

Natural Inquirer

A science education resource for climate change education...

Natural Inquirer

FACELOOK!

Exploring the relationship between carbon, photosynthesis, and the roots of trees



The Natural Inquirer Monograph Series

NATURAL INQUIRER

THE WORLD'S FORESTS EDITION - VOLUME XI / NUMBER 1



What kind of forests grow on Earth and how do they differ?



How well are we managing our forests worldwide?



How much carbon is being held by the world's forests?



How much of Earth's land is covered by forests?



2002 Olympic Winter Games Edition

SALT LAKE 2002

WINTER 2001 • USDA FOREST SERVICE

NATURAL INQUIRER

Should Ditches Be Graded? Page 24

Beetles Are Supercool! Page 6

One fish, Two fish, No fish? Page 41

Facts to the Future

VOLUME 5, NUMBER 1 • USDA FOREST SERVICE

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Where in the World Is Carbon Dioxide? Page 7

Let Nature Take Its Course Page 12

Born To Be Wild Page 25

Using **Natural Inquirer** for climate change education allows your students to:

- Practice critiquing & critically assessing current climate change information
- Practice critical thinking about research in general, & climate change research specifically
- Through such education, we create global citizens & promote environmental & cultural sustainability
- Make better informed judgments & decisions

Soil carbon pools and fluxes in urban ecosystems

R. Pouyat^{a,*}, P. Groffman^b, I. Yesilonis^c, L. Hernandez^d

^aNortheastern Research Station, c/o Baltimore Ecosystem Study, 5200 Westland Blvd., Room 134, University of Maryland, Baltimore, MD 21227, USA

^bInstitute of Ecosystem Studies, Millbrook, NY 12545, USA

^cUniversity of Maryland, College Park, MD 20742, USA

^dNatural Resource Conservation Service, Staten Island, NY 10306, USA

“Capsule”: Soil organic carbon pools are directly and indirectly affected by urban land-use conversions and these changes can be observed in adjacent undisturbed forests.

Abstract

The transformation of landscapes from non-urban to urban land use has the potential to greatly modify soil carbon (C) pools and fluxes. For urban ecosystems, very little data exists to assess whether urbanization leads to an increase or decrease in soil C pools. We analyzed three data sets to assess the potential for urbanization to affect soil organic C. These included surface (0–10 cm) soil C data from unmanaged forests along an urban–rural gradient, data from “made” soils (1 m depth) from five different cities, and surface (0–15 cm) soil data of several land-use types in the city of Baltimore. Along the urban–rural land-use gradient, we found that soil organic matter concentration in the surface 10 cm varied significantly ($P=0.001$). In an analysis of variance, the urban forest stands had significantly ($P=0.02$) higher organic C densities (kg m^{-2} to 1 m depth) than the suburban and rural stands. Our analysis of pedon data from five cities showed that the highest soil organic C densities occurred in loamy fill (28.5 kg m^{-2}) with the lowest occurring in clean fill and old dredge materials (1.4 and 6.9 kg m^{-2} , respectively). Soil organic C densities for residential areas ($15.5 \pm 1.2 \text{ kg m}^{-2}$) were consistent across cities. A comparison of land-use types showed that low density residential and institutional land-uses had 44 and 38% higher organic C densities than the commercial land-use type, respectively. Our analysis shows that as adjacent land-use becomes more urbanized, forest soil C pools can be affected even in stands not directly disturbed by urban land development. Data from several “made” soils suggests that physical disturbances and inputs of various materials by humans can greatly alter the amount C stored in these soils. © 2001 Published by Elsevier Science Ltd. All rights reserved.

Keywords: Soil organic carbon; Anthropogenic soils; Urban soils; Human modified soils; Baltimore Ecosystem Study

1. Introduction

The expansion of urban areas worldwide makes our understanding of the effects of human land use on soils increasingly important. The effects of urbanization on soil carbon (C) pools and fluxes in urban areas (World Resources Institute, 1996). In the lower 48 states of the USA alone, urban areas have increased two-fold in area between 1969 and 1994, and cities have increased by 50% (Dwyer et al., 1994). The loss of arable land is annually being lost to the expansion of urban areas (World Resources Institute, 1996).

