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PARTNERS IN A PARADISE:

MIGRATORY BIRDS and OUR HABITAT

A Secondary School Curriculum Providing a Focused Introduction to ECOSYSTEM PROTECTION and BIODIVERSITY

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DEDICATION:

To you, the educator who values ecosystems and recognizes their worth, and who cares enough to share this key knowledge with others.

ACKNOWLEDGEMENTS:

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Partners in Flight

PARTNERS IN A PARADISE:

Migratory Birds and Our Habitat curriculum

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INTRODUCTION

The in-depth study of migratory birds may well be a subject you have never even considered teaching or learning before. Whether you are a teacher of biology, geography, political science or social studies, the topic of birds is clearly not an ordinary curriculum component in schools today.

The study of migratory birds can be extraordinary, though, because in addition to its novelty, it has the potential to: 1) provide an interesting and focused introduction to the important topic of biodiversity and ecosystem protection; and 2) meaningfully interrelate a variety of school subjects that are usually packaged separately and taught in isolation.

First, learning about migratory birds provides a focused introduction to the crucially important planetary matters of biodiversity and ecosystem protection, and of sustainable survival for us all.

In addition, a focused examination of 'Neotropical' (meaning New World tropical) migratory birds can link together the fields of:

- biology: including zoology, in studying the birds themselves and their classifications, and techniques of biological observation; and ecology, in learning about the ecosystems in which the birds survive, and recent serious problems in ecosystem protection;

- geography, in exploring patterns of migration of the birds throughout the Americas;

- social studies, in focusing on how various cultures impact the sustainability of bird populations and natural habitats and ecosystems;

- land use planning, and law, civics, economics and political science, in examining how different nations and diverse cultures handle the increasingly important issues of these international birds and of ecosystem protection and biodiversity.

In the timeless words of Aldo Leopold, "It is an irony of history that the great powers should have discovered the unity of nations at Cairo in 1943. The geese of the world have had that notion for a longer time, and each March they stake their lives on its essential truth."[1]

Each of these individual areas, and then the inter-relationship among them that birds create, provides an out-of-the ordinary vehicle for students to approach a meaningful topic in a holistic, in-depth and integrated manner.

For both of these significant reasons, then, the study of those 'ordinary' birds, waiting for you to discover them just outside your window, has truly out-of-the ordinary potential, and offers us all a truly extraordinary opportunity to see and appreciate a paradise around us.

We all can become partners in helping to assure the survival of this paradise around us. Understanding, appreciating and valuing ecosystems and the miracles within them is a key first step in this partnership.

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[1] Leopold, Aldo, A Sand County Almanac, copyright @ 1966 by Oxford University Press, Inc. (page 24).

COURSE GOALS

Next year, then ten years from now . . . twenty years and fifty years into the future, will the students remember this course? Will they have gained anything from it? Will they have an awe, wonder and respect for migratory birds and for the ecosystems that sustain us all? Will they value them, and understand that protection of ecosystems is key to human survival? Will they want to learn more about them?

This is the fundamental goal to think about when organizing the class time.

Some students may not remember the difference between a bluejay and a bluebird. Hopefully, all the students will keep with them their chance to question, to explore and learn more about, and to treasure birds, biodiversity, the natural world and its sustaining ecosystems. But most of all, they will remember you, the teacher. They will remember your interest in migratory birds, in biodiversity, in the environment and humanity's relationship to the natural planetary cycles. They will remember the values you have placed on migratory birds and biodiversity, and your sincere curiosity about, respect for, and valuing of natural habitats and ecosystems.

So, most of all, your genuine appreciation for the beauty and importance of the natural environment, your willingness to question, wonder at, learn about, and value the natural cycles of the world around us all, are fundamental to the success of this course.

Don't shortchange the students and yourself, with dry, predictable lectures. Instead, embark on a journey of wonder, exploration and learning about the natural systems of this earth, that every one of us can, and wants to, continue for the rest of our lives.

A WORD ABOUT BIRDS AND BIODIVERSITY

We are losing 'our' Neotropical migratory birds - - many of which are the colorful and familiar songbirds - - at an alarming rate[2]. We are losing intact natural ecosystems and the present era biodiversity of this planet at a rapid and escalating pace[3]. Human activity is now causing this planet to lose its incredible and fragile ability to sustain human life[4].

Studying migratory birds, then, is not a narrow enterprise. It is a wide opportunity to key into and learn about, and learn from, the natural world around us, and eventually to help learn how to sustain our human civilizations on this planet over the long run.

The hallmark Baltimore oriole, so familiar to us all, but who has actually seen one lately? One source reports that numbers of Baltimore orioles have declined about thirty percent between 1980 and 1990[5]. Or who has recently seen a wood thrush or a rose-breasted grosbeak? These birds are incredibly beautiful, glittering in the spring sunlight and offering their haunting melodies. Their recent steep population declines are communicating something to us, also, if we listen.

What are they telling us?

According to another source, population densities of migratory songbirds in the mid-Atlantic United States dropped 50% from the 1940's to the 1980's, and "many species became locally

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[2] Partners in Flight, First International Migratory Bird Day fact sheet, May 8, 1993.

[3] Wilson, Edward O., The Diversity of Life. Selections from Edward O. Wilson, The Diversity of Life are reprinted with the permission of W.W. Norton & Company, Inc., New York. Copyright @ 1992 by Edward O. Wilson. All rights reserved. This material may not be further reproduced without the written permission of the publisher.

[4] "Reducing Risk: Setting Priorities and Strategies for Environmental Protection", U.S. Environmental Protection Agency, Science Advisory Board Report, 1990.

[5] "Silence of the Songbirds", copyright @ June 1993, National Geographic Society (page 81).

extinct."[6] The recent disappearance of the migratory birds is not keyed to a sole discrete culprit, such as pesticide use, which was the cause of songbird declines several decades ago.

The songbirds are but one relatively easily seen and understood example of the frightening recent decline in the biodiversity of the present era that is threatening, in the end, the ability of people to survive on this planet. Like the classic canary in a mine cage, the demise of the birds may be telling people something we need to know about our own survival. The birds, then, can be a colorful key to learning broader concepts of biodiversity - - which can be described as the present era variety of life and its processes. Studying migratory birds also leads meaningfully into the broad area of ecosystem protection and ecological sustainability for the human population.

The experiences of the students in this class therefore may be bittersweet. Bitter, because the truth is that some of the species the students may see or learn about this year could well be extinct by the time the students become adults. And the learning may be bitter, as well, because unfortunately the truth about the rapid decline of species can be harsh and frightening.

But the class experience can be very sweet, too, as the students begin to see and hear first-hand the beautiful natural habitats and ecosystems right around them, but which they probably never really noticed before. And the students will be learning key concepts about natural ecological systems, and how humans relate to them, that will be their essential tools in a fundamental enterprise: helping to sustain their own long-term survival, and the survival of their own offspring, amid the magnificent natural systems of this planet.

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[6] Wilson, Edward O., The Diversity of Life, p. 256.

APPROACH

This curriculum focuses on the students' own experiences and ideas, and attempts to personalize the topic of migratory birds in a way that will have long-term meaning for each student. The in-depth and integrated study of birds is important, but the overriding goal of the course is to develop in each student a curiosity for, a delight and intrigue in, and a respect for, the topics of migratory birds, biodiversity, and human relationships to natural systems that will last a life-time of independent pursuit.

As such, this course does not require an instructor who is even trained in zoology. A teacher who is willing to explore, listen to and learn along with the students is all that is fundamental. Lectures on the taxonomy and scientific classification of birds are simply not necessary for this course, and frankly would be counter-productive to the overall goal.

What is important is for the teacher to feel secure enough in the essential areas of inquiry to be able to recognize, link and reinforce the main concepts, and to help the students carry on thoughtful and meaningful discussions. Typically, an instructor can do this by becoming familiar with this curriculum package, and by taking the initiative to help obtain materials on particular areas of interest. Of course, any specialized expertise of the instructor can provide an individual enhancement to the course. But since the basic approach is of personalized discovery, it is simply not necessary for the leader to feel obliged to feed a package of facts to the students.

When I led this course with a group of seventh and eighth graders, I asked them in the beginning who would be teaching the course. After they pointed at me, then they suggested every member of the school faculty and still I shook my head 'no', they had no more ideas. When I called each one of their own names, and identified them as teachers of each other, they weren't sure how to react; they looked at each other in a new and unfamiliar light. But throughout the course, each student was entitled to respect as a teacher of the others, and each person's ideas were listened to and accorded importance. It was a journey of teaching, learning and respect, for all of us together.

It was the birds themselves, though, that taught us the most. This is a key part of the educational experience. Just as 'teachers' can learn from 'students', humans have a great deal to learn by carefully listening to and valuing the natural world around us.

Thus, a key to one crucial awakening of the course itself - - that humanity has an immense journey of learning in front of us, if people would only open our eyes, ears and minds to the natural world around us - - can be first introduced by redefining traditional roles of the 'teacher' and the 'students'.

Welcome, to a challenging and rewarding journey of discovery and wonder, for all.

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"A March morning is only as drab as he who walks in it without a glance skyward, ear cocked for geese. I once knew an educated lady, banded by Phi Beta Kappa, who told me that she had never heard or seen the geese that twice a year proclaim the revolving seasons to her well-insulated roof. Is education possibly a process of trading awareness for things of lesser worth? The goose who trades his is soon a pile of feathers".

Aldo Leopold, A Sand County Almanac, copyright @ 1966 Oxford University Press, Inc.

"The edifice of civilization has become astonishingly complex, but as it grows ever more elaborate, we feel increasingly distant from our roots in the earth. In one sense, civilization itself has been on a journey from its foundations in the world of nature to an ever more contrived, controlled, and manufactured world of our own imitative and sometimes arrogant design. And in my view, the price has been high. At some point during this journey we lost our feeling of connectedness to the rest of nature.

. . . The ecological perspective begins with a view of the whole, an understanding of how the various parts of nature interact in patterns that tend toward balance and persist over time. But this perspective cannot treat the earth as something separate from human civilization; we are part of the whole too, and looking at it ultimately means also looking at ourselves . . ."

excerpt from Earth in the Balance, by Al Gore. Copyright @ 1992 by Senator Al Gore. Reprinted by permission of Houghton Mifflin Company. All rights reserved.

OVERVIEW

This curriculum is organized into several broad, sequenced segment areas: A) The Wonder of Birds, Migration and Survival in Natural Ecosystems; B) Flight to New World Habitats; C) Discovering Birds First-Hand; and D) Problems and Partnership in Biodiversity. Classes are provided in sequenced topics within each of the segment areas.

The curriculum provides numerous focused classes on migratory birds and our environment. Of course, given the breadth of this subject, it is not possible for the students to examine and consider every topic area in depth. Accordingly, this curriculum provides a compass and a road map of the major route to follow in getting to the destination. A number of the rewarding side roads and key landmarks of this journey of learning are not set out in depth in this curriculum, but are identified for the students and teacher to explore more fully, perhaps drawing upon traditional texts and source materials that are already in use by the class for areas such as political science and sociology. In those instances, this curriculum identifies these related topics as a "Link" to the general topic area, and the teacher is alerted that these classes and subjects can be integrated with the otherwise available curriculum materials on that specific topic.

The teacher can go up as many side trails as desired in this journey of exploration, but keep in mind that it may not be a complete and rewarding learning experience for the students if a side trail is explored in such depth and length such that there isn't enough time to reach the destination at the end of the main trail, or if you have to hurry quickly up the rest of the trail and won't get a chance to carefully explore the important attractions on the latter half of the trail.

Nevertheless, in deciding whether to indulge a class's interest in learning about a particular aspect in greater depth than is scheduled for the classes of this curriculum, the teacher should keep the basic Course Goals in mind. Reaching the end of this curriculum and superficially "covering" the material and information may not achieve the "Course Goals" for your group.

Thus, the teacher will need to use the "Course Goals", specified above, as a guiding light in deciding whether to adjust the schedule to accommodate the interests of a particular group of students.

Because of the need to schedule field observations (Segment C) according to the best time for your area, the course leader will need to plan around this, and adjust the timing of the other segments, as necessary. See "Field Trips: Logistics", below.

Segment A) The Wonder of Birds, Migration and Survival in Natural Ecosystems

(Classes #1 - 3)

Initially, the curriculum challenges the students to focus on the life and journeys of the birds that are right outside their window, that the students have likely not even thought much about before. In this way, the students are awakened to look at the world around them in a new and unexpected light. These are things they have taken for granted, and probably have not really noticed nor appreciated before.

The life of migratory birds is incredible and astonishing, and all the more so when related to the students' own experiences in travelling (Class #1). Bringing concepts down to a personal level can be a way of thinking about how extraordinary the survival of migratory birds is, that students will find hard to forget. It can be a key eye-opener to the natural world around us.

Bring out quarters, one for each student, and flip them to feel the weight of one migratory bird, the blackpoll warbler, which migrates thousands of miles, each way, without a suitcase.

Class #2 continues to focus on the students' own personal view of birds, and begins to develop their individual appreciation of the diversity and wonder of migratory birds. The 'Personal Survey' that is presented in this class can be repeated near the end of the course (Class #22). A comparison between the two surveys can show each student one individual measure of how much their own general understanding of the topic has expanded through the course.

Class #3 is designed to help focus students on some of the mysteries and miracles of migration, and survival of birds throughout their journeys.

Segment B) Flight to New World Habitats

(Classes #4 - 9)

Class #4 is set up to be an immersion into the South American rainforest. The lush rainforest is looked at as a total habitat, of which birds are an important piece. The rich and colorful beauty of the rainforest is a treasure to explore, even in second-hand pictures. It leads into a mystery to which no-one really knows the complete answer . . . why would birds ever leave that warm paradise, to come to North America? These and similar questions are posed and considered in Class #5.

These questions stand on their head conventional teaching that the birds are really North American residents that just go south temporarily in the cold winter to 'vacation'. If looked at from another viewpoint, that the birds are really South American habitants, we can begin to honor and appreciate the colorful and melodious gifts the birds bring to North America every spring by leaving behind their lush rainforest homes and making incredible journeys to the United States and Canada.

Appreciating the magnitude, length and difference of these journeys, and locating the islands, continents and political countries along the way is the focus of Classes #5, 6 and 7. This segment of the course can be expanded for an in-depth focus and investigation of these countries, if the instructor desires. In addition to opportunities to discuss and investigate the political and social conditions in the various countries, it is an excellent opportunity to focus on comparative land use and sociological patterns, examining which types of land use and culture provide habitat in which the birds, and other wildlife, can survive and biodiversity can flourish.

The key work of ornithologist Frederick C. Lincoln provides the important migratory charts which are fundamental to this portion of the course.

The students' own interests can provide the basis for an in-depth examination of particular habitats along the migratory routes. A student who has been to the Gulf Coast or to Florida can be invited to prepare and share personal observations about these habitats, and the current challenges and opportunities these habitats pose to survival of migratory birds. In addition, students can research a particular geographic area and present their own conclusions about how a migratory bird would fare there.

During the spring, the birds' progress to their summer North

American habitat and ecosystems can be anticipated and traced by the students. Students can be introduced to the concept of isochronal charts (Class #3). Local news and newspaper reports can be monitored for the sighting of 'the first robin' and for Neotropical migrants.

Classes #8 and 9 are designed to give students appreciation and understanding about how scientists have figured out how and when bird migration happens, and how the students themselves are capable of doing basic scientific work.

Segment C) Discovering Birds First-Hand

(Classes #10 - 16)

Enhanced observation skills, featured in Classes #10 and 11, will make the students' eventual field observations more meaningful. One classroom period, Class #11, is devoted to the sheer discovery and exploration of an avian field guide. The students are encouraged simply to discover for themselves the astonishing diversity of birds. For the class I 'led', this otherwise unstructured hour proved to be a fascinating journey of personal discovery. The students had never before had the opportunity to explore and examine page after page of pictures and information about colorful, different and diverse birds. A few questions can be prompted here, if necessary, but for the most part the students will remember favorably this experience of discovery far longer than they would any lecture on the taxonomy of birds.

At some point, either in this class period, if there is time, or at a resting spot during a field trip, it is very helpful to focus the students into the organization of a field guide for birds . . . the related avian families, the index and the migratory charts. These are not for purposes of memorization, but for aid in finding out about the particular bird, and how it relates to the themes of the course.

