less harmful for the environment than pure salt.

A second solution is to grow plants that like salt water near roadways. These plants survive much better in salt rich environments, and they can be used as a buffer for other plants and waterways. It is important that these plants are native to the area or they will cause a new set of environmental problems.

3. Watch other *Science Bulletins* and complete the graphic organizers for each. (50 min)

Light Pollution: Beyond the Glare

Light reflected off cars, buildings, and roads can derail wildlife.

Recall the Ecology Disrupted curriculum learning goals:

- Human daily life can disrupt ecological function leading to environmental issues.
- Scientists can collect data to investigate human impact local ecology.

Students watch additional *Science Bulletins* videos to learn about how human daily life can affect ecological function, and to pull out the ecological principles. An introduction to the video and background information are provided below.

While watching the *Bulletins* they will complete a graphic organizer with the following questions:

5. What abiotic factor(s) have people changed and what is the impact on the biotic factors in the ecosystem?
6. What is the evidence/data for your conclusion?
7. How has daily life contributed to this change and how is it affected?
8. What are possible solutions?

Introduction

"Raise your hands if you use lights at night. What about admiring the NYC skyline at night? New York City produces a lot of light. We are going to watch another *Science Bulletin*. This one will be about light pollution. Get ready to fill out your graphic organizers."

Background Information

Artificial light can disrupt many species because it mimics natural light. This *Science Bulletin* is based on work done by a group of Hungarian and American scientists who studied the impact of polarized light. Natural light oscillates in many directions, but in polarized light many of the waves are oscillating in the same direction. Polarized light is dangerous because it mimics light bouncing off of water sources. Aquatic insects that normally lay their eggs near water sources are tricked into laying their eggs on roadways and other reflective surfaces, which decrease the size of these populations because the young insects die without food and shelter that the water provides. Their deaths disrupt food webs that depend upon these aquatic insects.

Urban Heat Island Effect

In cities like Atlanta, the high concentration of buildings, roads, and other artificial surface areas retain heat, making urban environments up to 10° C (18° F) warmer than rural areas.

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Students watch additional Science Bulletins videos to learn about how human daily life can affect ecological function, and to pull out the ecological principles. An introduction to the video and background information are provided below.

While watching the Bulletins they will complete a graphic organizer with the following questions:

9. What abiotic factor(s) have people changed and what is the impact on the biotic factors in the ecosystem?
10. What is the evidence/data for your conclusion?
11. How has daily life contributed to this change and how is it affected?
12. What are possible solutions?

Introduction

"Think about the summertime. Have you ever come out of your apartment and felt the heat come up from the sidewalk and hit you in the face? How about stepping out of a car onto the blacktop? Do you feel the heat envelope you? This phenomenon has a name – The Urban Heat Island Effect. Think about the relief provided by sidewalk trees or the vegetation of a playground. This natural vegetation counteracts the urban heat island. We are going to watch another *Science Bulletin*. This one will be about urban heat islands in Atlanta, but what is true for Atlanta is true for New York City. In fact after this *Bulletin*, I will show you slides of the urban heat island in New York City. Get ready to fill out your graphic organizers."

Background Information

The heat island effect describes how urban areas that have large numbers of buildings and roadways have higher temperatures than surrounding rural and suburban areas. The concrete and other materials used to build the roads and buildings retain more heat than grasses and trees, which causes the higher temperatures. The buildings absorb heat during the day, and these "heat islands" like Atlanta (and NYC) show the highest temperatures during evenings and when there is little wind (up to 4° Celsius or 7° Fahrenheit warmer). These areas have longer growing seasons for plants, but the higher temperatures can affect weather patterns and human health. It is much hotter in these areas, which also increases the amount of energy used to cool these structures during summer months.

Note: Use the included slideshow with pictures of the urban heat island effect on NYC to connect this Atlanta example to New York.

Climate Change Affects Ecosystems

Impacts from the Intergovernmental Panel on Climate Change (IPCC) 2007 report.

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Students watch additional Science Bulletins videos to learn about how human daily life can affect ecological function, and to pull out the ecological principles. An introduction to the video and background information are provided below.

