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How does reducing air pollution help birds?

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Abstract

When you think of pollution, what image comes to mind? Litter? Oil spills? We think of these types of pollution first because they are visible. But the most dangerous form is one that we cannot see: air pollution.

We know that chemicals and small particles in the air can harm human health, so governments create laws and programs to reduce air pollution. We wanted to know if these same programs also positively affect birds. After all, birds are such an important part of our world! We built a mathematical model using bird population and air pollution data to see which air pollutants (tropospheric ozone and/or fine particulate matter) harm birds. Then we looked at how a United States air pollution reduction program affected the bird populations. From this analysis, we found that air pollution programs not only benefit humans, but they also protect birds.

Introduction

You may not know this, but air pollution is one of the world's largest health and environmental problems. According to the World Health Organization, 4.2 million people die each year from outdoor air pollution. Because air pollution is so dangerous, governments created laws to reduce its impact. And these **regulations** have been successful! The levels of pollution in the U.S. have decreased over the last few decades.

While the improvement of human health is a reason to celebrate, we wanted to see if there was more to our success. We wanted to know how air pollution regulation affected nonhuman species. Specifically, we focused on fine **particulate matter** and **ozone**. Fine particulates are small particles released during **combustion**. They are about thirty times smaller than the width of one piece of your hair. Ozone is a complicated gas because we find it in two parts of our atmosphere. When it is in the **stratosphere**, ozone acts like sunscreen, protecting us from the sun's **ultraviolet** (UV) light. But when ozone is in the **troposphere** (the lowest layer of the atmosphere where we live), it forms **smog** from gases produced during fossil fuel combustion. This tropospheric ozone causes asthma and other respiratory problems.

Because these pollutants are so harmful to humans, we wanted to know if they are also dangerous for birds. We also wanted to figure out if the regulations created to help humans protect bird populations as well.

Tropospheric ozone is the main component of the brown smog seen in cities like Los Angeles.

Photo: Temeku

Methods

We created a model that shows the effect of tropospheric ozone and fine particulate matter on relative bird abundance. **Relative abundance** is used in ecology to tell us how many individuals of a species are present in a location at a particular time. If we compare relative abundance over time, then we can know how bird populations are changing. We estimated relative bird abundance using eBird, an online database where people can submit bird observations. We combined this information with air pollution data from the United States Environmental Protection Agency's Air Quality System database. The data spanned 3,214 counties across the United States over a 15-year period.

Next, we looked at how bird populations changed in response to the US EPA's **nitrogen oxides** trading program, which reduced how much could be emitted during summer months. We chose this program because nitrogen oxides are the main ingredient for making tropospheric ozone. To estimate the impact of this program, we made three comparisons:

1. States that participated in the program versus states that did not.
2. Summer months when the program restrictions are in place versus winter when they are not.
3. The first 13 years after the program's start date in 2003 versus years before it started.

Finally, we estimated what bird populations would be if tropospheric ozone had remained at 1980 levels.

Results

Our model showed that as tropospheric ozone levels increased, bird populations declined. We did not find evidence that fine particulate matter was related to bird numbers. Figure 1 illustrates our findings.

The EPA's nitrogen oxide trading program reduced tropospheric ozone levels and increased relative bird abundance. The program had the strongest positive impact on small landbirds, like chickadees, robins, warblers, and sparrows. There was little to no impact on ducks, geese, herons, shorebirds, and other birds associated with water. We also discovered that if tropospheric ozone had remained at 1980 levels, the bird population would have been 1.5 billion birds smaller.

Which air pollutant caused a change in bird abundance? What happens to bird abundance when the amount of this pollutant increases?