Another important activity is to play pre-recorded tapes of bird songs. I have found this best to schedule flexibly, among the field trips, because with the unpredictable spring weather, one trip at least, inevitably, will need to be postponed. Listening to tapes of bird songs is some solace to students who are disappointed at missing a refreshing spring walk. And listening to tapes of bird songs is surprisingly uplifting and

intriguing . . . bird songs can be charted on the blackboard and help provide students with a new dimension and expertise in natural observation. This activity is scheduled for Class #14, among the field trips.

The 'field trips' to actually observe birds out of doors, in natural habitats, should be scheduled for the most appropriate times for your area. Although some birds can be found virtually anywhere, it may be helpful to select nearby spots where a variety of birds may be observed, to reward and challenge the beginning observer. However, the behavior of even one common pigeon, starling or crow can provide interesting material for the beginning bird-watcher, and can help students to notice the natural world around them that they have not looked at closely before, even though the observations may not be of a migratory bird.

Field trips are included in this curriculum as Classes #12, 13, 15 and 16. See "Field Trips: Materials and Logistics", below, for comprehensive information on scheduling field trips.

Segment D) Problems and Partnership in Biodiversity

(Classes #17 - 21)

This segment provokes students to think about broader issues concerning birds as important populations in the earth's natural systems, and to realize that migratory birds raise crucial issues at the local, national and international levels, particularly regarding ecosystem protection. The final classes of the course are designed to be upbeat, focusing students on the existing tools humans have to protect migratory birds and biodiversity, and how the students can use these tools effectively.

Class #17 centers on discussion of two eye-opening articles about the serious declines in migratory bird populations. The articles will need to be assigned as homework reading previous to this class.

In Class #18, the focus expands to the general and extensive problem of loss of natural ecosystems and biodiversity. The decline in bird populations is an indicator of this problem. Some of the recommended reading material for this class contains scientific terms with which the students may be unfamiliar. For this reason, a number of these terms are assigned as a homework

learning assignment during the earlier field trip classes. Obviously, the ideal situation would be for the students to be solidly familiar with these biological concepts. But such instruction is beyond the scope of this course, and it is not essential for understanding the key covered points from these articles. Some familiarity with the terms, however, will enable the students to read through the assigned passages without becoming bewildered.

Conversely, the realization that learning what these terms mean can be keys to an in-depth understanding of broader biodiversity concepts and issues. The experience may reveal to the students the importance of studying these otherwise remote and foreign terms, as the students participate in more basic biology courses as they continue their school careers.

Class #19 can be a continuation of discussion of biodiversity issues, and it also introduces new reading materials and concepts. "Land use" is the central theme.

Class #20 centers on an introduction of significant, existing tools we have to protect birds and biodiversity, including the Endangered Species Act. Students are encouraged to actually examine provisions of this laws, and to read an interpretive article on the Endangered Species Act, which includes a detailed discussion of the survival of one songbird species.

In Class #21, the focus shifts from the national and international, down to the local level. Newspaper articles dealing with issues in the students' own community are the source materials here. The crucial message is to have students see how broad national and international issues are played out at the community level, and conversely, how community issues on biodiversity are impacted by the umbrella national laws and policies studied in Class #19.

Because it can vary so much from state to state, no specific source materials have been identified in this curriculum for state policies, laws and initiatives dealing with migratory birds and biodiversity. However, this is an important area for the leader or the class to look into, obtain materials on, and weave into the discussions for either Class #19, #20 or #21. States are important players in this area. Even the lack of any laws and policies in your state dealing with protection of migratory birds, biodiversity or encouraging preservation of natural habitat areas is important to find out about. The Partners in Flight newsletters (see Preparation, Section V, below) contain helpful information identifying migratory bird conservation contact people for many states. Be sure you write to them well before the course begins to be placed on their mailing list.

Depending on the group of students you have, the topics covered in this Segment could be discussed and explored in greater depth, and at greater length than provided in this curriculum. You might consider this possibility when scheduling your course.

Course Conclusion and Challenge

Finally, Class #22 is scheduled to be a repeat of the 'Personal Survey' given in Class #2. It can be a good concluding class to remind students of the path they have taken in learning about the importance of migratory birds and biodiversity.

Hopefully, students' interest in the subject of birds and biodiversity, and ecosystem protection will continue beyond this course. You might consider preparing suggestions for their further reading, and appropriate periodicals to which they might want to subscribe, or to look for in the library when they can. A few are suggested in Resource Information, Section V, above.

Students are embarking on the journey of their lives. Be sure the students leave the class with their bird-watching 'life lists', which they may want to continue adding to, on their own, throughout their life-journeys. Challenge students to notice the birds, no matter where they may be.

Bring out a quarter, as was done in Class #1, and encourage students to think about the amazing wonder of migratory bird journeys and survival, and the survival of us all, because of the richness of biodiversity and natural ecosystems, with every quarter they use.

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GENERAL PREPARATION, MATERIALS AND LOGISTICS

Inspired by the prospect of teaching my first class on the migratory birds of the Americas, one of my first organizing tasks was to set off on a purposeful outing downtown, to the center of a major North American city, to a major map makers store. I wanted to get several copies of a tool I deemed essential for the class . . . a large map of just the Americas - - North, South, Central and the Caribbean - - depicted in relationship and connection with each other.

I could not find such a map.

My fascination with the chance to browse leisurely through the map store and to explore the various maps of the world became mingled with increasing embarrassment as I, a college major in Latin American studies, could not locate anything that even resembled the Americas map that I wanted for the class. The salesman then helpfully and carefully searched the store racks for me. Finally, he said to me authoritatively that, given the Earth's contours, it was impossible to make such a map of just the Americas.

Failing in my very first attempt to organize a fundamental piece of this course on American wildlife, I stared at the salesman in astonished disbelief.

The lack of a map of the Americas could have been seen as a serious obstacle to this course. Instead, it opened my eyes as to the potential importance of a curriculum that focuses on the natural links and connections between South, Central and North America that sustain us all. In a world where global understanding is becoming increasingly essential, the unsuccessful map search incident starkly showed me that there is a real need to focus on the basics of the relationships among the Americas, our peoples, and the mutual ecosystems that help sustain us. It is a challenge to us all.

Almost fifty years ago writer Aldo Leopold, observed in Wisconsin that " . . . on cool August nights you can hear whistled signals [of the upland plovers] as they set wing for the pampas [of Argentina], to prove again the age-old unity of the Americas. Hemisphere solidarity is new among statesmen, but not among the feathered navies of the sky."[1]

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[1] Leopold, Aldo, A Sand County Almanac, Oxford University Press, Inc., 1949.

Let's not waste the next fifty years in discovering the connection of these ecosystems.

Let's not waste the next fifty weeks.

This curriculum can help chart the territory of the Americas and the common natural systems that have been sustaining us all this time. But in making this journey, the teacher and the students will need to be resourceful.

Don't be discouraged if you have to help map part of the territory. The teacher should identify needed classroom materials early on, ideally well before the course actually starts, so there will be sufficient time to obtain all the needed materials, and to improvise if important materials cannot be located. An ample list of possible source items is presented in the following sections, that can give a solid start to any course of this topic. There is plenty to go on, and our perseverance and creativity can lead us the rest of the way.

I finally did locate a connected map of just the Americas, with an excellent depiction of migratory routes, published by National Geographic. The map is still available for purchase (see Maps, III, below).

I) General Course Scheduling and Logistics

This course is designed for the middle or high school level.

The curriculum is designed for a spring semester of once a week class meetings of approximately an hour in length. It can easily be adapted, however, for other structures such as more frequent meetings, or longer class periods, either covering several classes at once, or covering material for a particular class in greater depth. It could even be structured as a one-week intensive course.

Or, it could be expanded as a once a week course to meet over an entire school year. In that event, field trips could be added and scheduled to observe the interesting fall migrations of geese, hawks and other birds of prey. Even teenagers are awed by these impressive large birds.

Other curricula are available dealing with the migratory bird topic in a different manner, such as adding isolated topics on birds to already

existing standard school subjects. If the approach or structure set forth in this curriculum doesn't work for your school, try something else, but don't give up on this important topic.

When trying out this curriculum, I led a group of approximately ten students. This was an excellent group number. You may not have the choice but to work with a larger group. The in-school activities should work fine, but organizing and supervising the field trips will be more complicated.

II) Field Trip Materials and Logistics

A) Materials

1) Field guides

Ideally, each student should have their own field guide to birds. A reputable source, such as North American Birds, (Peterson, 4th ed.), costs about $16. Students and their families could be asked to pay for this directly, or other funding sources could be considered, such as community sponsors, an allowance from a parent-teachers association, or a fund-raiser.

The course will still work fine if students share the field guides in pairs.

2) Binoculars

Binoculars or field glasses are very expensive, well beyond modest course fees, fund raising or stipends. If needed, an acceptable course can be taught without them at all. So don't give up on leading a migratory birds course because you or your students don't have binoculars.

In one of the first classes, you can ask each of the students if they or their family has binoculars that they will be able to use for the

field trips. Be sure students do not bring expensive or special binoculars to school, unless your school has the ability to assure the safety of this expensive equipment.

With the several old or inexpensive pairs the students are likely to have, along with your pair or two, and an old extra that an assistant leader or field trip guide may have, there will be enough for everyone to have a chance to see the birds close-up. The resourcefulness of the students and other school personnel interested in bird-watching should not be underestimated. In the class I led, one of the students arranged to borrow a nice pair of binoculars from the school janitor, who kindly unlocked the glasses from his supply closet each week before the field trips.

3) Life lists

The students will be intrigued by the idea that they can begin recording a list of all the birds that they see, a 'life list', their own personal list of all the birds they see throughout their life. And when they first start bird-watching is the best time to start a life list. Call a local nature center in your area for free copies of a checklist of the birds students are likely to see in the area, that can be used as a first life-list record. Each student will need their own copy.

B) Logistics

1) Trip scheduling

Decide how many trips you want to include in your course, and find out the time you will have available for them. In my course, I planned for four trips, each to take a double class period. Even though the trip locations were all within a mile of the school, there just wasn't enough time in one standard 50-minute class period to get to the trip destination, get oriented and organized, to carefully explore the area for wildlife, and then to return in time for the next class period. The double-period solution worked well.

Four trips was a good number, because it allowed flexibility in the event of bad weather, and it

provided opportunity for important reinforcement of identification of birds observed and ideas learned, from one trip to the next.

2) Trip timing

Discuss with an experienced local bird-watcher the best time during the spring to observe migratory birds in your locality. In the Mid-Atlantic area, for example, trips are best scheduled for after the weather gets warm, but before the leaves come out on the trees.

Trips are ideally scheduled for as early in the morning as feasible, given your school schedule. That is when the birds are actively feeding and singing.

3) Trip locations

The destinations of your field trips will of course be determined by your locality. But be sure to look beyond the obvious. Birds can be observed in urban areas, where there are nearby natural areas that might be inhabited by an interesting and rewarding array of birds. A small park close by may offer opportunities to observe in-depth the behavior of common crows, pigeons or starlings in a new light. Also, don't overlook the zoo as a field trip location. But, be sure you focus on the birds. The zoo may even offer speakers on birds or bird walk leaders.

In contrast, a rural or suburban area presents different challenges to successful field trips. The most well-known areas may have steep entrance fees or leaders who, although bird experts, don't relate well to the students. Aim for areas and leaders that will relate to and interest your students.

Be sure, if you are going to an area that is not a public area, that you have made appropriate arrangements with the property owners to visit their property.

Also, keep in mind that nearby areas may be best to visit on your trips, because students will be able to go back to them themselves, well after your course is over. The field trips can serve as an important introduction of students to nearby natural area locations that they will be interested in returning to, to observe wildlife, and can easily go back to themselves or with their families.

4) Trip preparation

Be sure your transportation is confirmed and the directions to the destination are completely clear. Know how long it will take to get there. Signed standard school permission slips are essential, of course. Confirm with the students exactly when and where to meet.

Advise the students as to appropriate field attire. In many areas, protection against ticks and Lyme disease are very important. Advise students to wear long pants, long-sleeved shirts and head coverings, all of a light color. Follow advisories issued for deer ticks and other local problems, including staying away from areas that deer go to, and keeping on established paths.

5) Trip leaders

You may want to ask experienced bird-watchers from the community to help you lead a trip. Many people have a wealth of bird-watching knowledge and experience, gained over a life-time, that they are very gracious to share. This is an invaluable human resource, that is important for students to recognize. The knowledge of experienced birders is impressive, and it provides inspiration for the beginning student that it is possible to become expert in this subject.

It is your job as teacher/coordinator to screen potential speakers and leaders to find those who are genuinely interested in working with students, and who relate well to them. A highly experienced leader who is not interested in the students or who does not relate well to them is not a good use of anyone's time.

In any event, try to have enough adults to accompany you so that you have a 1:4 or 1:5 students ratio. The assistants need not be birding experts. If they are responsible, and familiar with how to approach using binoculars and field guides, and if they are enthusiastic, that is all that is needed.

The best field trip my class had was on a cold, misty day that indeed did deteriorate into intermittent drizzle, and the nature center leader was stuck out in the woods with another group. Confined to the porch of a small log cabin, this became our special observation deck, as the students were encouraged to discover for themselves, and themselves find in their field guides about, the colorful variety of birds that ventured, with songs that warmed us, into the small natural area clearing.

6) Trip protocol

It should go without saying that in no event should bird observers harrass or disturb the birds that are being observed. Intentional malicious acts are clearly inappropriate. Over and above that, be aware that even well-meaning activities are inappropriate, such as disturbing a nest, eggs or young birds. In some cases, these activities are even illegal. Demonstrate to the students that they can learn a great deal by observing, and by not interfering with the activities of the birds.

III) Maps

In this course, the purpose of maps is not to tack impressively on a wall and point at with a distancing instrument.

Buy a few cheap world maps (they cost about $3 apiece in general bookstores or paper supply stores) so they can be marked up, breathed over, explored, and understood. Be sure to bring one or more to each class. The world maps can be used to show all the Americas in relationship to one another.

Additionally, a large map of the Americas, with the reverse side featuring a superb depiction of dozens of migratory routes, is still available from National Geographic. The map can be ordered for $2.65 by calling 1-800-638-4077. The purchase includes the National Geographic volume associated with the map. Ask for Vol. 156, No. 2, August 1979.

See Classes #5 - 9 for how the maps can be used.

Maps are indispensable. Use them as much as possible.

IV) Recorded Tapes of Bird Songs

For Class #14 (Listening to, and Hearing, Biodiversity), you will need a pre-recorded tape of bird songs. These are generally available at nature center stores and museum stores, or you may find them or be able to order them from a local bookstore. What you are looking for is a cassette tape containing about twenty segments of recorded songs and calls of individual, identified birds. Look for a tape that features birds found in your area. These tapes generally come in a package that contains a booklet identifying the birds featured on the tape. The booklet will be useful for the teacher in preparing the class, and it is not necessary to distribute to the students.

These tapes typically run in the $10 to $20 range.

If you are unable to find a source in your area, the Cornell Laboratory of Ornithology (address in (V)(D), below) is one possible source from which you could order a tape.

V) Resource Information on Migratory Birds

There is ample information currently available on migratory birds and their current plight for an introductory course. Below is a list of helpful possible sources, and sources of further information. If you are considering obtaining any of these, it is a good idea to try to get them *before the course begins.* Or, if they are to be used as specialized student research materials, allow enough time for the students to obtain them.

This curriculum does not recommend or require use or reading of any of the identified possible sources. Rather, it is left up to the course instructor to choose and decide on appropriate source material. The sources identified below are provided as possibilities solely for the convenience of the instructor.

There are an increasing amount of publications on ecosystem protection, biodiversity issues, and about migratory birds, and it is simply not possible to include them all in an introductory course. The teacher is cautioned against trying to include too much, and overwhelm the students. This course curriculum schedule is designed to focus on particular aspects of this large topic, so that the issues are presented in an interesting and integrated progression.

The teacher can always recommend other materials for the supplementary reading of interested students.