While watching the Bulletins they will complete a graphic organizer with the following questions:

13. What abiotic factor(s) have people changed and what is the impact on the biotic factors in the ecosystem?
14. What is the evidence/data for your conclusion?
15. How has daily life contributed to this change and how is it affected?
16. What are possible solutions?

Introduction

"You may have heard the catchwords – “climate change”, “global warming”, and maybe even “carbon footprint.” Scientists have looked at past temperature and carbon dioxide levels and found a disturbing correlation. Since the beginning of the industrial revolution when people started burning great quantities of fossil fuels and carbon dioxide levels began to increase, temperatures have also been increasing. Carbon dioxide traps the sun’s heat on our planet – this is a good thing, because without it our planet would be very cold. Unfortunately, now excess carbon dioxide is trapping too much heat, rapidly warming our climate. This next *Bulletin* describes just a few ecosystem responses to a rapidly warming climate. Get ready to fill out your graphic organizers."

Why burn fossil fuels?

Burning fossil fuels has transformed daily human life. Instead of huddling freezing in our homes in winter, we have **heating**. Instead of trying to see at night with candlelight, we use **electric lighting**. **Food** is more diverse and easier to come by than in the past before refrigeration, tractors, fertilizers, and worldwide transportation networks. **Travel** to different parts of the globe or even to other areas of the State are all easy with the use of buses, trains, **cars**, and **airplanes** – all powered by fossil fuels. Finally, **cell phones**, **television**, **computers**, or any of the other products that you use in your daily life would not exist without the electricity to power them or the fossil fuel powered factories to manufacture them.

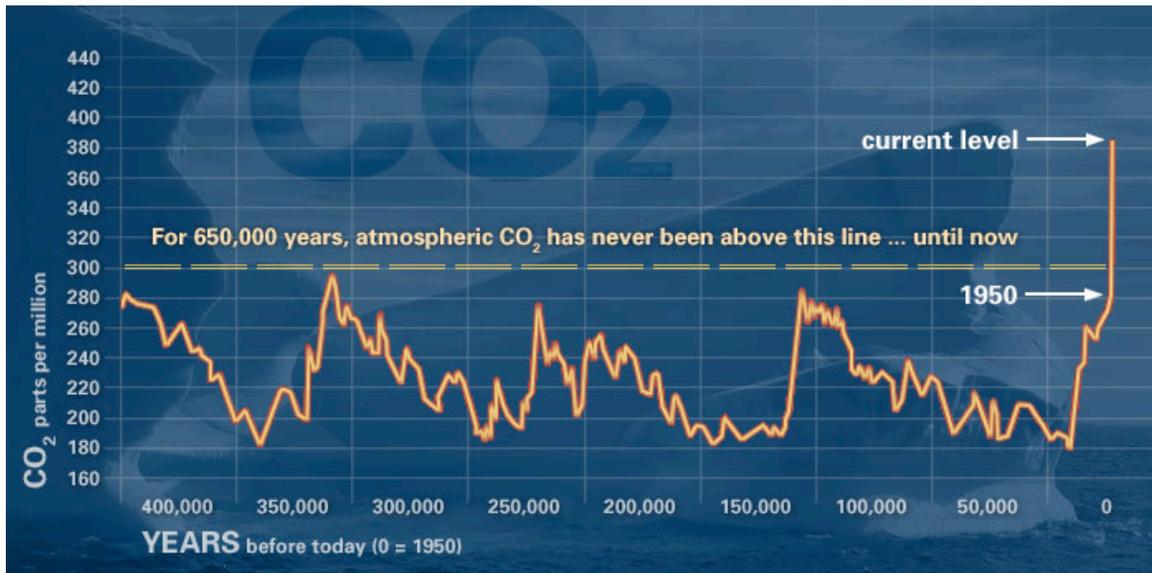
Burning fossil fuels disrupts the carbon cycle

Before industrial times, the carbon remains of ancient organisms lay mostly sequestered deep in the Earth, a **dormant stockpile** of stored **carbon**. These **dead** organisms had dropped out of the carbon cycle. However, today by burning the

carbon remains of these fossilized organisms (fossil fuels), we are drastically changing the carbon cycle. We have suddenly **injected** into the **carbon cycle** what was for millions of years only a cycle spectator buried underground. This sudden great **influx** of stored carbon into the carbon cycle is contributing to our warming planet, just as an unexpected influx of water can start a flash flood and a great influx of nutrients can cause algal blooms.

