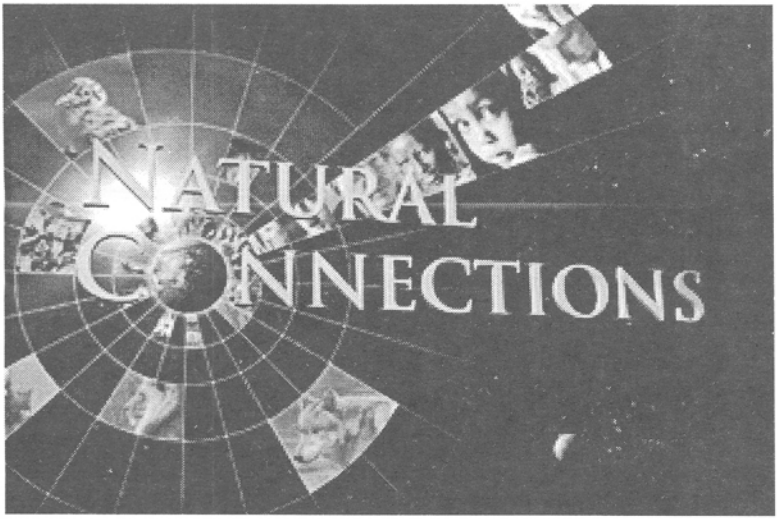

STUDY GUIDE

by Leslie Karasin

ABOUT THIS FILM AND GUIDE

Natural Connections is a film that explores the issue of biodiversity, how nature and human nature are related, and how our behavior impacts natural systems and biodiversity. Commissioned by Washington's King County Department of Natural Resources and produced by Howard Rosen Productions, Inc., the film weaves together the words and work of some of the world's greatest living scientists.

Natural Connections is currently available as one 46 minute program, or as a series of five shorter videos that may be more easily incorporated into classroom periods and into lesson plans. These shorter pieces include:

Introduction to Biodiversity 14 minutes
The Significance of Salmon 12 minutes
Keystone Species 9 minutes
Forests, Biodiversity and You 10 minutes
Biodiversity vs. Extinction 11 minutes

This guide will be useful for either the continuous program or the shorter videos. Users of the continuous program will find all of the 'Before Viewing' and 'After Viewing' questions pertinent. Users of the shorter videos will want to focus on the relevant questions, but will also want to consult the other sections of the guide, particularly, the 'Themes, Activities and Critical Questions' section.

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Natural Connections Website
http://dnr.metrokc.gov/swd/naturalconnections.htm

NATURAL CONNECTIONS

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LEARNING OBJECTIVES

After viewing this film, your students will be able to:

• describe how all parts of the ecosystem are connected, either directly or indirectly; and to illustrate how changes in one part of an ecosystem affect other parts of the ecosystem.

• explain the importance of *biodiversity* and how a great diversity of species increases the chance that some living things will survive under large changes in the environment.

• show that human activity has the greatest effect on the environment and the lives of all species, including our own.

SYNOPSIS

The natural world is a rich tapestry, and each species on earth is a thread which contributes to the whole. There are estimated to be as many as 100 million species on Earth, the vast majority of which we have not even identified. Together, these species, the genetic information they carry and the ecosystems which they comprise, constitute an enormous wealth of biological diversity, or biodiversity. Biodiversity makes our natural systems stronger, richer and more resilient; it allows ecosystems to "work"—to cycle air, nutrients, and water for the benefit of all species; and it enriches our appreciation of the natural world.

Humans, however, often behave as if we were not just one thread in the tapestry of the world's species. At times we fail to recognize the many services which the natural world provides for us, and we act, as the film says, like "creatures living apart from all others." Our actions are currently contributing to a massive loss of biodiversity, a potential crisis that demonstrates that we have lost touch with our natural connections.
The film links human behavior, particularly consumption, with the loss of biodiversity in a number of ecosystems, including Central American rainforests, salmon runs of the Pacific Northwest, tidal zones off the state of Washington, and temperate rainforests. Some of the world's leading ecologists speak both about their primary ecological concerns, and their concern for humans' impacts and thoughtless behavior. The film sends a message that we, as a species, and particularly as Americans, must re-establish contact with the natural world, change our behavior progressively, and rethink our role in relation to other species.