The transformation of landscapes from primarily agricultural and natural lands to urban areas has the potential to greatly modify soil carbon (C) pools and fluxes (Groffman et al., 1995; Pouyat et al., 1995b). While conversion of native ecosystems to agricultural use, and recovery from agriculture, have been rela-

tively well studied, urban ecosystems have received little attention. We know, for example, that as agricultural practices have been abandoned in previously forested areas in the United States, regrowth in these areas has led to a partial recovery of above ground C pools (e.g., 1994; Caspersen et al., 2000). Urban land conversions, however, often result in poor conditions for plant growth, and if the land is abandoned, the soil may be a source for large geobiosphere feedbacks (e.g., 1994; Caspersen et al., 2000). Urban land conversions, however, often result in poor conditions for plant growth, and if the land is abandoned, the soil may be a source for large geobiosphere feedbacks (e.g., 1994; Caspersen et al., 2000).

On a global scale soil C pools are roughly three times larger than the C stored in all land plants (Schlesinger et al., 1996). Soil C pools are primarily composed of organic matter to the ecosystem (net primary productivity, NPP) and the average rate of decay within the ecosystem (soil heterotrophic respiration), both of which are controlled by soil temperature and moisture. Soil temperature and moisture sensitivities of decay rate and NPP to soil temperature and moisture, a

The heart of the NI is the scientific paper, written at the middle school level.

The heart of each article is the standard scientific paper format:

- Introduction
- Method
- Findings
- Discussion (or Implications)

Takes the published work of Forest Service scientists and transforms it into a science education resource.

* Corresponding author. E-mail address: rpouyat@aol.com (R. Pouyat).

Using **Natural Inquirer** for climate change education addresses the following **National Science Education Standards**:

- **Science as inquiry**: Abilities necessary to do scientific inquiry
- **Life science**: Regulation and behavior; Populations and ecosystems
- **Earth and space science**: Structure of the earth system
- **Science and technology**: Understandings about S&T
- **Science in personal and social perspectives**: S&T in society
- **History and nature of science**: Science as a human endeavor;
Nature of science



Note: Each edition is improved based on feedback from students and educators.

Beetles Are Supercool!

Understanding the Life Cycle of Mountain Pine Beetles

Glossary:

annual (an yoo ul): Covering the period of 1 year.

climate (kli met): The average condition of the weather at a place.

larva (lär vuh): Wormlike feeding form that hatches from the egg of many insects.

metabolize (muh ta buh liz): Chemical changes in a living body that provide energy to the cells for survival, growth, and reproduction.

Meet Dr. Jesse Logan:

I like being a scientist because of the excitement of learning new things and the rewards of being creative. I became interested in natural resources as a young boy enjoying the out-of-doors in the Rocky Mountains.



Meet Dr. Barbara Bentz:

I like being a scientist because I enjoy the art of discovery. I became interested in natural resources when I was a young child, traveling and camping with my family.



The
So

temperature changes in the length of the scientists are interested in studying the effects of seasonal changes on the life cycle of plants and animals. The scientists that study these effects is called phenology (fuh nol o jee).

phenology is the study of the influence of climate on the life cycle of plants and animals. This is important because many scientists believe that climate change is affecting the life cycle of many organisms. Scientists were interested in understanding how climate change might affect the life cycle of a particular beetle. They had to wait a hundred or more years

Students meet the scientists who conducted the research. Demonstrates diversity, encourages identity.

Supports outreach by showing students that they can be scientists. Puts a human face on science.

Beetles Are Supercool!

Understanding the Life Cycle of Mountain Pine Beetles

A glossary of terms introduces scientific terms used in the article.

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interested in natural resources when I was a young child, traveling and camping with my family.



changing. In this study, the scientists were interested in understanding how a change in climate might affect the life cycle of a particular species of beetle. Because they could not wait a hundred or more years

Thinking About Science



Many plants and animals live in annual cycles. They respond to seasonal temperature changes and changes in the length of the day. Some scientists are interested in the effect of these changes on the life cycles of plants and animals. A science that investigates life cycles is called *phenology* (fēn'ol-uh-jē). The science of life cycles is also called *phenology*.