Evidence

The evidence for climate change is overwhelming. Visit <http://climate.nasa.gov/evidence/> for more information. Included is a graph of carbon dioxide levels from the NASA website.



Solutions

Many steps can be taken to reduce our carbon footprint (the amount of carbon dioxide we emit). The government can set limits on global warming pollution levels, invest in green jobs and clean energy like wind and solar power. Also, we can create more energy efficient jobs, homes, and buildings, and invest in public transportation. (Note: New York City already models many of these items like an extensive public transportation network and high-density dwellings that conserve more energy than freestanding homes).

Bronx River Restoration

Can an urban waterway reclaim its historical ecological health?

Recall the Ecology Disrupted curriculum learning goals:

- Human daily life can disrupt ecological function leading to environmental issues.
- Scientists can collect data to investigate human impact local ecology.

Students watch additional Science Bulletins videos to learn about how human daily life can affect ecological function, and to pull out the ecological principles. An introduction to the video and background information are provided below.

While watching the Bulletins they will complete a graphic organizer with the following questions:

17. What abiotic factor(s) have people changed and what is the impact on the biotic factors in the ecosystem?
18. What is the evidence/data for your conclusion?
19. How has daily life contributed to this change and how is it affected?
20. What are possible solutions?

Introduction

"Have any of you been to the Bronx River? It is the river than runs through the Bronx Zoo. Before the arrival of European settlers it used to be a spectacular home for wildlife. Not surprisingly, building this enormous city has damaged the River, but the good news is that people are working to restore it. People are also trying to restore other water bodies in the City, like Newtown Creek between Brooklyn and Queens and the Gowanus Canal. The Bronx River restoration is the furthest along and the most inspiring. This time we are going to watch a *Science Bulletin* video about this story, and cheer up because this story is upbeat. Get ready to fill out your graphic organizers."

Background

The Bronx River has a high level of pollution that has impacted the native species of the river like oysters and fish. It became polluted during the 19th and 20th centuries because it was used as a natural sewer to dispose of industrial wastes like fertilizers (nitrogen and phosphorous), PCB's, and oil. At this time there was also a loss of the vegetation around the river, which led to the Bronx River ecosystem being severely disrupted. Many of the original species like freshwater plants and fish are no longer found in the River due to the pollution. The River is in the process of being restored by scientists, students, and environmental activists by removing invasive species and pollutants and re-introducing native species into the river.

4. Discuss findings from the *Science Bulletins*. (10 min)

Bringing the Stories Together

How mundane or ordinary aspects of daily life can lead to environmental issues by disrupting ecological function (in this case abiotic factors).

Convene a final discussion of the *Science Bulletins* bringing the stories together through a discussion of how mundane or ordinary aspects of daily life can lead to environmental issues by disrupting ecological function (in this case abiotic factors)

Discussion

Key Idea: The daily lives of people add abiotic factors to ecosystems, which disrupt many species.

Question: After watching these *Bulletins* of the environmental issues that result after changing abiotic factors, give examples of how **changing abiotic factors impact species** in unforeseeable ways?

Answer:

- Adding salt kills freshwater ecosystems
- Building concrete buildings absorbs heat and makes the environment hotter
- Adding artificial light at night kills aquatic insects
- Driving and using heating, air conditioning, electronics like cell phones and computers contribute to a rising carbon dioxide levels and temperature.
- Water pollution disrupts large water ecosystems

Question: What are some possible ways to reduce changing abiotic ecosystem factors?

Answer:

- Using alternatives to salt like CMA
- Constructing buildings with green roofs and planting more trees
- Using non-polarized light, motion sensors, and full cut-off fixtures
- Cleaning up polluted rivers

Note: For more detailed answers see the Answer Keys of the graphic organizers for the *Science Bulletins*.

5. Complete and discuss the *Final Thoughts* section of the Investigation Booklet. (25 min)

Ask students to complete the *Final Thoughts* section of the Investigation Booklet, available in the Downloads section on this page.