BEFORE AND AFTER VIEWING:

Themes, Activities and Critical Questions

Website There is a website specific to Natural Connections, with a wealth of information, activities, and links to sites that provide more ideas and information. Visit it at http://dnr.metrokc.gov/swd/naturalconnections.htm

Biodiversity The diversity of life on the planet--the benefits that we receive from it and our impact upon it--is the central theme of the film. Read the Biodiversity Primer for a more thorough explanation of issues associated with biodiversity.

- How do we benefit from biodiversity? Is biodiversity important only because we benefit from it? What threatens biodiversity? In the Biodiversity Primer, there is an extended quote by Edward O. Wilson. Explain the statement, "Humanity in a less resilient world is going to be a less secure humanity."

Consumption Tied to the theme of biodiversity is the theme of consumption.

- Do we have more than we need? What is the relationship between consumption and happiness or quality of life? Why does the United States use 25 percent of the world's resources, though it represents only 5 percent of the world's population?

Ecosystem Services Forests reduce the amount of carbon dioxide in the atmosphere and remove pollutants from the air; the rainforests regulate the global atmosphere and temperature; insects and invertebrates recycle decomposing waste and make our soils fertile; healthy ecosystems cleanse water naturally.

- Do we take these services for granted? Are there other services that natural systems perform? What happens when natural systems aren't able to perform these services? Can we put a price tag on these services?

Our role as a species Humans, according to the film, are "creatures living apart." Evolution has given us certain skills and capabilities which other species lack, but we are still dependent upon the natural world.

- What is our relationship to other species? Is it dangerous for us to ignore our natural connections?

Everyday choices Humans have caused a great deal of damage to the environment, but we can reverse this process by making thoughtful, positive choices in our everyday lives. Each one of us can be an agent of positive change, and we can help to bring the abstract concept of biodiversity preservation down to earth with the choices that we make each day.

- What are some things that we can do each day to protect habitat and minimize pollution?

Balance When people do not interfere with natural systems, a balance is achieved among species and natural cycles. This generates strength. Yet the balance is precarious, and humans have made disconcerting changes.

- How is it possible that the natural world is both strong, and fragile? How do human actions affect that situation?

Experiencing the natural world One of the ways in which we can affirm our natural connections is to spend time in natural surroundings. There are hundreds of activities that could be done outdoors, ranging from hands-on ecological studies to individual exploration.

- One possible activity is to pick a relatively natural setting and have students spend ten or fifteen minutes alone, recording observations about the place and their emotions. Then perform the same activity on a busy street or in a mall, and have students share their comparisons.

QUESTIONS RELATED TO *Introduction to Biodiversity*

Key Concepts

Biodiversity – the wide variety of life forms – ensures stability in any ecosystem, large or small.

Because human beings are part of the web of life, loss of biodiversity, due to habitat destruction, is a serious threat to the human species.

Tropical rainforests hold more biodiversity than any other ecosystem. Half of all species on Earth live in tropical rainforests.

Tropical rainforests help regulate global atmosphere, temperature, wind patterns, and rainfall.

Costa Rica is an international leader in identifying and protecting biodiversity.

The almost one million species of insects, particularly ants, play one of the most important roles in the global ecosystem, by

turning the soil, circulating matter, and helping to create plant growth.

Nearly two million species have been identified, but that is only a tiny fraction of existing life forms waiting to be discovered and understood.

Thousands of species are going extinct before we even know what role they play in the biosphere.

Human beings are mammals, one of the smaller groups of life forms on the planet.

Unlike ants and other insects, the activities of human beings often have a negative impact on biodiversity.

The United States makes up less than 5% of the world's population, but consumes over 25% of the world's resources. Ecotourism to the tropical rainforests of Costa Rica produces more income than cutting the trees down.