A) General periodicals

American Birds magazine

American Birding Association (quarterly newsletter aimed at middle school students; $5.00/year. Also various other educational materials. Student memberships are available at $18.00/year.)
Write to:

American Birding Association
P.O. Box 6599
Colorado Springs, CO 80934-6599

(tel. 719-578-9703)

Audubon magazine

Bioscience magazine

National Geographic magazine

Nature Conservancy magazine

Partners in Flight newsletter

(write to: Peter Stangel
National Fish and Wildlife Foundation
1120 Connecticut Avenue, NW
Suite 900 Bender Bldg.
Washington, D.C. 20036

- - in order to be put on the Partners in Flight mailing list)

B) Books

Griffin, Donald R., Bird Migration, Dover Publications, Inc., New York, 1974.

Lincoln, Frederick C., The Migration of American Birds, Doubleday, Doran & Co., NY, 1939 (ill. Louis Agassiz Fuertes).

Mead, Chris, Bird Migration, Facts on File Publications, 1983.

Wilson, Edward O., The Diversity of Life, W.W. Norton & Company, Inc., 1992.

This recent book also contains reference to other source materials on birds and biodiversity, including:

Forsyth, Adrian, Portraits of the Rainforest, (Ontario: Camden House, Camden East, 1990);

"The Last American Parakeet", Doreen Buscami, Natural History, 87(4):10-12 (1978);

"Where Have All the Birds Gone?" Essays on the Biology and Conservation of Birds that Migrate to the American Tropics, (Princeton University Press, 1989);

David S. Wilcove and J.W. Terborgh, "Patterns of Population Decline in Birds,"American Birds, 38(1):10-13 (1984);

The Last Rain Forest: A World Conservation Atlas, Oxford University Press, 1990. (Described by Edward O. Wilson as a "beautifully illustrated book . . . the best popular reference work of its kind");

Wilson, E.O. and F.M. Peter, eds., Biodiversity, National Academy Press, 1988;

Philip A. Fearnside, "Extractive Reserves in Brazilian Amazonia," Bioscience, 39(6):387-393 (1989);

Leonard Berry et al.,Technologies to Sustain Tropical Forest Resources, (Office of Technology Assessment, U.S. Congress, 1984).

C) **Other Written Sources**

Birds in the Balance, Action Packet, National Audubon Society, 666 Pennsylvania Ave, SE, Washington DC 20003 (two dollars).

Boyle, Robert H., "The Killing Fields", Sports Illustrated, March 22, 1993 (Reports that "toxic drainwater from irrigated farmland in California and other Western states has created an environmental calamity")

Gulf of Mexico Program
Department of Interior
U.S. Fish & Wildlife Service
Building 1103 - Room 202
Stennis Space Center, MS 39529

(various publications)

Lincoln, Frederick C., Migration of Birds, circular 16, U.S. Dept. of Interior Fish & Wildlife Service (original edition 1950; updated edition 1979).

Habitat Establishment, Enhancement and Management for Forest and Grassland Birds in Illinois, J.R. Herkert, R.E. Szafoni, V.M. Kleen, J.E. Schwegman. A comprehensive guide for private landowners. Free. (IL DOC, Division of Natural Heritage, 524 S. 2nd Street, Springfield, IL 62701, tel. 217-785-8774).

"Migratory Songbird Conservation" informational brochure on Partners in Flight and how you can help. Free. (Catrina Martin, USFWS, OMBM, 1849 C Street, ms 634 ArlSq, Washington, DC 20240, tel. 703-358-1821). 20036

Schneider, K.J. and D.M. Pence, eds., Migratory Nongame Birds of Management Concern in the Northeast, U.S. Department of the Interior, Fish & Wildlife Service, 1992 (Region 5, Newton Corner, Massachusetts 02158).

Status and Management of Neotropical Migratory Birds, eds. D.M. Finch and P.W. Stangel. Symposium Proceedings from the Estes Park National Training Workshop held September 1992. Free. USFS Rocky Mt. Forest and Range Expt. Station, Publication Division, Craddock Bldg., 3825

Mulberry, Ft. Collins, CO 80524-8597.

"U.S. Fish and Wildlife Service Cooperative Programs with Mexico", a 32-page report describing cooperative efforts for conservation of migratory birds, endangered species, wetlands, and law enforcement and training. Compiled by Doug Ryan, International Affairs- FWS. Free. USFWS Publication Unit, 130 Webb Bldg., 4401 N. Fairfax Drive, Arlington, VA 22203.

Wetlands: A Celebration of Life. Final report for two-year study of the current status of Canadian wetlands. Single copies of this 67-page report are available free. ("Wetlands Publication", North Aermican Wetlands Conservation Council, Suite 200, 1750 Courtwood Crescent, Ottawa, Ontario, Canada K2C 2B5, tel. 613-228-2601).

"Will We Lose Our Songbirds" full-color brochure providing general information on Partners in Flight. Free. Contact: "Songbird Brochure," National Fish and Wildlife Foundation, 1120 Connecticut Ave., NW, Suite 900, Washington, DC 20036 20240, tel. 202-857-0166.

D) Audio-Visual Materials

"Birds of Two Worlds - Tropical birds of the Midwest" poster. Free. (Brad Jacobs, MO DOC, Box 180, Jefferson City, MO 65102, tel. 314-751-4115).

"Out of the Blue" video. Ten and a half minutes describing the annual spring migration of songbirds along the upper Texas coast. $10.83 (TX residents add 8.25% tax). Also available is the 45-minute "Birding Texas" video, which includes the "Out of the Blue" segment. $15 (plus tax for Texas). Contact: susie Gonzalez, TPWD, 4200 Smith School Road, Austin, TX 78744, tel. 512-389-4994.

Partners in Flight Slide Show. 13 minutes, with accompanying cassette tape and text depicting the plight of neotropical migratory birds and what PIF is doing to help. $53.95 (includes S&H). Contact: Meg Ghallagher, Cornell Lab of Ornithology, 159 Sapsucker Woods Road, Ithaca, NY 14850, tel. 607-254-2440.

Note: the Cornell Laboratory of Ornithology is a valuable source for ordering books, videos and other study aids on migratory birds. Write or call them for a brochure.

"Songbirds of forest and field" full-color poster featuring 11 neotropical migratory songbirds by Louis Agassiz Fuertes, $6.50, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325, tel. 202-783-3238. Please reference stock #024-010-00699-4.

E) Contacts for Further Current and Local Information

Your state may have local information on migratory birds and resource protection issues. There are sepcialized educational programs on migratory birds in several states. For example, contact:

Wisconsin:

One Bird - Two Habitats
DNR Research Center
1350 Femrite Drive
Monona, WI 53716

New Jersey:

The New Jersey Conservation Foundation
300 Mendham Road
Morristown, NJ 07960

(tel. 201-539-7540)

The Partners in Flight newsletter also contains information on migratory bird contacts in many states.

F) Further General Reading for Interested Students

Gore, Al, Earth in the Balance, Penguin Group, 1992.

Leopold, Aldo, A Sand County Almanac, Oxford University Press, Inc. 1949.

Wilson, Edward O., The Diversity of Life, W.W. Norton & Company, Inc., New York, 1992.

RETURN FORM FOR COMMENTS AND SUGGESTIONS

Your comments, suggestions, ideas and experiences in helping students learn about migratory birds and biodiversity are important. Please take a few moments to share them. Your ideas will be considered in revising and updating the curriculum. Thank you.

Please return this comment sheet to:

Heather Gray Torres (3RC21)
U.S. Environmental Protection Agency
841 Chestnut Building
Philadelphia, PA 19107

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COMMENTS:

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Please use other side or attach additional sheets as needed. If possible, include your comments on what were the most helpful parts of this curriculum, and those parts that you found the least useful. Thank you!

Your name: _____
Address: _____
_____
Phone #: _____

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SEGMENT A
THE WONDER OF BIRDS, MIGRATION AND SURVIVAL IN NATURAL ECOSYSTEMS

Class #1
The Miracle of Migration and Survival in Natural Ecosystems

****

OBJECTIVE: Awaken curiosity about, and wonder at, the amazing miracle of bird migration.

THEME: Long distance journeys pose difficult challenges to meeting basic needs such as food, water, clothing and shelter, and finding your way, for people and the birds.

CLASS ACTIVITIES:

I. Identify how people obtain basic necessities while travelling:

A. On a map, locate long-distance locations to which each of the students in the class have travelled.

B. Ask the class members to identify what they took with them on their trip in order to stay warm, protect themselves from the weather, have a place to sleep, have enough to eat and to drink. Record this list on the blackboard, overhead projector, or a large flip-chart pad (a permanent list may be advantageous for future reference).

In addition to obvious items, encourage the students to think about less obvious articles, such as:

- maps (to know where they were going)

- compass (to know direction they were going in)

- water (they probably took this for granted)

- food (if they didn't carry it all, they needed to bring money to buy it)

If a class member went hiking or on a camping trip, this experience may warrant detailed discussion of how difficult it was to obtain basic necessities for survival and comforts that they may take for granted around their home.

Encourage class members to identify other unique complications or problems that they faced in travelling away from their home.

C. Open up a pre-packed suitcase or backpack (see "Preparation", below) and identify each item that you have packed for a long trip, and the purpose of the item. You can run quickly through items that the class has already identified in (B), above, and dwell on those they hadn't thought of.

Another approach, quite a bit more dramatic, is to begin the class by making an entrance with the suitcase or backpack, and go through the contents before doing the exercise in (B), above.

D. Illustrate how heavy the suitcase it, and how it holds only a small portion of the travel items the class identified, and how it holds only enough food and shelter materials for a very short journey.

II. Identify basic facts about migratory bird journeys:

A. Ask students to take out a quarter; hand out quarters to each student who doesn't have one. (Expect the students to toss and flip their quarters.)

B. Hand out a copy of the Blackpoll warbler page (see "Handouts", below) to each student.

C. Focus attention on the over 2,000 mile journey of this quarter-weight bird, which doesn't carry any suitcase or backpack, but which finds ways to survive.

D. Ask the class to think about how the bird survives and how the bird gets basic necessities such as water, food, shelter and warmth, without bringing anything with it, or carrying a suitcase. Explain that these are the kind of questions we will try to explore in this course.

E. Suggest that, each time they handle a quarter, the students think about the amazing journey of the blackpoll warbler and other migratory birds.

III. Course introduction:

Explain to the students that this will be a course on migratory birds, and they will learn about birds and the environment. Explain other general course information, including that this subject area can link together a number of topics, including science, sociology, geography and political science.

PREPARATION:

A. Pack suitcase;

B. Obtain quarters for each student;

C. Copy blackpoll warbler page for each student.

RESOURCES NEEDED:

A. Suitcase or backpack, packed with various items representative of survival necessities while on travel, such as the following:

LIST OF SUITCASE ITEMS

- sweater
- warm jacket
- hat
- gloves
- change of clothes
- shirts (warm, and warm-weather)
- shorts
- pants
- dress clothes (for dinner!)
- alarm clock
- toothbrush
- wash cloth
- pillow (if room for it)
- shoes
- boots
- sandals (for warm weather)
- sunscreen
- sunglasses
- pajamas
- socks

- raincoat
- food
- water
- money
- maps (South America, North America, and local)
- compass
- alarm clock
- band-aids (for injuries)
- umbrella
- flashlight (to see at night)
- phone book and address book (to find your friends)

Use your experiences to include additional useful items from your own journeys.

B. A quarter for each student;

C. Copies of blackpoll warbler illustration (see "Handouts", below);

D. Blackboard, or overhead projector and sheets, or large flip-chart pad.

HANDOUTS:

Blackpoll warbler illustration, from "Birds Over Troubled Forests", p. 16.

HOMEWORK TO ASSIGN:

Have students write about:

1. What is a migratory bird? (no research needed, just identify the current state of their understanding); and

2. If migratory birds don't carry suitcases, how do they keep warm, stay cool, get enough to eat and drink, and find places to rest and to sleep? (Again, no research needed, just have students write down their own thoughts).

FOLLOW-UP:

Put away suitcase items, or repack for another class.

LINKS: Science and ecology.

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SEGMENT A
THE WONDER OF BIRDS, MIGRATION
AND SURVIVAL IN NATURAL ECOSYSTEMS

Class #2
There is a Lot to Think About and Explore Concerning Migratory Birds

****

OBJECTIVES:

1. To help students refresh themselves on the various bits of information they have learned about birds so far in their lives;

2. For the instructor to gain an understanding of the students' currents knowledge of birds, in order that the instructor can more closely tailor the remainder of the classes to the level of the students;

3. For the students to tie concepts about birds closer to their own personal experiences and frame of reference;

4. To identify areas of inquiry that the students may be interested in exploring.

THEME: Every student is starting on a journey of questioning and discovery about the natural world and our relationship to it.

CLASS ACTIVITIES:

I. Give a brief refresher (1 - 2 minutes) of the last class.

II. Collect Homework assignment from Class #1. Explain that it will be discussed during the next class period.

III. Conduct the Personal Survey (attached, below)

IV. Discuss each students answers to the Personal Survey. Encourage students to discuss and share their answers, and their questions.

PREPARATION: Review survey questions; possibly add others that are appropriate to stimulate the students' interest.

RESOURCES NEEDED:

Paper and pencils

HOMEWORK TO ASSIGN:

Have students think and write about what they think birds do all day. This should include their own personal observations, if any.

FOLLOW-UP:

1. Carefully review students' answers to the Personal Survey;
2. Compare and adjust the activities planned for future classes to the needs and learning level of the students;
3. Weave the students questions (item #13 on the survey) into the topics covered for the course, if possible.
4. Save the students' individual answers to the Personal Survey. They will be handed out again in the last class, #22.

LINKS: Science and ecology.

PERSONAL SURVEY QUESTIONS

1. Write down the names of all the birds you know.

2. Go back to the list you wrote down for question #1, and put a little star down next to the name of each bird you listed that you have actually seen.

3. Put down an "x" next to the names of birds you know about, but have never seen.

4. What is your favorite bird? (If you have more than one, you can rank them, #1, #2, #3).

5. Why is the bird you picked your favorite?

6. Are there any birds you don't like? (Name them).

7. Why don't you like them?

8. If you were a bird, which one would you like to be? (this can be different than question #4).

9. Why?

10. If you were a bird, where would you like to live?

11. Do birds live by themselves?

12. Do they have groups of friends with other birds? Explain.

13. What would you like to learn about birds, in this course? (Write down as many things as you can think of).

14. A true/false question: All birds migrate, true or false?

    (May require some discussion of what migration

basically is, and then some thinking. This question may help the students focus on the idea that migration may not be as clear a concept as they initially thought).

15. Why do birds migrate?

16. When birds migrate, how do they know where to go?

17. Where do birds go when they migrate?

18. Why do they go there?

19. Have you ever been birdwatching?

20. Do you know any people who are birdwatchers?

21. If you wanted to watch birds, where would you go to find them?

22. Do birds have jobs? (Explain your answer)

23. (If this is an elective course)
Why did you decide to take this course?

****

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SEGMENT A
THE WONDER OF BIRDS, MIGRATION
AND SURVIVAL IN NATURAL ECOSYSTEMS

Class #3
Starting the Migratory Journey

****

OBJECTIVE: Organize and prepare the students for beginning to learn specifics of migratory journeys.

THEME: There are many challenging questions about migratory birds, that still remain to be explored.

CLASS ACTIVITIES:

I. Review of Homework from Class #1:

Redistribute Homework papers from Class #1. Ask students to share their ideas and thoughts from this Homework assignment. Remember, every thought and idea is a useful one! Reassure students that, although they may not have all the answers, this course will give them the chance to help find the answers to these questions.

Discuss the answers.

II. Review of Homework from Class #2:

Ask students to take out the Homework assigned from Class #2. Ask students to share their thoughts from the Homework assignment from Class #2. Discuss them.

III. Discuss Course Logistics:

Provide the students with a clear overview of the course, and an individual printed calendar

schedule of the classes, and discuss with them the dates for which the field trips are scheduled. Identify and discuss logistical concerns related to field trips.

IV. Introduce that Spring Bird Migration is Beginning:

Hand out copies of the isochronal map provided in "Handouts", below, and lead the class in discovering that it depicts the general times that particular species of birds are found in certain areas on their spring migratory journeys. Be sure to identify where the birds are at <u>this</u> particular time.