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carbohydrate (kār bō hī drāt): Starches and sugars that are used as food by animals.

phloem (flō em): Tissue that transports nutrients from the leaves to the rest of the plant.

pupa (pyoo puh): Intermediate stage of insect growth between larva and adult.

resin (rez in): Cloudy, sticky substance that oozes from some trees.

population (pop yoo la shun): The whole number of individuals of the same type occupying an area.

stand (stand): A group of trees growing in a continuous area.

complexity (käl'm plek suh te): The state of being complicated or having many related parts.

simulate (sim yoo lat): To create the appearance or effect of something for purposes of evaluation.

indicator species (in di kat ūr spē sez): Type of plant or animal that serves as a measure of the environmental health of an area.

Pronunciation Guide

a	as in ape	ō	as in for
ā	as in car	u	as in use
e	as in me	ū	as in fur
i	as in ice	oo	as in tool
o	as in go	ng	as in sing

Beetles Are Superscool!

Understanding the Life Cycle of Mountain Pine Beetles

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Thinking About Science

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Glossary:

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Preparation to read. Students should be given background material so that they have some knowledge of the subject matter. This helps them to maintain their focus and interest (Santa, Havens, & Maycumber, 1996).

Meet

I like being a scientist because of the excitement of learning new things and the rewards of being creative. I became interested in natural resources as a young boy in the

Takes a science process concept from the article and introduces it to students. For example, teamwork in science, or the concept of various scales of inquiry.

wait a hundred or more years

o as in go

ng as in sing

scales, of songbird habitat, so that she could better understand which kind of natural place songbirds prefer to live.



Thinking About the Environment

Species diversity is a particular kind of *biodiversity*. Species diversity is a measure of how many different kinds of *species* live in an area and the numbers of each species. For a natural area to be healthy, it should have many different forms of life. It is best when those species are *native* to the area. When *nonnative* species move into an area, they sometimes compete with the native species for food and homes. An example of a nonnative

Some people think that wildlife is important on the immediate in which it lives. interested in ex...

Western Idaho (Figure 2). In the past, large riparian wood forests grew along the river (Figure 2). No...



st...ches of fore... to mor...



Reflection Section

- If Dr. Saab finds that different types of

Takes an environmental concept from the article and introduces it, such as species migration or the principle of adaptation.



Figure 2. Cottonwood tree.

the smallest area a *microhabitat* (as in microcomputer, meaning small computer). The microhabitat included the

Students need a purpose to read and comprehend well. For example, giving them background information and helping them to understand how they will use the information are powerful tools for better reading (Tovani, 2005).

scales, of songbird habitat, so that she could better understand which kinds of natural places songbirds prefer to live.



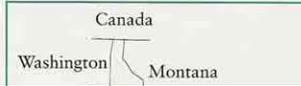
Thinking About the Environment

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Introduction

Some scientists think that wildlife is mostly *dependent* on the immediate natural area in which it lives. Dr. Saab was interested in exploring this idea, because she thought that native songbirds might also be affected by the larger environment surrounding their immediate forest home. She decided to study areas of land on either side of the South Fork of the Snake River in southeastern Idaho (Figure 1). In the past, large riparian *cottonwood* forests grew along the river (Figure 2). Now only

small patches remain. In addition to these areas, agricultural houses and yards found here. The bird species, regardless of where they would live, are dependent on their immediate environment, and not the larger environment surrounding their immediate forest home.



Relation Section

The principal parts of a written research paper are presented. These include the sections of Introduction, Method, Findings, and Discussion (or Implications).

Comprehension is enhanced if students know how a text is organized (Coutant & Perchemlides, 2005).

Think of a newspaper. It helps to know how publications are organized.



Figure 2. Cottonwood tree.