People are starting to renew their "natural connections" to the earth.

Before Viewing

Define biodiversity. Why is biodiversity important? (See Biodiversity Primer) Are insects important? What do they do?

How do we benefit from/depend upon rainforests?

After Viewing

Go back to the question about insects. Did the film shed new light on their importance? E. O. Wilson says that they are "the little things that run the earth." Explain.

What factors threaten the rainforest? How do our decisions impact those threats?

The film says that "The nature of ants and other insects is to contribute to the maintenance of the earth's ecosystems.

Unfortunately, history shows that human nature often has the opposite effect." Explain this statement. How do ants contribute? What negative impacts do we have? What does that say about our role as a species?

How does our consumption affect biodiversity?

QUESTIONS RELATED TO *The Significance of Salmon*

Key Concepts

Irresponsible human activity is contributing to major losses in the population of many species, including the salmon population of the northwest United States.

Salmon face incredible odds throughout their dramatic life cycle, even without the effects of human activity.

The decreasing number of salmon suggests poor water quality.

People and salmon both need clean water to survive.

The decline of salmon is the sign of an ecosystem out of balance.

Everything is connected over space and time, meaning, by polluting water, humans are not only jeopardizing the lives of salmon, but the lives of humans as well.

Before Viewing

Discuss the life cycle of salmon.

The film is going to deal with the decline of native salmon

After Viewing

Go back to the question of how humans are affecting salmon. What factors does the film list? (poor logging practices, industrial waste, urban and suburban development, runoff from

farms and yards, wasteful water use and climate change) What can we do to help?

Is there an imperiled species in your area? What human actions affect it? How would its loss contribute to a "poverty of the spirit"?

The ecologist in the film, Bob Fuerstenberg, says "Everything is connected over time and space." What does this mean? What are some examples of this concept? Pick two organisms and see if you can find ways in which they are connected, either directly or indirectly.

Bob Fuerstenberg also says that we can get back to a condition of balance and harmony through "a series of small, thoughtful actions." Why is this important? What does it mean? What are some "small, thoughtful actions"?

QUESTIONS RELATED TO *Keystone Species*

Key Concepts

Tidepools are rich in biodiversity.

One scientist, Bob Paine, has spent 30 years doing research, on the small island of Tatoosh, off the coast of Washington.

Bob Paine's discovery of the role of "keystone species" is one of the most significant principles in modern ecology.

Bob Paine discovered that starfish were critically important to the ecosystem of the intertidal zone on Tatoosh. If removed, mussels crowd out most other life forms.

Paine reasoned that in many ecosystems there are certain species, which he called keystone species, that are critically important to the balance of that ecosystem.

The loss of a keystone species dramatically simplifies an ecosystem and alters the diversity of life within it, making it weaker.

Humans are the greatest keystone species. We impact the biodiversity of the world more than any other creature.

The Earth's ecosystems are vital to human survival, and are priceless.

All species have a right to coexist with us on this planet.

Before Viewing

Define intertidal zone. (See glossary) p. 16

How do we assess the value of a species, or of a forest or other ecosystem?

Discuss the concept of ecological disturbance. (See glossary) p. 15

After viewing

Review the concept of keystone species. Which is the keystone species in the starfish/mussels example? In the otters/urchin/kelp example? Keystone species help to maintain ecological balance. What does this say about the importance of preserving species? Why does the film say that we are "the greatest keystone species of all"? What kinds of ways do humans affect ecosystems? Do we need to change our behavior?

In the intertidal zone according to ecologist Bob Paine, there is a "regional balance of species. No one species takes it all." Do humans behave as if they are part of a balance of species? In the intertidal zone, larger species can't withstand winter storm damage. Is there a message for humans?

QUESTIONS RELATED TO *Forests, Biodiversity and You*

Key Concepts

Northwest forester, Jerry Franklin, developed his love for trees at a very early age, and has spent his whole life finding out new information about how forests work.

The forest canopy is where much of the activity that affects life in the forest happens.