V. Introduce Research into Habitat Areas:

A. Introduce the students' Homework assignment. Students will be choosing to focus on specific habitat areas along the migratory paths for their individual research:

- Tropical rainforest
- Gulf Coast
- Caribbean
- Your local area (ask the students to explain, if they can, what kind of a habitat they live in)
- Northern United States
- Canada (including Canadian forests)
- Other geographic areas the students may be interested in examining along the migratory routes

B. Make assignments. Students working on the rainforest will need to prepare their research for next week.

C. The students will need to research several key questions for each area, set out below in the "Handouts" section.

You may want to copy the page identified in "Handouts" and provide it to each student.

PREPARATION:

1. Bring Homework papers from Class #1.

2. Organize a calendar schedule of the course, and bring a copy for each student.

3. Make copies of the isochronal map identified in "Handouts", below.

4. Make copies of the research questions for each student.

5. Collect and bring information on the tropical rainforest, for the students who will need to make their presentation in the next class.

RESOURCES NEEDED:

Any available information about the rainforest. See possible sources in "Resource Information on Migratory Birds" in General Preparation, Materials and Logistics, above.

With the increased attention on the rainforest in recent years, there is a wealth of information available, right in your local and school libraries. Consult natural history periodicals, including National Geographic, other environmental journals, and importantly, current world atlases. Rainforest interest groups may have members in your area who could serve as an information resource; also community members may have travelled to the rainforest, and could offer their personal observations. Don't overlook the science section of local video stores and libraries. Local science museums in your area will also have information on this topic.

One particular topic recommended to cover is the rubber tappers who live in the rainforest. A source for this information is identified in "Resource Information on Migratory Birds", above, in General Preparation. Another source is Wilson, Edward O., The Diversity of Life, pp. 322-329.

Along with other information presented, be sure to provide a large map on which American rainforest areas can be identified.

HANDOUTS: Attached page on "Questions to Focus on For Each Habitat Area".

Isochronal maps (for discussion during class).

HOMEWORK TO ASSIGN:

Students assigned the rainforest area will need to complete their research and make their presentations in the next class. Students with other topic areas will have more time to prepare their presentations, scheduled for Class #7, but can be encouraged to get started.

FOLLOW-UP: Be available, ideally at identified times, to assist the students who will be preparing their rainforest presentations during this week.

LINKS: Science and ecology.

****

QUESTIONS TO FOCUS ON FOR EACH HABITAT AREA

1. Where is the particular topic area located, and what are special characteristics of the climate?

2. Discuss types of plants in the specific area.

3. Discuss types of animals in the specific area.

4. Find and discuss interesting information about the people who live in the area, particularly their relationship to the habitat around them.

5. Explain the climate(s) of the area.

6. Describe the natural vegetation zones of the area.

7. Which activities by people affect the natural vegetation zones of the area?

8. What are the identified land uses of the area, and how do they compare with the natural vegetation zones? Contrast these two, and identify conflicts and opportunities for harmonizing both.

9. Identify the major economic and commercial activities for the area.

10. Identify the relationship, if any, between the land uses, economic and commercial activities of the area, and if this could affect the ability of the migratory birds to survive in the area.

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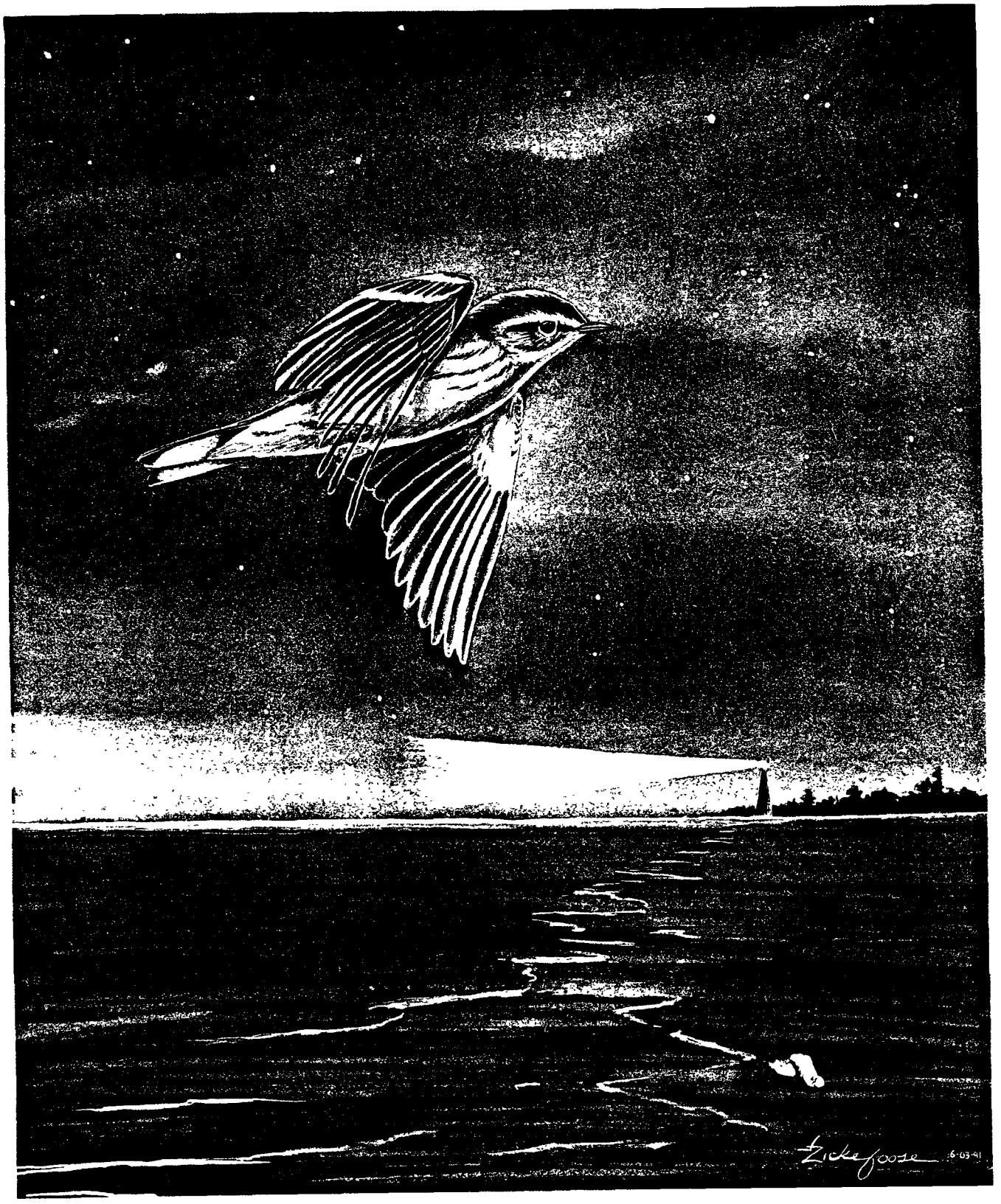
Class #1

HANDOUT

Excerpt from:

"Birds Over Troubled Forests", p. 16.



Blackpoll Warbler

Weighing as much as a quarter, the Blackpoll Warbler can fly from New England to Venezuela in 60-80 hrs., the metabolic equivalent of a person running 4 minute miles for 80 hrs straight. They accomplish this feat at the frigid and oxygen poor altitude of 5,000 meters.

Class #3

HANDOUT

Questions to focus on for each Habitat Area

Partners in Flight

Migratory Birds and Our Environment

QUESTIONS TO FOCUS ON FOR EACH HABITAT AREA

1. Where is the particular topic area located, and what are special characteristics of the climate?

2. Discuss types of plants in the specific area.

3. Discuss types of animals in the specific area.

4. Find and discuss interesting information about the people who live in the area, particularly their relationship to the habitat around them.

5. Explain the climate(s) of the area.

6. Describe the natural vegetation zones of the area.

7. Which activities by people affect the natural vegetation zones of the area?

8. What are the identified land uses of the area, and how do they compare with the natural vegetation zones? Contrast these two, and identify conflicts and opportunities for harmonizing both.

9. Identify the major economic and commercial activities for the area.

10. Identify the relationship, if any, between the land uses, economic and commercial activities of the area, and if this could affect the ability of the migratory birds to survive in the area.

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Class #3

HANDOUT

Isochronal Maps, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, circular #16, revised edition 1979, pp. 19, 22, 23 and 29.

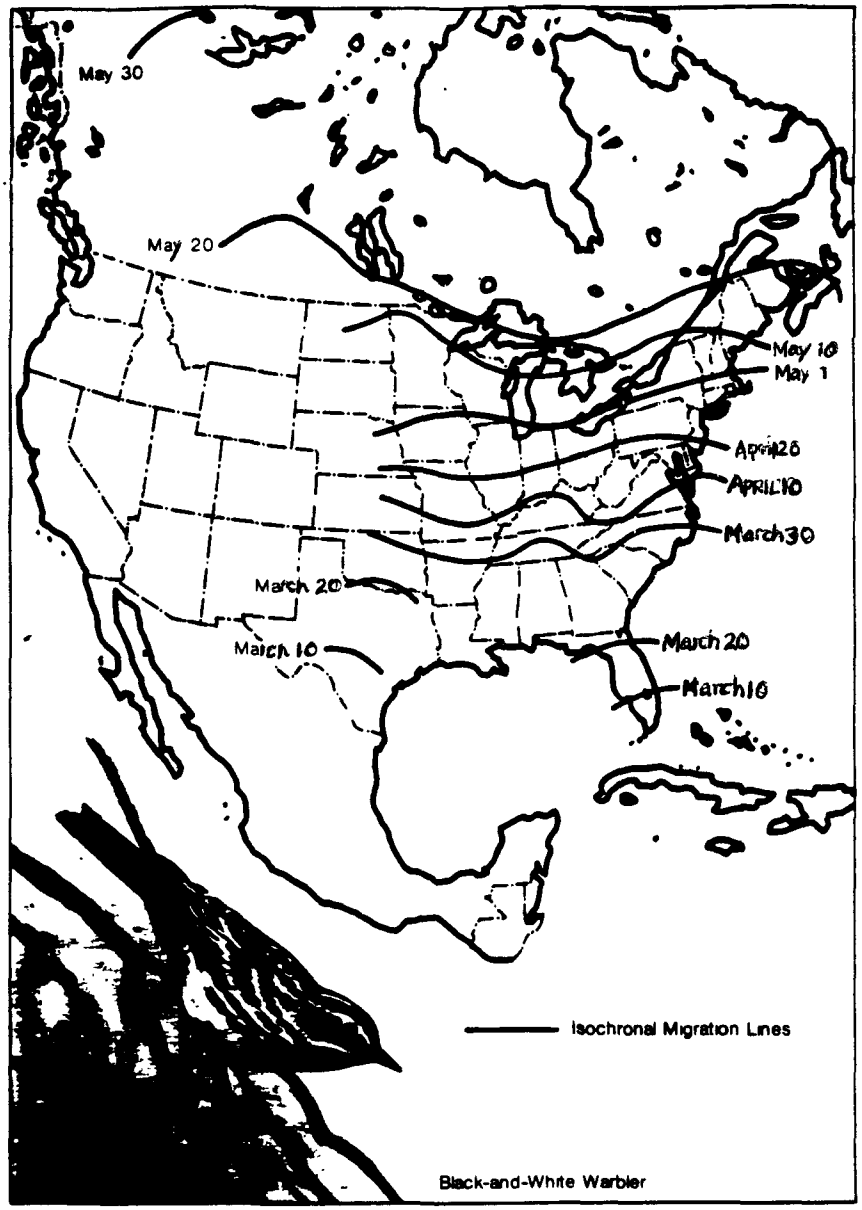

Figure 2. Isochronal migration lines of the black-and-white warbler, showing a very slow and uniform migration. The solid lines connect places at which these birds arrive at the same time. These birds apparently advance only about 20 miles per day in crossing the United States.

Isochronal Map, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, revised edition 1979, p. 19.

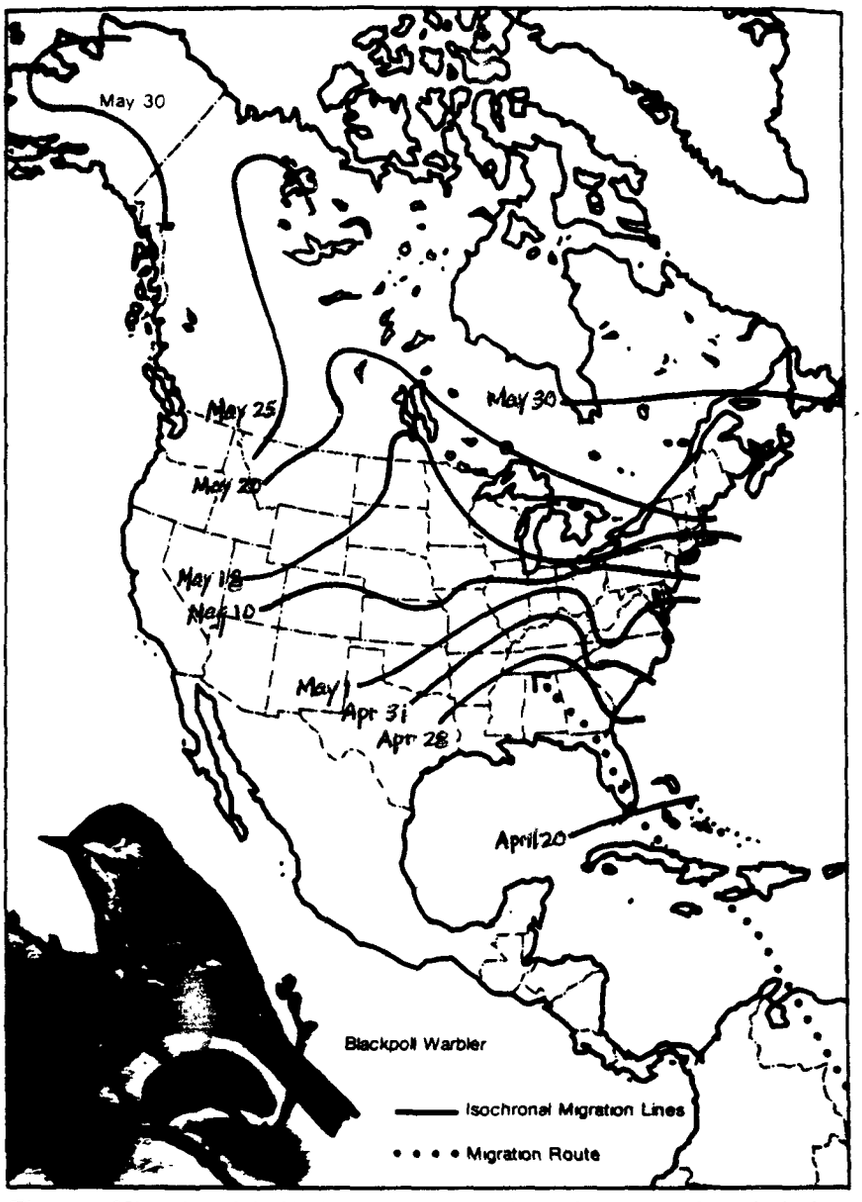

Figure 3. Migration of the blackpoll warbler. As the birds move northward, the isochronal lines become farther apart, which indicates that the warblers move faster with the advance of spring. From April 30 to May 10 the average speed is about 30 miles per day, while from May 25 to May 30 it increases to more than 200 miles.

BLACKPOLL WARBLER

Isochronal Map, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, revised edition 1979, p. 22.

Figure 6. Isochronal migration lines of the gray-cheeked thrush, an example of rapid migration. The distance from Louisiana to Alaska is about 4,000 miles and is covered at an average speed of about 130 miles per day. The last part of the journey is covered at a speed several times what it is in the Mississippi Valley.

GRAY-CHEEKED THRUSH

Isochronal Map, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, revised edition 1979, p. 29.