... (as in microcomputer, meaning small computer). The microhabitat included the

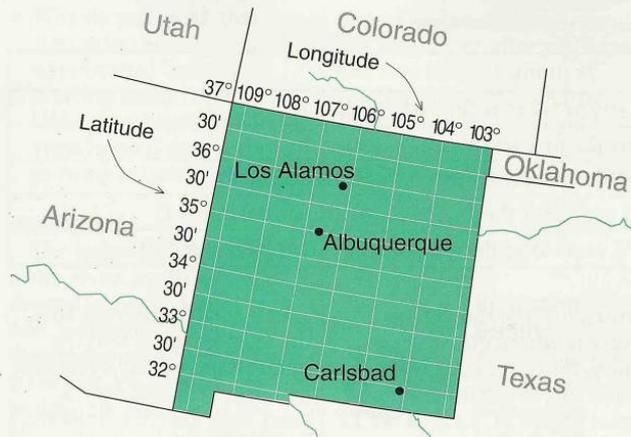


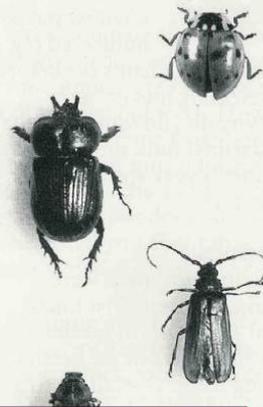
Figure 2. Map of New Mexico with lines of latitude and longitude. Latitude consists of imaginary lines around the Earth from the equator to the poles. Longitude also consists of imaginary lines around the Earth. Each line of longitude circles the Earth through both the North and South Pole. These lines are used to identify locations on the Earth. Both latitude and longitude are identified by degrees ($^{\circ}$), minutes ($'$), and seconds ($''$). The study area for this project was $36^{\circ} 31'$ latitude north, $103^{\circ} 3'$ longitude west. See if you can locate where in New Mexico the scientist conducted her study.

2.47.) Within this area, the scientist marked off 12 separate

The scientist observed and measured six things. The six



Figure 3. A research assistant purposely setting fire to an area of prairie.



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Geography, math, and social studies are integrated into the articles where appropriate.

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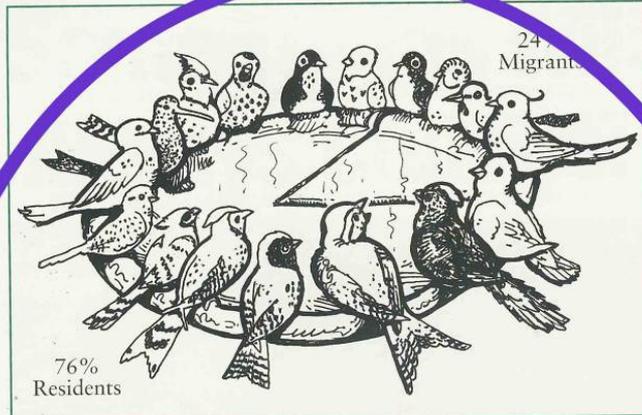


Figure 4. Percentage of permanent and migratory birds.

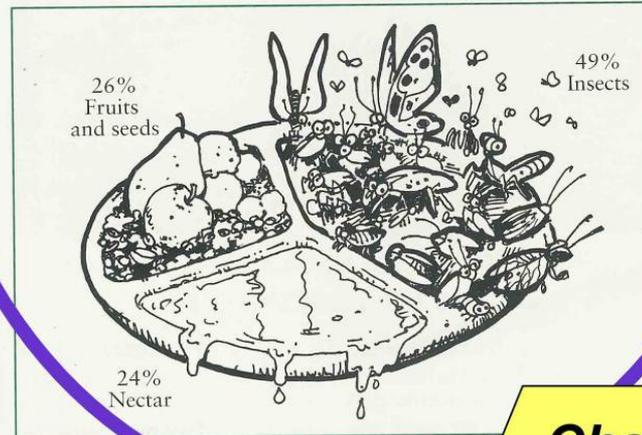


Figure 5. Food sources of birds in the Caribbean.



Reflection Section

- Name two examples of diversity described in this

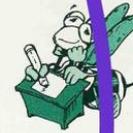
article. Think about the type of birds, the foods they eat, how they get their food, and the trees and plants where they find food.

in what way help the

Implications

Through American bird species of the migratory species

resident birds can live in the same place at one time. With this information, people can make sure that resident and migrant birds have the kinds of places in the tropics that they need to survive. By providing and protecting the forests that different kinds of birds need, people can help reduce the declining number of songbirds in the future.



Reflection Section

- A food web is balanced between food sources

and the animals that eat the food. Think about insect-eating birds. What would happen to the population of insects if the birds were not there to eat the insects?