*Forests of the Northwest, which naturally eliminate pollutants from the air, are being destroyed rapidly.

Forests can be managed to retain both their productivity and biodiversity.

What humans consume in the way of forest products has a direct impact on the health of forests.

Forests do a tremendous amount of useful work. They take greenhouse gases out the air and store them, protect the soil, and regulate the flow of streams and rivers.

By consuming less, we help forests to retain their biodiversity, and continue to perform their function in nature.

*(A 40% loss in tree cover in just over two decades, in the Puget Sound region, would have eliminated 35 million pounds of pollutants from the air.)

Before Viewing

Why do we log forests? Is logging destructive? Are some kinds of logging more harmful than others?

Why are forests important? How do we benefit from them directly? Define ecosystem services (see Glossary). How do other species benefit from forests?

What is the forest canopy? (See Glossary) What natural processes occur there?

After Viewing

Explain Jerry Franklin's statement that "a dead tree is as important as a living tree."

What changes in logging practices did the film recommend to help preserve biodiversity?

Do we have too much stuff?

Pick a common object, like the paper cup in the film. What went into the production of your object? What raw materials, energy, packing and shipping? How do our choices—to buy something, for example—impact the environment?

Some of the trees in the film are over 500 years old. What did the US look like when they were seedlings?

A forest is a system which recycles everything: nutrients, air, energy, etc. There is no waste. What can we learn from that about our own society? What do the images in the "Too Much Stuff" sequence suggest about our society?
Jerry Franklin says that we should "be humble." What does he mean?

QUESTIONS RELATED TO *Biodiversity vs. Extinction*

Key Concepts

Every species on earth took millions of years to develop.

Edward O. Wilson, one of the world's leading experts on ants, has become known as the "father of biodiversity".

Extinction is a natural process. Species become extinct and new species are "born" through evolution.

Human activity has increased the rate of extinction exponentially; perhaps thousands of times faster than species can be replaced naturally through evolution.

We are in the midst of the sixth major global extinction, the first one <u>not</u> to have been caused by natural disasters like meteorites.

The most important human activities causing the destruction of biodiversity are Habitat destruction, Introduction of exotic species, Pollution, Population growth, and Overconsumption (HIPPO).

Humans are totally dependent on the living world (i.e. air, water, soil, and sunlight), therefore we must protect it for our own survival.

No matter what your religious belief or lack of religious belief is, it is simply wrong to destroy the creation.

Before Viewing

Discuss evolution. How is a new species "born"? Is this a quick process?

List some known species that have gone extinct. Define mass extinction. (See Glossary) p. 16

What factors do you think are exacerbating the loss of species?

After Viewing

What are some problems associated with extinction? (Discuss risk, the importance of genetic diversity, etc. See the Biodiversity Primer for information.) If we lose biodiversity, will our natural systems be more or less resilient?

Discuss the acronym HIPPO (see Glossary or the Biodiversity Primer). How does each letter, or concept, affect biodiversity? How are we each connected to these ideas; what does the acronym suggest that we need to do in order to preserve biodiversity?

A species, according to the film, is a "priceless collection of genetic material." Explain. What does this suggest about extinction? Edward O. Wilson believes that every culture has three forms of wealth: material, cultural and biological. What is biological wealth?
The film says that we should "embrace the earth more as a community to which we belong rather than a commodity belonging to us." Explain this. How do we treat the earth as a commodity? How can we instead embrace it as a community?

Why are introduced species a threat to biodiversity?

Habitat loss is one of the most important causes of extinction. Has there been a loss of habitat in your area in the last ten, twenty or thirty years? Ask parents or older members of the community what the area used to look like.

BIODIVERSITY PRIMER

Biological diversity has become a popular term among environmentalists and an oft-touted goal for governments and NGOs alike, but public understanding of the meaning and importance of biodiversity is low. The basic definition of the phrase is fairly self-explanatory (see Glossary) but it is important to remember that, in addition to diversity among species, the phrase encompasses ecological and genetic diversity.