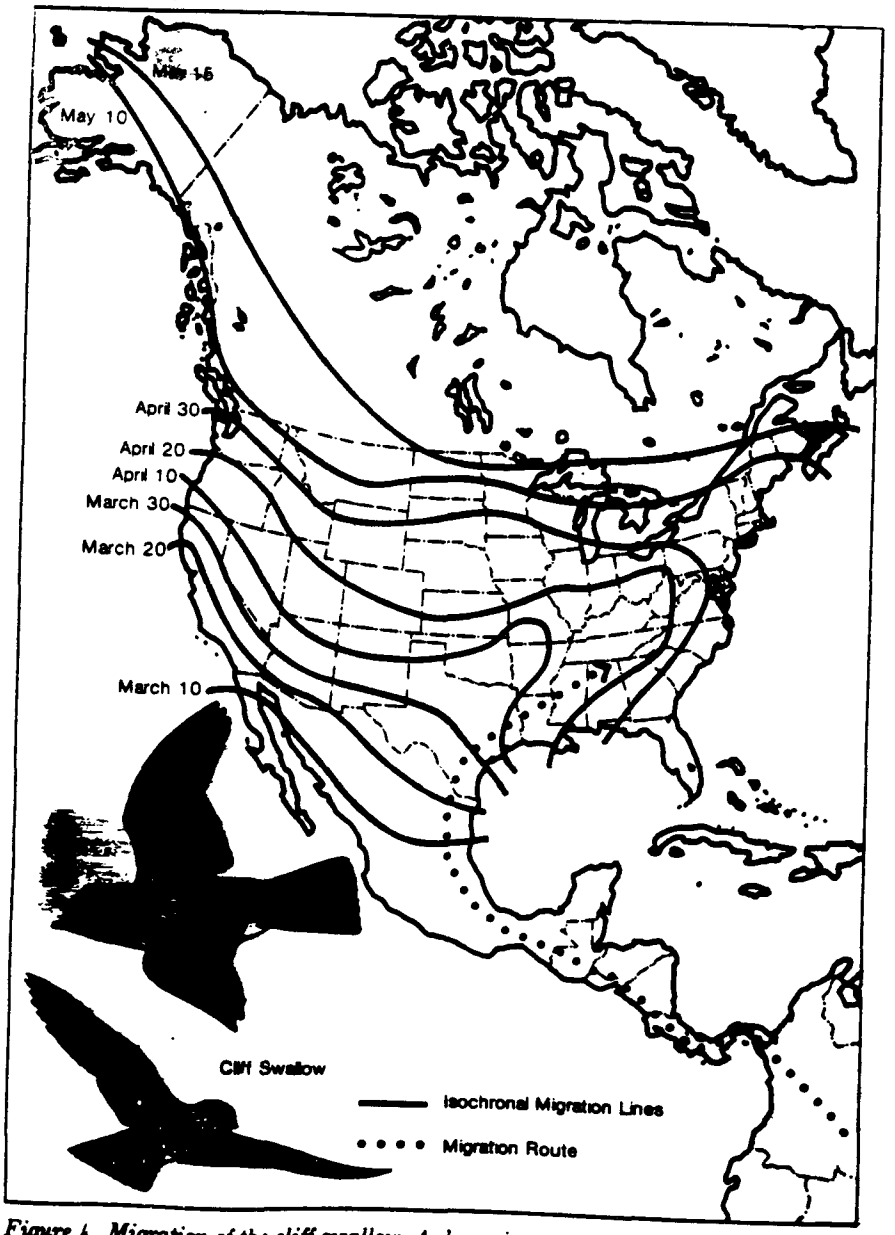

Figure 4. Migration of the cliff swallow. A day migrant that, instead of flying across the Caribbean Sea as does the blackpoll warbler (see Fig. 3), follows the coast of Central America, where food is readily obtained.

CLIFF SWALLOW

Isochronal Map, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, revised edition 1979, p. 23.

****

SEGMENT B
FLIGHT TO NEW WORLD HABITATS

Class #4
The Tropical Rainforest Habitat

****

OBJECTIVE: Gain an appreciation of the habitat in which Neotropical migratory birds spend the winter months.

THEME: All about the American tropical rainforest, where many Neotropical migrants spend our winter months.

CLASS ACTIVITIES:

I. 'Travel' to the American tropical rainforest:

1. Present information about the rainforest and its inhabitants, including native peoples, focusing on the topic areas and issues identified for research in Class #3.

2. Be sure to locate rainforest areas on a map.

PREPARATION:

The teacher will need to collect and organize materials, unless the students fully take on this responsibility. Keep in mind that the focus is not necessarily the birds in the rainforest, but rather an integrated view of the beauty and uniqueness of the tropical rainforest environment and habitat.

RESOURCES NEEDED:

See discussion in "Resources" section for Class #3.

HOMEWORK TO ASSIGN:

Have each student write their own thoughts about: Why would birds want to leave the rainforest and migrate to North America? Why do birds leave the rainforest?

FOLLOW-UP:

Make note of good resources to use for next year's class on this topic; return videos and other borrowed materials.

LINKS: Science, ecology, sociology, economics, land use planning, geography and anthropology.

****

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SEGMENT B
FLIGHT TO NEW WORLD HABITATS

Class #5
Migration Routes

****

OBJECTIVE: Gain an appreciation of the long journeys made by Neotropical migratory birds, and the vast ranges throughout the Americas that they travel and live in, when they leave the rainforest.

THEME: Examine migratory routes of a number of birds, mostly Neotropical.

CLASS ACTIVITIES:

I. Ask students to share their thoughts from the Homework assignment from Class #4. Discuss the important questions raised in the Homework assignment.

II. Learn about migration routes through migration charts:

Examine a sequence of migration charts. For each of them, discuss:

a. the countries and places each bird spends the winter;

b. the time when the bird starts migrating north;

c. how the birds of each species know when to migrate north?

d. have birds started migrating north yet, this spring? Which ones?

e. how far north have they reached yet?

f. what are particular problems the birds face in flying over specific land areas, or large expanses of water? (ie. hunters, high mountain ranges, exhaustion, lack of food, predators)

g. relate the number of miles the birds are shown to have travelled on the map to how far each student has travelled, as discussed in Class #1.

h. do the students have any ideas as to why different birds would choose different migration routes?

i. how do birds know how to find the same route, year after year?

2. Ask the students to make observations about each chart, and from comparing the charts (ie. some routes are shorter than other, some go over land, while other routes are over water), and take down all the observations on the blackboard, flip-chart or overhead projector. Remind the students that <u>all</u> observations are important, and that is how field biologists get new ideas and theories.

3. Introduce and explain fully the concept of "Neo-tropical" migrant, ie. that the bird lives in the American tropics for at least part of the year. Contrast this with the Canada Goose (copy of isochronal chart provided in "Handouts"), which does migrate in the Americas, but not to the tropics.

4. Ask the students where the information on the migration charts comes from. (You may not want to definitively answer this question, but it is a useful question to raise, that will be dealt with in detail in class #9).

PREPARATION:

Copy enough of each of the migratory charts to allow one per student.

RESOURCES NEEDED:

Copies of migratory charts are essential. Copies of several charts, are provided in the "Handouts" section.

Additionally, the National Geographic map identified in General Preparation, above (Section III, Maps) would be an excellent tool for this class.

HOMEWORK TO ASSIGN:

No specific Homework for this class; students should continue their research into individual habitat areas for presentation in Class #7.

FOLLOW-UP:

At some point around this time, the students may break for spring vacation. Challenge the students to find and observe birds wherever they may go in their travels, or even if the students remain right in the area. Suggest that the vacationing students look to observe migrating birds. Find out where students may be going in their travels, and ask them, if they possibly can, to bring back easily obtainable information on habitat conditions, particularly those that may be important to bird survival. Remind them that this does not need to involve any real expense: they can make their own observations, take their own pictures, buy cheap postcards or get free travel pamphlets. These can fit into the areas of research for class #7, or students can report on their observations when they return from vacation.

Remind the students of the first class, and the difficulties in travel, as they set about on their individual vacations. Encourage them to think about the birds beginning to migrate north now, and the travel challenges they face.

HANDOUTS: Migration charts

LINKS: Science, ecology and geography.

****

Classes #5 and 6

HANDOUTS

Migration charts, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, circular #16 (original and revised editions).

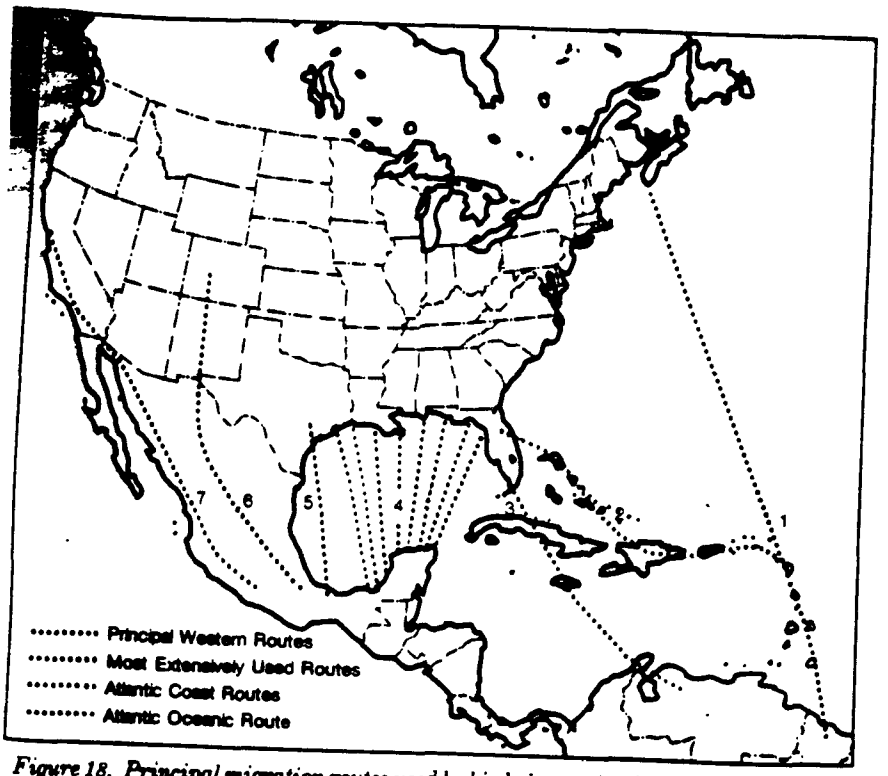


Figure 18. Principal migration routes used by birds in passing from North America to winter quarters in the West Indies, Central America, and South America. Route 4 is the one used most extensively while only a few species make the 2,400 mile flight down Route 1 from Nova Scotia to South America.

MIGRATION ROUTES

Classes #5 and 6

HANDOUT

RED-EYED VIREO
Migration chart, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, circular #16 (original and revised editions).

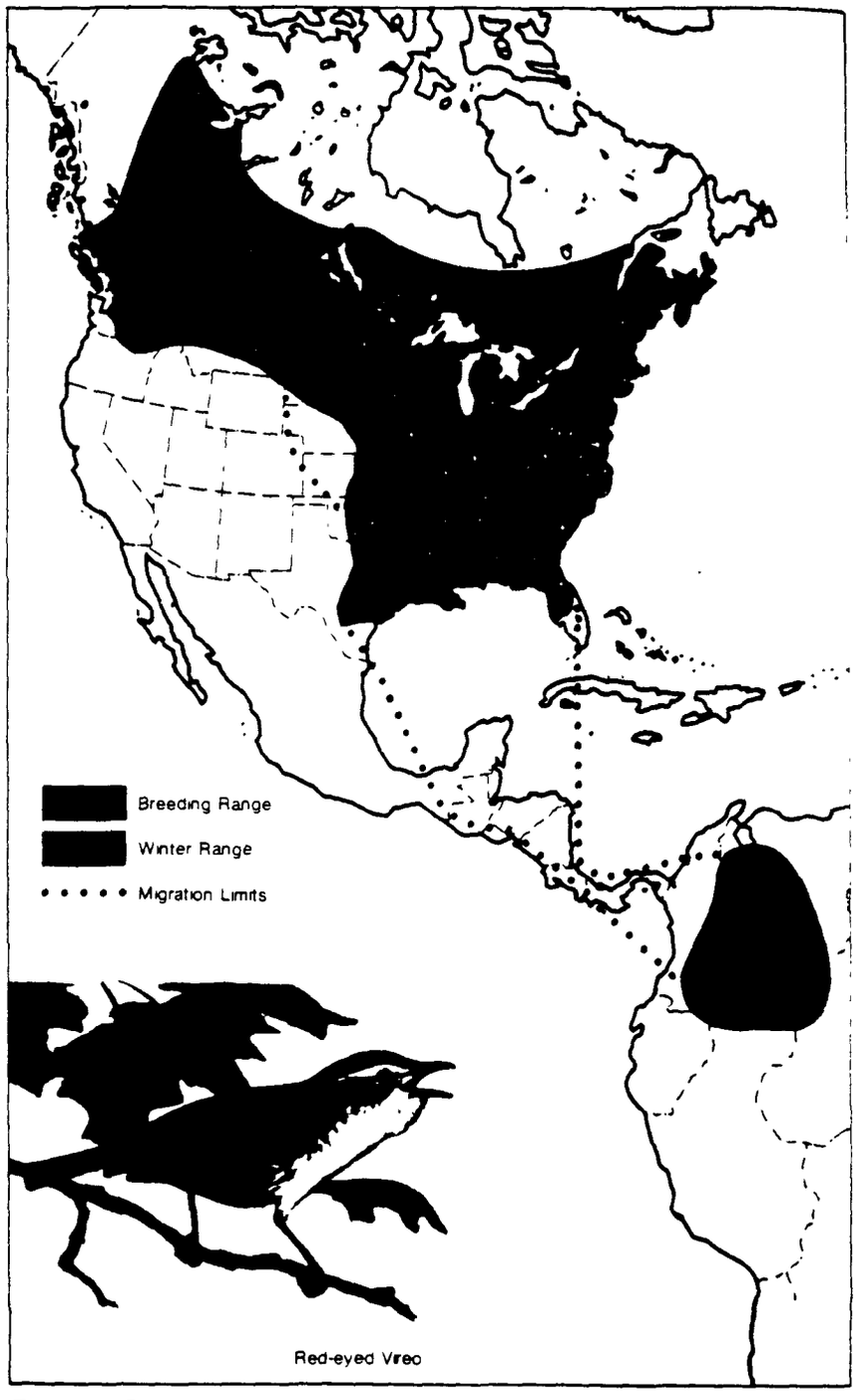


Figure 30. Distribution and migration of the red-eyed vireo. It is evident that the red-eyed vireo has only recently invaded Washington by an extension of its breeding range almost due west from the upper Missouri Valley. Like the bobolink (Fig. 19), however, the western breeders do not take the short cut south or southeast from their nesting grounds but migrate spring and fall along the route traveled in making the extension.

RED-EYED VIREO

Classes #5 and 6

HANDOUT

BOBOLINK
Migration chart, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, circular #16 (original and revised editions).