- How might protecting some tropical forests help reduce the declining number of songbirds in North America?

FACTS

Charts and graphs display findings in an easy to read and fun format.

Middle school students should learn how to read and interpret charts and graphs.

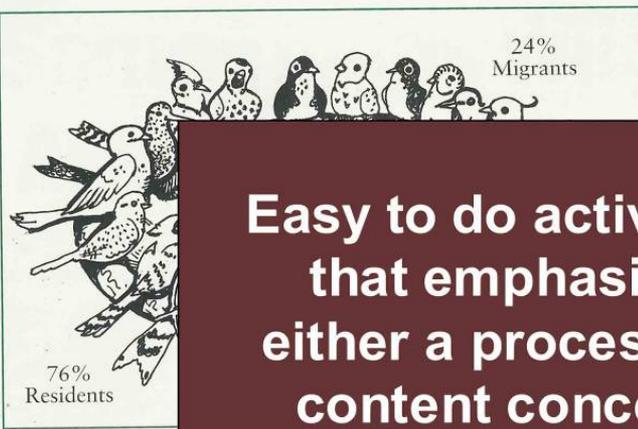


Figure 4. Percent



Caribbean pine forest. ...ays did diversity

Implications
Throughout North America, the number of songbird species is declining. Many of those songbirds are migrants that live in the tropics during the winter. This study shows how migrant and

resident birds can live in the same place at one time. With this information, people can make sure that resident and migrant birds have the kinds of habitats that they need to survive. By protecting the different kinds of habitats, people can help make sure that birds will be around in the future.

Reflection

A healthy food web is balanced between food sources and consumers. Birds that eat the insects about insect-eating birds. What would happen to the population of insects if the birds were not there to eat the insects?

- How might protecting some tropical forests help reduce the declining number of songbirds in North America?



FACTivity

The scientist found that birds ate three kinds of foods. These foods were 1) insects, 2) fruits and seeds, and 3) nectar. They also found that birds captured their food in the air, and they gleaned, jumped, and probed for their food (See Table 1). In this FACTivity, you will answer the question: What kinds of physical characteristics might

Easy to do activities that emphasize either a process or content concept from the article.

Students should develop the abilities and understandings that will enable them to engage in scientific inquiry (National Research Council, 2000).

Reference to Project Learning Tree activities added in later editions.

For Today's Activity, You Can Follow the Lesson Plan Yourself!

1. Divide into groups
2. Each group gets a Natural Inquirer article
3. Read your article:
(skip glossary, scientists, reflection sections, FACTivity)
 1. Complete the questions
 2. Discussion

Introduction: Provides background about the problem. Leads to the research question. States the research question.

Method: Outlines the methods used to answer the research question. Should include information about the variables studied (and their definitions), time frames and design of data collection, and type of analysis (data handling: summary, comparisons, etc.

Findings: Gives the results of the analysis.

Discussion or Implications: Discusses the findings in light of the original problem. Provides possible implications, the “so what” of the findings in light of the original problem.

This article's title:

The topics covered by this article include climate change and.... (check all that apply)

- Trees and plants
- Insects and diseases of plants or animals
- Weather or climate
- Invasive species (plants or animal species that are not native)
- Fresh water
- Oceans or ice
- Coastal
- Carbon/carbon dioxide
- Ecological (dealing with natural relationships)
- Economic (dealing with the value of goods, services, or the environment)
- Social or cultural
- Dealing with the scientific discover process itself

This article's title

What was the **problem** the scientists addressed in the research?

What **question or questions** did the scientists want to answer?

What **variables** did the scientists study?

When, where, and how were the **data collected**?

How did the scientists **summarize, compare, or otherwise analyze** their data?

What did the scientists **find or discover**?

What **implications** were discussed? In other words, what potential impact will the findings

What is the **source** of the research article? For example, did the information originally come from a scientific journal, a conference proceedings, or from an interview? Your teacher may need to help you with this.

On a scale of 1 to 5, how much confidence do you have in the research findings? In other words, is there enough information provided about how the research was done to give you confidence in the findings? 1=little confidence, 5=a lot of confidence

Why did you give the rating that you did?