Millions of years of evolution have resulted in a tremendous variety of life forms—estimates range from 30 to 100 million species on Earth—as well as phenomenal genetic and ecological variety. We depend on all of these forms of diversity. Some of the ways in which we are dependent are quite obvious; we use various species for sources of food, energy, raw materials, and medicines. Other ways are less obvious; we rely on organisms as pest control and for the recycling of natural resources. And it is also important to remember the ways in which we depend on ecological and genetic diversity—unique ecosystems serve important functions in the oxygen, water and carbon cycles as well as myriad subtler roles; genetic diversity makes future evolution, adaptation, and resilience to change conceivable. The "genetic library", which has developed through evolution, functions as an insurance policy against disasters for all species, including humans.

Despite all of the benefits of genetic, species and ecological diversity, there are very real threats at work. The primary foe of biodiversity is extinction, a process that has accelerated frighteningly as humans have expanded their sphere of activity. Estimates of extinction rates vary, but at the most considerable, up to 100 species may be disappearing from the earth each day, many of them species that we never had a chance to know or understand. Their loss is permanent, and with them the unique contributions they made to ecosystems and the genetic information they carried. With each loss, we risk severe consequences.

The causes of extinction at human hands revolve mostly around the destruction and alteration of habitat. Deforestation, desertification and the loss of wetlands are most notable. Also important are poaching, the impacts of pollution, and the introduction of non-native species. These forces threaten the capability of our species and other species to survive. Human population growth and overconsumption aggravate the issues of pollution and habitat loss, making the loss of biodiversity more serious. These threats can be remembered with the acronym "HIPPO": Habitat loss, Introduction of exotic species, Pollution, Population growth, Overconsumption.
There is much that we do not know about the consequences of the loss of biodiversity. Some argue that species loss has caused no major problems thus far. But the longer we heedlessly destroy habitat and threaten the viability of life forms, the greater our risk of serious ecological collapse. We are eating away at life's insurance policy and meddling with the natural balance of the ecosphere.

One cornerstone of biodiversity on the planet is the tropical rainforests, home to a stunning variety of life. A single example of the importance of these ecosystems is the medicines, which use plants from them for raw material. Approximately one fourth of medications rely on these plants for raw materials; if the rain forests continue to disappear, potential cures for life-threatening diseases may be lost.

Another key issue involved with biodiversity is our dependence on a few key food crops. Over time North American agriculture has shunned the diversity of crops available to us, preferring to make intensive use of a few high-yield species. These monocultures are vulnerable to the threat of disease (ecosystems with a variety of species are stable ecosystems—monocultures interfere with natural balance), and we are losing species which could be alternative crops for us. Many of the rice, wheat, and corn species that we depend upon originated in the tropical regions now threatened by a massive loss of biodiversity.

Dr. Edward O. Wilson, considered by many to be the leading champion of biodiversity, comments on extinction, "As those species disappear, you're changing the natural environment of

the world. You're simplifying them, causing them to shrink in their capacity to rebound from stress like drought and burning. You're making the world less flexible, less resilient, as you remove species from it. And humanity in a less resilient world is going to be a less secure humanity."

An ever-growing human population, of people who have an ever-expanding desire for consumption, would be unlikely to be able to preserve biodiversity. The rapid acceleration of extinction that we are currently causing, meanwhile, threatens the stability of our ecosystems and the natural processes upon which we depend. This conflict can only be resolved if we are more considerate of our place in the natural world: if we appreciate the services we derive from nature, if we think about the impacts of our actions, and if we recognize that we, as humans, are only one species among many who live together and depend upon each other here on Earth.