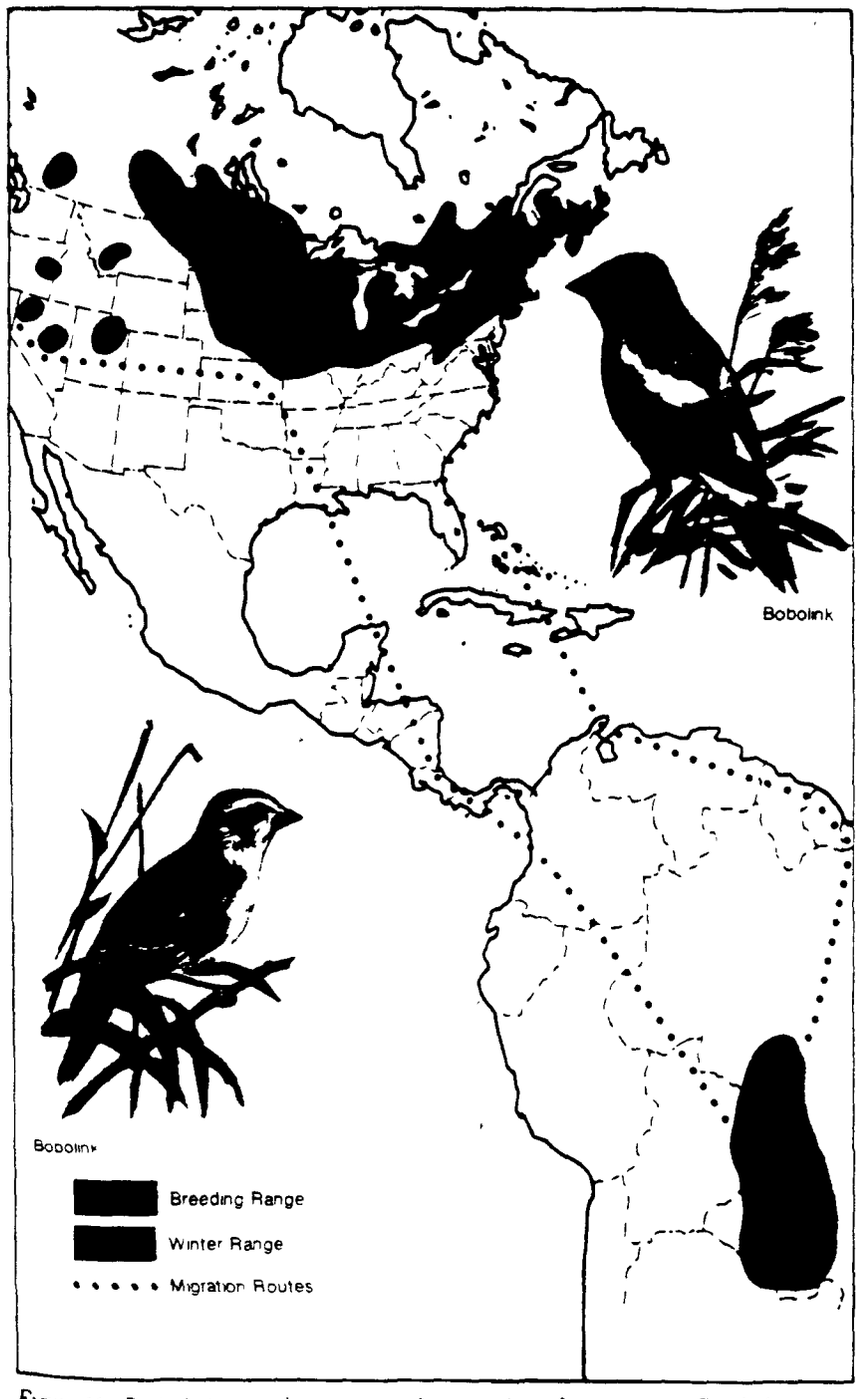


Figure 19. Distribution and migration of the bobolink. In crossing to South America, most of the bobolinks use route 3 (Fig. 2), showing no hesitation in making the flight from Jamaica across an islandless stretch of ocean. It will be noted that colonies of these birds have established themselves in western areas, but in migration they adhere to the ancestral flyways and show no tendency to take the short cut across Arizona, New Mexico, and Texas.

BOBOLINK

Classes #5 and 6

HANDOUT

CANADA GOOSE
Migration chart, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, circular #16 (original and revised editions).

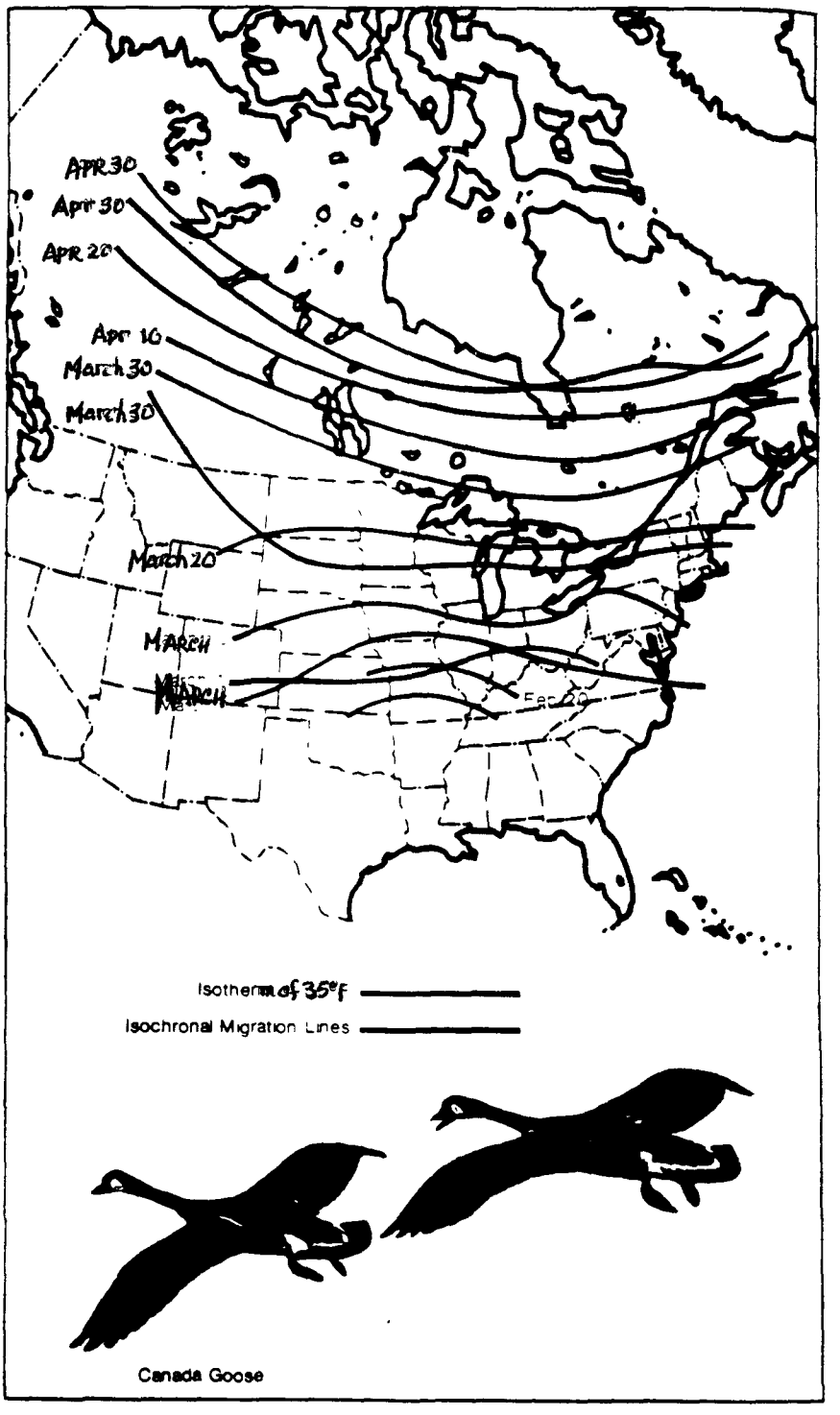


Figure 5. Migration of the Canada goose. The northward movement keeps pace with the progress of spring, because the advance of the isotherm of 35° F agrees with that of the birds.

CANADA GOOSE

Classes #5 and 6

HANDOUT

BLACK AND WHITE WARBLER
Migration chart, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, circular #16 (original and revised editions).

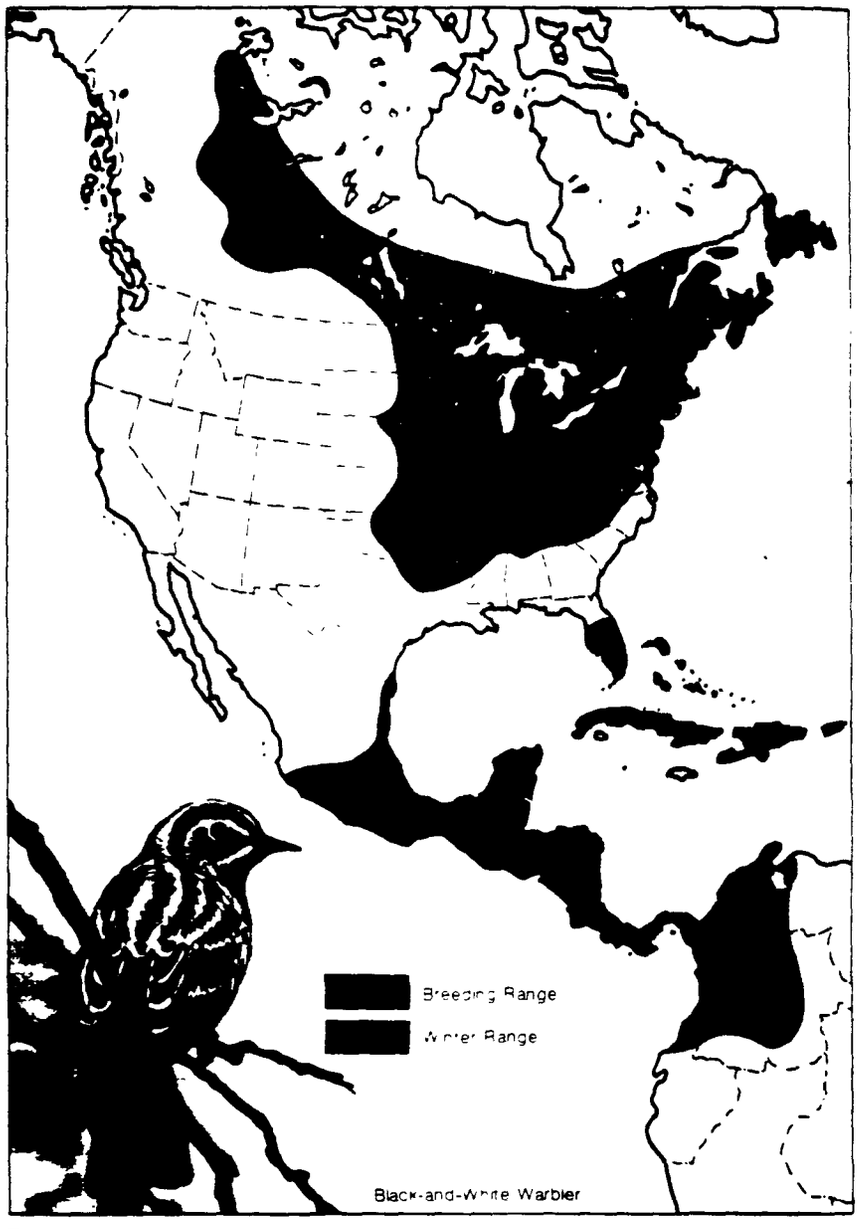


Figure 1. Summer and winter homes of the black-and-white warbler. A very slow migrant, these birds nesting in the northern part of the country take 50 days to cross the breeding range. The speed of migration is shown in Fig. 2.

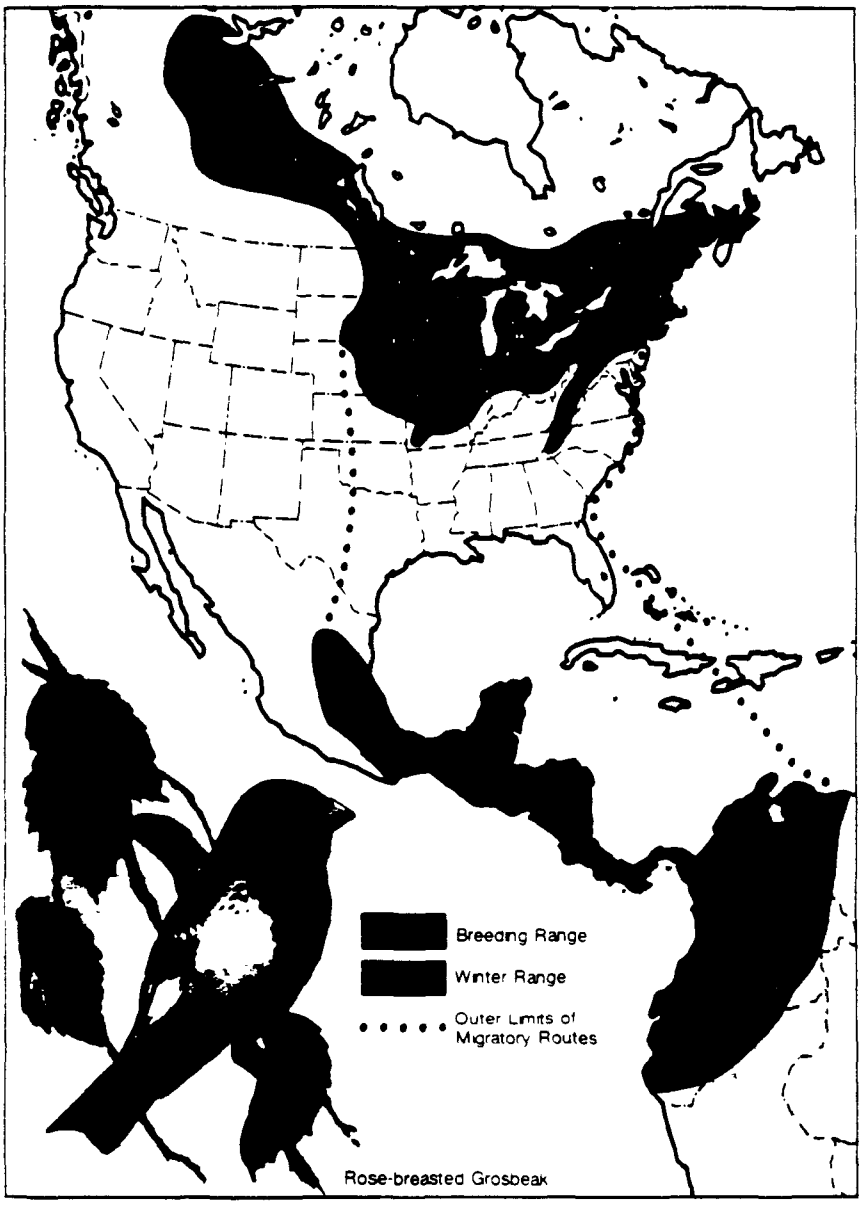
BLACK AND WHITE WARBLER

Classes #5 and 6

HANDOUT

ROSE BREASTED GROSBEAK
Migration chart, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, circular #16 (original and revised editions).



ROSE BREASTED GROSBEAK

Classes #5 and 6

HANDOUT

SCARLET TANAGER
Migration chart, from:

"Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, circular #16 (original and revised editions).

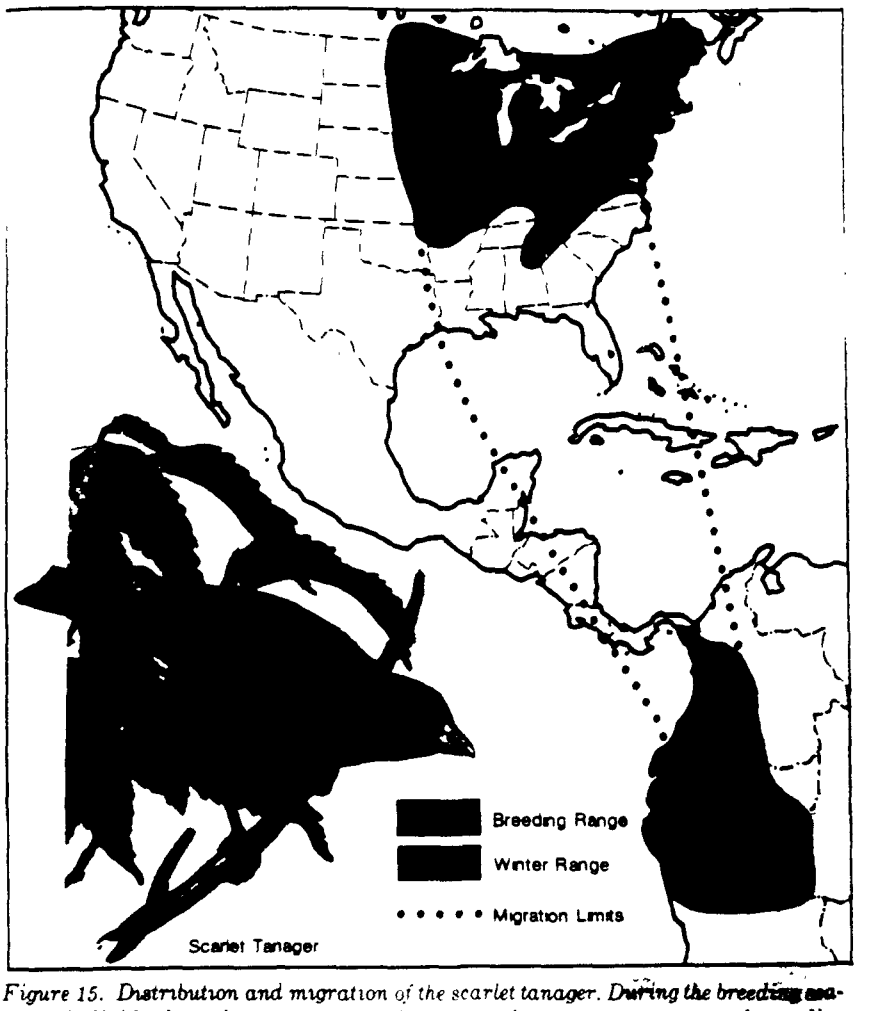


Figure 15. Distribution and migration of the scarlet tanager. During the breeding season individual scarlet tanagers may be 1,500 miles apart in an east-and-west line across the breeding range. In migration, however, the lines gradually converge until in South America they are about 500 miles apart.