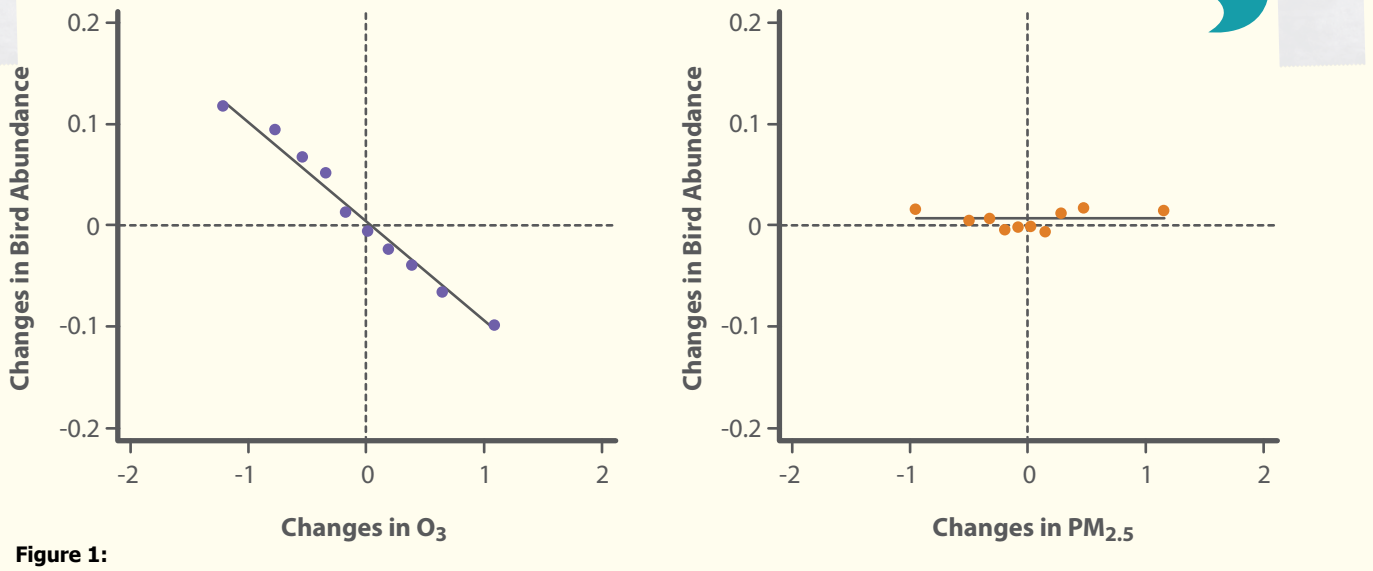

Figure 1:

A) Change in bird abundance as the amount of tropospheric ozone changes.

B) Change in bird abundance as the amount of fine particulates changes.

Discussion

Our study showed that the air pollution programs designed to protect human health also benefit birds – especially populations of small landbirds. That tells us that birds are also indirectly harmed by air pollution.

There are several reasons why ozone is bad for birds. We know from research done by other scientists that tropospheric ozone can damage a bird's respiratory system and can lower **immune function**. Other studies show that tropospheric ozone also harms the plants and insects that provide habitat and food to birds. These effects can result in less healthy birds that are more likely to die and less able to reproduce. With fewer birds surviving and fewer baby birds hatching each year, bird populations decline. Without the EPA's air pollution programs, bird populations would have decreased more significantly over time.

Why does this matter? Birds provide a variety of services to humans, so protecting them benefits society. For example, since birds eat insects that damage plants, they protect crops and trees from pests. Because they get rid of pests for free, it saves farmers and foresters a lot of money. And it means we don't have to use chemicals that could pollute our water resources to get rid of these insects. Birds also bring money to communities since people like to travel to watch birds or spend money on birdseed. Our air pollution policies are even more important because they benefit valuable bird populations.

Conclusion

By keeping people healthy from air pollution, we can keep birds healthy too. Governments have already started to create and enforce air pollution laws to keep our atmosphere clean. So what can you do to help the birds? You can reduce the amount of tropospheric ozone in the air by reducing the amount of driving you and your family do – remember, combustion engines like the ones in cars produce nitrogen oxides. By carpooling, using public transportation, riding a bike, and/or walking whenever you can, you can help reduce air pollution. And with cleaner air, both you and the birds will be healthier.

Glossary of Key Terms

Combustion – the process of burning a fuel that produces heat and light. Common fuels include: wood, natural gas, coal, oil, and gasoline.

Immune function – the ability of an organism to defend itself against viruses, bacteria, and other substances that can cause illness.

Nitrogen Oxides (NO_x) – a group of air pollutants containing nitrogen and oxygen. These gases form from the combustion of fossil fuels. Tropospheric ozone forms when nitrogen oxides interact with sunlight and other gases in the atmosphere.

Ozone (O_3) – a molecule that contains three oxygen atoms.

Particulate Matter (PM) – particulate matter is solid particles and liquid droplets in the air that cause damage to our lungs when inhaled. Examples include soot, dust, and pollen. Particulate matter is classified by size; PM_{10} and $PM_{2.5}$. $PM_{2.5}$ are the smallest particles.

Relative abundance – a measurement used in ecology. It tells us how common or rare a species is relative to other species in the area.

Regulation – a rule that is created and enforced by the government. The United States Environmental Protection Agency does this in the United States.

Smog – a form of air pollution that reduces visibility. Brown smog that commonly forms in cities forms when air pollutants interact with sunlight. It contains multiple air pollutants, including ozone.

Stratosphere – The second layer of the atmosphere, found just above the troposphere. Ozone found in this layer protects us from the sun's ultraviolet (UV) light.

Troposphere – The layer of the atmosphere that is closest to the Earth's surface. The troposphere is the layer of the atmosphere in which we live. Ozone found in this layer is dangerous for human health.

Ultraviolet (UV) light – a type of radiation produced by the sun that causes suntans and burns. This type of radiation is absorbed by ozone in the stratosphere.

Check your understanding

1. Why have governments created and enforced air pollution laws and programs?

2. What is one direct and one indirect effect that tropospheric ozone has on birds?

3. Why does reducing nitrogen oxides in the atmosphere benefit birds?

4. The article identifies two services that birds provide humans. Can you think of another reason why birds are important?

5. Fossil fuels are not just used for transportation, but also for heating, and for generating electricity. Brainstorm a list of additional lifestyle changes not listed in the article that you can make to reduce the combustion of fossil fuel. Which change is the hardest to make? Why is this change so hard? Is there a change you think you can easily make? Why?

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