GLOSSARY

biodiversity, biological diversity Diversity of living things; includes not only variation of species on Earth, but also variation of ecosystems and genes

canopy, forest canopy The upper layer of a forest, composed mostly of the leaves and upper branches of the tallest trees. The canopy is the layer that receives the most sunlight.

ecosystem Community of different species interacting with one another and with the chemical and physical factors making up its nonliving environment

ecosystem services, natural services Vital functions carried out by or in ecosystems which sustain life, generally related to the water cycle, nutrient cycles, or cycles of various gases.

ecological disturbance Alterations in an ecosystem caused by forces from outside the system. Ecological disturbance tends to affect the species which are best suited to the area, and consequently there are often implications for succession and the population mix of an area.

extinction The elimination of a species from Earth through the death of the species' last living members.

exotic species, invasive species, non-native species One which is introduced, whether through migration or deliberately or accidentally by humans. These species sometimes do no harm, but may sometimes take over and eliminate native species, upsetting the ecosystem's previous balance.

HIPPO An acronym for the primary threats to biodiversity: Habitat loss, Introduction of exotic species, Pollution, Population growth, and Overconsumption.
indicator species Species that can be used to gauge the health or cleanliness of an ecosystem or area by assessing the population of the species. For example, certain invertebrates are excellent indicators of the health and cleanliness of streams; when they are found in abundance it is a sign that the stream is relatively clean, and when they are not found it suggests that the stream is polluted or otherwise unhealthy.

intertidal zone The area between the mean high tide and low tide lines.

keystone species Species that are considered to have a critical importance in an ecosystem, often because of their role in keeping populations in balance.

mass extinction A period when extinction occurs much more rapidly than the average historical rate, and when there is a pronounced corresponding drop in biodiversity.

salmon runs Migratory routes for salmon to return to spawning grounds

RESOURCES

Books

A Sand County Almanac by Aldo Leopold. Ballantine Books, Inc., 1987.
Biodiversity by Dorothy Hinshaw Patent. Houghton Mifflin Company, 1996.

Consumer's Guide to Effective Environmental Choices by Michael Brower and Warren Leon. Crown Publishing Group, 1999.
The Diversity of Life by Edward O. Wilson. Norton, Ww, 1999.
Gaia: An Atlas of Planet Management edited by Norman Myers. Doubleday and Company Inc., 1992.
Silent Spring by Rachel Carson. Houghton Mifflin Company, 1977.
Stuff, The Secret Lives of Everyday Things by John C. Ryan and Alan Thein Durning. Northwest Environment Watch, 1997.
Use Less Stuff: Environmental Solutions for Who We Really Are by Robert Lilienfeld and William Rathje. Fawcett Book Group, 1998.
Watersheds: A Practical Handbook for Healthy Water by Clive Dobson and Gregor Gilpin Beck. Firefly Books Ltd, 1999.

Organizations and Websites

Natural Connections website
http://dnr.metrokc.gov/swd/naturalconnections.htm
Biodiversity Conservation Network www.bcnet.org
Conservation International www.conservation.org
Envirolink's Endangered Species Act On-line Resource Guide www.envirolink.org
Environmental Education Links on the Net www.eelink.net
Environmental Protection Agency www.epa.gov
Horizons Solutions www.solutions-site.org
King County Department of Natural Resources
dnr.metrokc.gov
National Wildlife Federation www.nwf.org
Salmon Information Center www.salmon.gen.wa.us
Union of Concerned Scientists www.ucsusa.org
National Institute of Biodiversity, Costa Rica (INBio)
www.inbio.ac.cr
The Virtual Library of Ecology and Biodiversity
conbio.rice.edu/vl
National Biological Information Infrastructure
www.nbii.gov/issues/biodiversity
Biodiversity and Conservation, University of California--Irvine darwin.bio.uci.edu/~sustain/bio65/Titlpage.htm
Biodiversity and Biological Collections Web Server
www.biodiversity.uno.edu
Biodiversity Resource Center, California Academy of Sciences www.calacademy.org/research/library/biodiv

RELATED BULLFROG TITLES

Biodiversity: The Variety of Life
Preserving the balance of dynamic ecosystems.

Home Place
Putting the role of human beings in the biosphere back into proper perspective.

Gaia: The Living Planet
A portrait of James Lovelock, originator of the theory that the earth is a living organism.

John Livingston: The Natural History of a Point of View
Naturalist John Livingston questions whether humans are the "chosen species".

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