SCARLET TANAGER

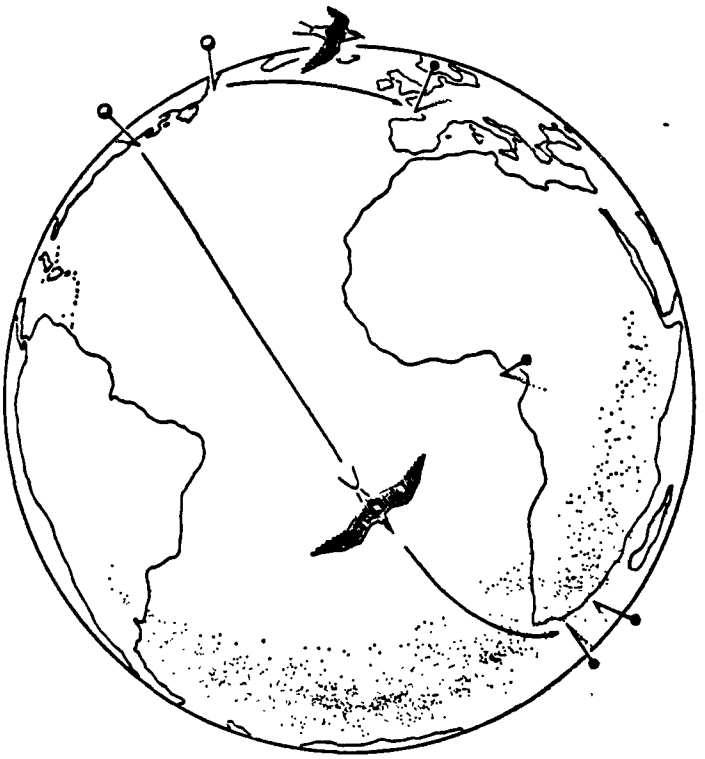


Fig. 2. Migrations of banded arctic terns. Places where young terns were banded off the coast of North America are shown by pins with white heads. Points where these birds were recovered a few months later are indicated by pins with small black heads.

One view of a migration that encompasses much of the planet.

Another depiction of this migration is on the reverse side of the page.

Figure 11. Distribution and migration of arctic terns. The route indicated for this bird is unique, because no other species is known to breed abundantly in North America and to cross the Atlantic Ocean to and from the Old World. The extreme summer and winter homes are 11,000 miles apart.

A view of a migration that encompasses much of the planet.

Reprinted from "Migration of Birds", U.S. Fish & Wildlife Service, United States Department of the Interior, circular #16, revised edition 1979, p. 45.

Another depiction of this migration is on the reverse side of this page.

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SEGMENT B
FLIGHT TO NEW WORLD HABITATS

Class #6
Migration Routes

****

Class #6 can be a continuation of examination of the migratory charts presented in Class #5. It is set apart here as a separate class for schedule planning purposes.

****

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SEGMENT B
FLIGHT TO NEW WORLD HABITATS

Class #7
North American Habitats

****

OBJECTIVE: Gain appreciation of the diversity of habitats occupied by the migratory birds (other than the tropical rainforest habitat) including your local habitat area, and the particular survival challenges of each area.

THEME: Each habitat and ecosystem poses its own different opportunities and challenges for survival and success. Habitat areas and ecosystems cross political boundaries.

CLASS ACTIVITIES:

I. Habitat investigations:

A. Present information on the various habitat areas investigated by the students as the homework assigned for Class #3. Have the students make their own presentations, either individually or as teams. Be sure, during each presentation, to locate on a map where the area is on one or more of the migratory bird charts introduced in Class #5. Focus on the topic areas and issues identified for research in Class #3.

B. Organize the presentations so they follow a general northward migratory pattern: Caribbean, Gulf Coast, Mississippi Basin, Northern United States, Canada.

C. Discuss differences in the habitats for the birds, and discuss advantages and disadvantages of each,

for the birds, and for people. Discuss how birds and people can accommodate their mutual interests. Ask students for each habitat area: which of people's activities there adversely affects the birds ability to survive there?

D. Identify and discuss the various countries and states in each habitat and ecosystem area. Focus on that observation that, in many instances, the habitat area (also could be called an "ecoregion") is not confined to political boundaries. What are the consequences of this to a migratory bird?

PREPARATION:

The teacher will need to collect and organize research materials for each habitat area, unless the students fully take on this responsibility.

RESOURCES NEEDED:

See discussion in "Resources" section for Class #3.

HOMEWORK TO ASSIGN:

Ask students to choose, of all the habitat and ecosystem areas they have learned about, which they would prefer to live in. They should explain why. Advise them that, as some birds do, they can choose to move among areas. They should explain what their choices are, and why.

Ask students to keep a continuing watch for in-depth information about local habitat conditions, ecosystems and land use patterns, such as that occasionally printed in local newspapers.

FOLLOW-UP:

Monitor local newspapers for interesting articles about local habitat conditions and land use. These will be needed for Classes #19 and 21.

LINKS: Ecology, geography, anthropology, sociology, political science.

NOTE: Depending on the number of students in the class, and their interest in examining and comparing each habitat area in depth, this topic could take more than one class. You could adjust the schedule to allow another class for this purpose, and make scheduling adjustments to later classes.

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SEGMENT B
FLIGHT TO NEW WORLD HABITATS

Class #8a
Why and How do Birds Migrate?

****

OBJECTIVE: Help students appreciate the importance and depth of basic scientific questioning and research.

THEME: There is an immense amount that we don't know about bird migration and the mysteries of natural systems. First-hand observations by people form the basis of what we do know.

CLASS ACTIVITIES:

I. Discuss students' preferences for habitat in the Homework assigned for Class #7.

II. Conduct Group Survey #1:

Ask the class to think about what they have learned in the class so far, and as a group to think of answers to the following:

1. Why do birds migrate?

2. Why do birds leave the rainforest to come to North America?

3. Given all the problems with the habitat areas in North America that we have identified in recent classes, why do migratory birds continue to come here?

4. Then, why do birds then leave North America to go back to South America?

5. What do birds do during the time they spend the summer in North America?

6. How do birds know <u>when</u> it is time to migrate?

7. How do birds find their way when they are migrating?

8. What problems do birds have when they are migrating?

9. How do <u>you, personally,</u> know that birds migrate?

10. Have you ever seen a bird migrating and ending up in South or Central America?

11. Where does the information on the migratory charts examined in previous classes come from?

12. How and when did bird migration begin?

13. What is the home of migratory birds?

14. What do these birds need to survive?

15. Describe your home.

16. Describe what you need to survive.

Record the various ideas of the students below the questions. Remember, all sincere ideas are good ones.

When discussing some of these questions, you can mention that people used to think that when birds disappeared in the winter the birds had gone to the moon! The philosopher Aristotle thought that the birds hid in the local bushes all winter, and reappeared in the spring. These historic items, as well as much other interesting information about migration, are set forth in <u>Migration of Birds</u>, circular #16 of the U.S. Fish and Wildlife Service, identified in "Resources", above.

PREPARATION:

Write out the questions ahead of time, either on separate sheets of a large flip chart, on individual

overhead projector sheets, or spaced out on the blackboard. Leave enough space to write in students' ideas below the questions.

RESOURCES NEEDED:

Large flip chart pad, overhead projector and supplies, or blackboard.

HOMEWORK TO ASSIGN:

Ask students to write their own ideas about some of the questions asked during this class, such as:

1) How do you, personally know that birds migrate?

2) How do birds find their way when they are migrating?

FOLLOW-UP:

No specific follow-up needed.

LINKS: Science, ecology.

NOTE: This exercise is not designed to take a full class period. A good idea is to start Class #8b during this class period as well.

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Class #8

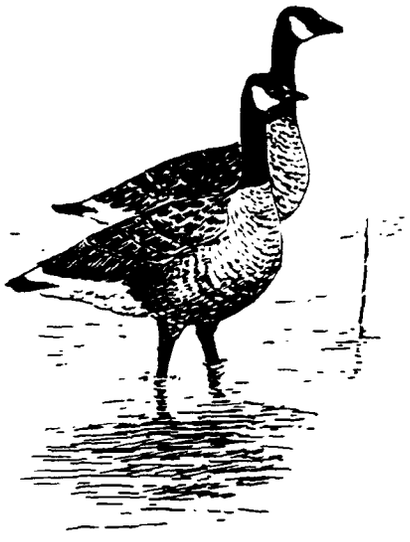
EXERCISE

Copy of Activity #2 ("Migratory Mapping"), from Migratory Birds Issue Pac, U.S. Fish and Wildlife Service, United States Department of the Interior, 1982.

Migratory Birds

Activity 2

Migratory Mapping



Purpose

Through this Activity, students will learn the migration route of a common migratory bird, the Canada goose. This will be done by compiling and mapping data from actual band reports.

Learning Outcomes

After completing this Activity, students will be able to:

A. Map the migration route of the Canada goose based on band reports.

B. Define the terms wintering and breeding grounds.

C. List two uses of band reports.

D. List the four major flyways in North America.

Organization

Who: Groups of four
Where: Inside
When: Any time of year
Time: One to two hours

Materials: For the Class

- Poster—Side 2
- Data Sheet—Page 1 (five copies)
- Paper bag or hat

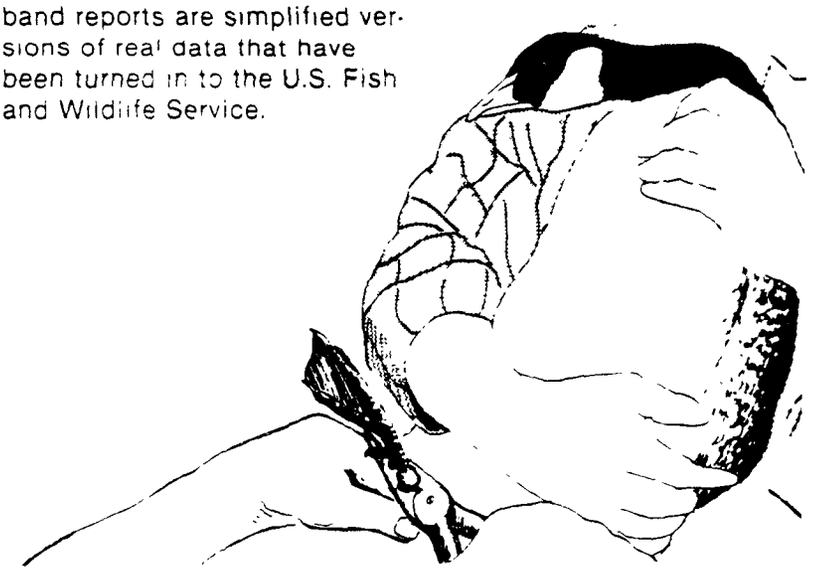
Materials: For Each Student

- Data Sheet—Page 2
- Colored pencils or crayons

Directions

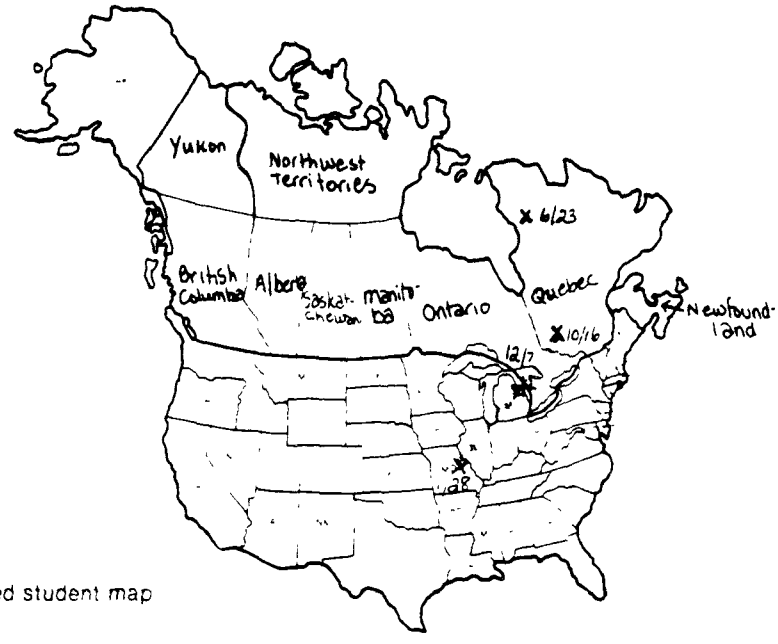
1. Data Sheet—Page 1 contains 50 banding results. Make five copies of these band reports. Cut Data Sheets into 250 strips and put these into a hat or paper bag. **Note:** These band reports are simplified versions of real data that have been turned in to the U.S. Fish and Wildlife Service.

2. Lead students in a discussion of bird banding. Banding is done to provide information regarding migratory birds' routes. Through recovery of bird bands, data on direction and duration of migration is obtained. Introduce students to the idea of flyways, which are generalized migratory corridors. Although species' actual migrations do not strictly conform with these flyways, they are a useful way of generalizing migration routes. Band recoveries help to indicate along which flyways birds migrate. (For instance, the Canada goose migrates along all four flyways.) Use the Poster-Side 2 and the pocket map to illustrate the idea and locations of flyways.



3. Hand out copies of Data Sheet—Page 2 to each student. Have students first label their maps with the Canadian provinces and major bodies of water. They may use reference materials.

4. Tell students they are wildlife biologists compiling banding returns. Data are being sent to them regarding the locations of banded Canada geese. Their job is to map Canada goose migration—spring and fall—based on the reports. Tell students they will each receive data from seven or eight bands. While bands are recovered year round, the information students receive will be mainly from summer and from fall migration periods. (Have the students suggest why more bands might be recovered at these times of the year.) Students can tell the difference by the dates: spring migrations generally occur between February and April and fall migrations between September and December. Reports from January, May, June, July, and August indicate non-migrating times of the year. During the summer months geese are at their breeding grounds; during January they are wintering in more southern areas. Tell students they will plot reports on the maps they have been given. They should use different colors for migration dates, and for dates indicating presence on wintering and breeding grounds.



Completed student map

5. Pass the hat around the classroom. Each student should take one strip (band result) and mark the date on the map in the correct location. Pass the banding reports around again, and continue this until each student has received at least seven reports. If students receive two of the same result, they should plot both.

6. Have students form groups of four to compare data. Students should map the banding reports of the other group members. Based on the additional information, have students plot spring and fall migration routes based on the U.S. flyways and indicate generalized wintering and breeding grounds. Their data will indicate that the Canada geese used in this Activity breed mostly in Canada. They migrate along either the Mississippi Flyway or the Atlantic Flyway. Therefore, the routes mapped can cover most of the States north of South Carolina and east of Wyoming.

7. If possible, make an enlargement of the Data Sheet map and plot all the band reports. Ask students where band report #1 was from and if the bird was recovered during the spring or fall migration. Plot each migration period in a different color. Continue collecting information from the class and plotting it until all reports have been shown.
8. Have students pick one of the flyways and research its geography. Generate a class list of possible problem areas and favorable habitats (refuges, rivers) which Canada geese might encounter on that route.

Followup

Through research and observations made throughout the school year, students can note the varying numbers, types, and varieties of birds in the area and determine which species migrate and which do not. They can then study one migratory species they have identified in the neighborhood and use a map and bird guides to examine where the species migrates. Research should include the route and timing of migration, obstacles encountered, and traditional habitats used during migration.

If possible, have a local conservation officer or Fish and Wildlife Service employee bring in samples of actual bird bands and mounted birds with bands to discuss banding in greater detail. Have the speaker tell students what they should do if they see a band on a bird (either live or dead). Some wildlife refuges allow students to observe banding operations and on occasion will allow upper-level students to participate.

Activity Review Answers

1. The Canada geese depicte in this Activity breed mostly i Canada and migrate along either the Mississippi or Atla tic Flyway.
2. **a**—Atlantic Flyway; **b**—Ce tral Flyway; **c**—Pacific Flywa **d**—Mississippi Flyway.
3. True. While bands are four by many different individuals different ways, the majority a sent in by hunters
4. Wintering grounds—Arger tina, South America. Breedin grounds—Alberta and Saskatchewan, Canada.
5. Band reports give informa tion regarding bird migration routes, wintering and breedir grounds, life expectancy, causes of death, etc.

Migratory Birds

Activity 2

Activity Review

Name:

1. Where do the Canada geese that you studied in this Activity breed and what flyways do they use?

_____

_____

2. The map below shows the four major flyways of the United States. Based on the banding results below, which flyway would the migrating birds be using?

a. Birds banded in northern Quebec and recovered in Maine, Delaware, North Carolina, Rhode Island, Maryland

_____

b. Birds banded in the Northwest Territories and recovered in Wyoming, New Mexico, Texas, Montana.

_____

c. Birds banded in Alaska and recovered in Oregon, Nevada, California, Idaho.

_____

d. Birds banded in Alaska and recovered in Alaska, North Dakota, Great Lakes, Tennessee, Louisiana, Missouri.

_____

3. Wildlife biologists rely on information from bands returned by hunters to learn about migratory birds. True or False?

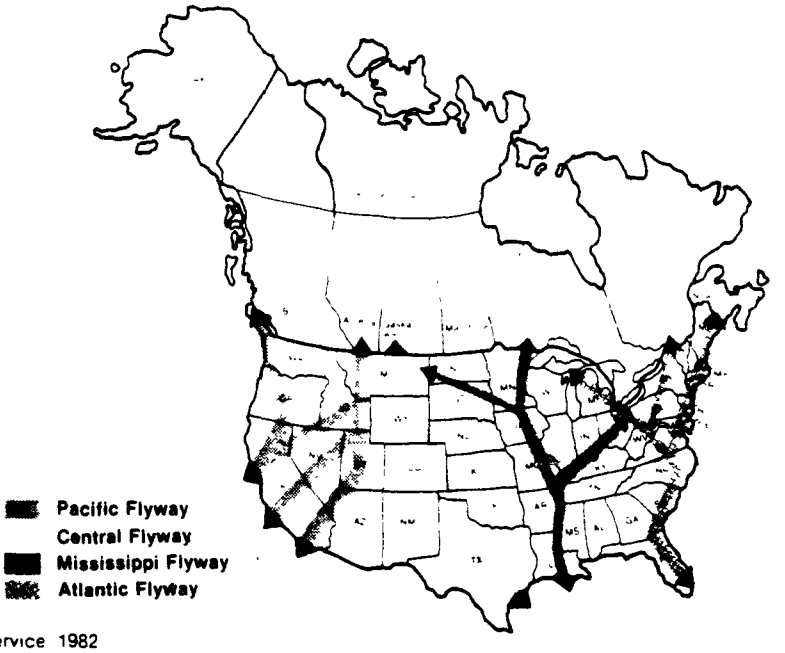
_____

4. The Swainson's hawk breeds around the beginning of May. Based on the following banding results, where do you think this bird winters? _____

_____

Breeds? _____

- Shot in Mexico, October 1980.
- Banded in Alberta, July 1977, and found dead in Kansas, August 20, 1978.
- Banded in Saskatchewan, July 13, 1974 and found dead in Argentina, March 4, 1976.



5. List two examples of information obtained from band reports.

a. _____

_____

b. _____

_____

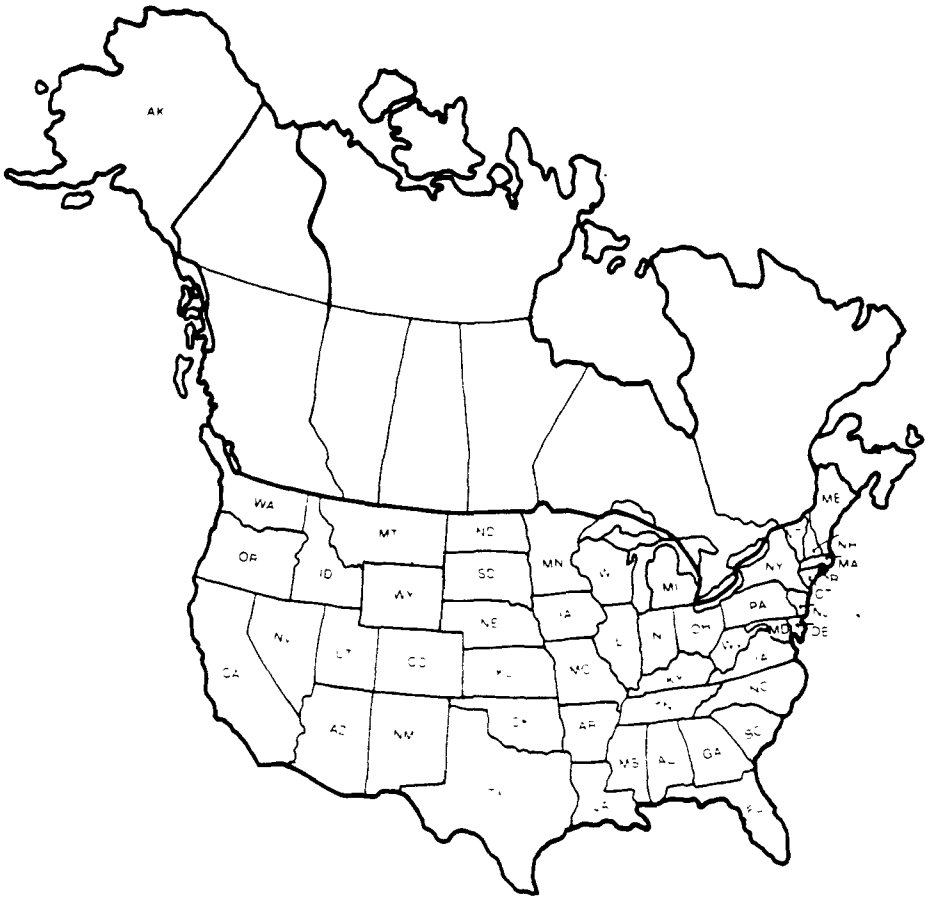
Department of the Interior/U.S. Fish and Wildlife Service 1982

Migratory Birds
Canada Goose Migration

Activity 2

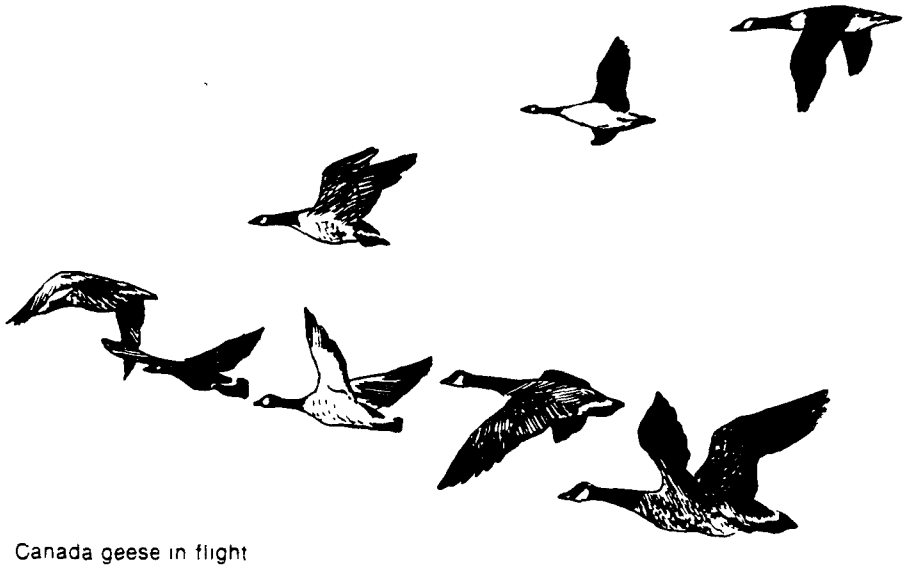
Data Sheet

Name:

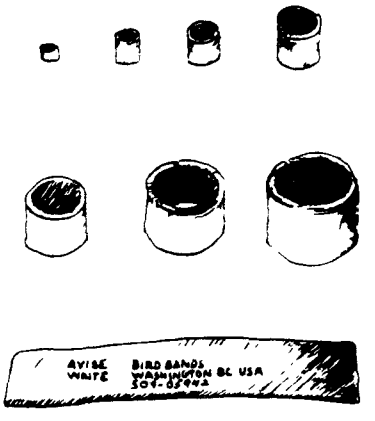


Canada geese migrate in a V-formation at about 50 mph. Their movement is steady and unhurried and closely follows the movement of the seasons.

Canada geese are often banded by scientists to obtain information about their migrations. Canada geese make their spring migrations (south to north) from about February to April. Fall migrations (north to south) occur from about September to December.



Canada geese in flight



Bird Bands

Migratory Birds Banding Reports **Activity 2** **Data Sheet**

Name:

1. Goose caught by hand in Maine, 8/16/81.
2. Neck-collared goose observed by person in New Jersey, 11/28/81.
3. Goose found dead by hunter in Maine, 10/16/81.
4. Band number of goose read from a distance by observer in Quebec, 7/9/81.
5. Hunter reports band from Pennsylvania, 11/12/81.
6. Goose caught after being forced down and weakened by bad weather in Pennsylvania, 12/30/77.
7. Goose shot by hunter in Missouri, 11/11/78.
8. Goose band sent in from Ontario with no information about recovery or cause of death, 8/4/81.
9. Hunter reports goose that was taken by his party in Iowa hunt, 10/13/81.
10. Goose banded in Iowa was identified by neck collar and reported from Wisconsin by resident, 9/19/81.
11. Skeleton of banded goose found and reported from Ohio, 9/8/81.
12. Goose recaptured almost a year later in the same place where banded in Wisconsin, 10/8/81.
13. Goose banded in Colorado killed by a hunter in Wyoming, 10/31/81.
14. Goose inadvertently caught by fur trapper in Manitoba, 10/10/81.
15. Goose banded in Oklahoma shot by hunter in Saskatchewan, 10/26/81.
16. Injured goose caught in Iowa, 11/28/81.
17. Goose banded 1/2/63 in Maryland and shot by hunter approximately 18 years later in Maryland, 11/12/81.
18. Goose banded in Manitoba shot three months later in Missouri, 11/8/81.
19. Goose banded in Manitoba 7/19/68 and recaptured near place of banding, 7/30/81.
20. Goose caught in Illinois after being hit by a vehicle, 7/29/81.
21. Goose banded in the Northwest Territories, Canada shot in Ohio three months later, 10/21/81.
22. Goose found dead in Massachusetts, 10/27/81.
23. Goose killed in Wisconsin by hunter, 10/29/81.
24. Goose banded in Ohio found injured in Michigan, 8/4/81.
25. Goose first banded 10/11/67, accidentally killed when recaptured in banding operation in Minnesota, 10/26/81.
26. Goose banded in Texas shot almost 13 years later in Manitoba, 10/2/81.
27. Goose banded in Utah identified by neck collar in California, 2/5/81.
28. Goose found dead on highway in Ontario, 9/1/81.
29. Goose collected for scientific specimen in Ohio, 4/27/81.
30. Goose found dead in South Dakota, 11/17/81.
31. Goose banded in Arkansas shot almost 17 years later in South Dakota, 10/20/78.
32. Goose found entangled in fishing gear in Michigan, 1/5/79.
33. Goose recaptured at the place of banding one year and one day later in Ontario, 6/22/81.
34. Goose captured after it joined a flock of domestic birds in Quebec, 6/23/81.
35. Goose shot by hunter in Ontario 40 days after it was banded, 8/3/81.
36. Band reported from North Dakota with no information regarding bird or circumstances of encounter, 6/15/81.
37. Goose found dead in Minnesota, 10/30/81.
38. Goose caught as a result of an unknown animal in Minnesota, 11/23/81.
39. Goose banded in Kansas 2/14/80 shot in Saskatchewan, 11/9/81.
40. Goose found injured in North Carolina, 6/28/80.
41. Goose found dead in New Jersey almost seven years after banding, 5/27/80.
42. Two geese banded on same day found dead almost a year later near a highway in Virginia, 1/5/72.
43. Goose banded in Kentucky 7/1/76 recaptured in Tennessee by another bander, 1/28/80.
44. Goose caught by a dog in Minnesota, 5/28/79.
45. Goose in Missouri found dead after striking a high tension wire, 3/8/79.
46. Ohio resident with binoculars reported a goose with a band number, 3/20/75.
47. Goose banded in Tennessee later recaptured by a bander in the Northwest Territories of Canada, 1/7/76.
48. Goose in British Columbia killed by a moving aircraft, 3/27/80.
49. Goose found dead due to parasite infestation in Minnesota, 7/22/80.
50. Goose found dead due to lead poisoning in South Dakota, 12/17/80.

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SEGMENT B
FLIGHT TO NEW WORLD HABITATS

Class #8b
How Do You Know Migration Occurs?

****

OBJECTIVE: Help students appreciate the importance and depth of basic scientific questioning and research.

THEME: There is an immense amount that we don't know about bird migration, and first-hand observations by people form the basis of what we do know.

CLASS ACTIVITIES:

I. Mapping Migration Patterns:

Use the referenced *group exercise* in "Resources Needed", below, to have students learn 'first hand' how we find out about bird migration, and about the problems birds face along the way.

More than one class period will be needed for this complete exercise. It can be started during this class period, and completed during the next class. It works well to get it organized and started during one class, and then students will be ready to begin right in on it and complete it in the next class.

PREPARATION:

For the mapping exercise, a large map of North America is needed. The migration information (provided in "Resources Needed", below) should be cut into strips ahead of time, and the teacher should bring a hat or

another container to the class into which the slips can be placed.

RESOURCES NEEDED:

The needed excerpts from Migratory Birds Issue Pac, Activity #2, Migratory Mapping (U.S. Fish and Wildlife Service, 1992) are included with the Course Handouts. This packet contains an interesting exercise of mapping of the migration of Canada Geese. This exercise is only part of a larger comprehensive packet, that could be ordered in its entirety. See "Course Logistics", above, for ordering information.

The teacher will need to bring a large map (preferably mounted, for ease of working), marking pens, and a hat or other container.

HOMEWORK TO ASSIGN:

One creative assignment could be for students to brainstorm and identify other possible ways that people could find out specific facts about bird migrations. For example, the New York Times reports in "New Technique May Clear Up Mystery of Vanishing Songbird" that chemicals in feathers may help trace birds to winter grounds (New York Times, May 31, 1994, p. C4). Students could come up with a variety of other ideas, too.

FOLLOW-UP:

No specific follow-up is needed.

LINKS: Science, ecology.

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SEGMENT B
FLIGHT TO NEW WORLD HABITATS

Class #9
How Do You Know Migration Occurs?

****

This Class period is a continuation of the exercise in Class #8b. It is set apart here as a separate class for schedule planning purposes.

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SEGMENT C
DISCOVERING BIRDS AND BIODIVERSITY
FIRST-HAND

Class #10
How to Identify Birds

****

OBJECTIVE: Learn the basics of how to recognize birds, in preparation for interesting and rewarding trips of field observation.

THEME: Identify basics of bird observation.

CLASS ACTIVITIES:

I. Depict the basic features of birds that will be helpful for students to know in the field:

1. Ask the students to draw an outline of a bird on a clean sheet of paper, and to mark on it the identification features that they already could recognize (ie. beak, tail, etc.) Spend only about five minutes on this.

2. Using the blackboard, overhead projector or large drawing pad, sketch out the outline of a bird, and mark the key features of the bird, particularly those that are helpful to field observation. For reference, use a standard chart depicted in the front of a bird identification book. See "Field Guides", in General Preparation, above).

   Have the students copy the chart and the identification names and markings as you go along.

3. Collect the students papers, hand them a blank paper, and challenge them to write from memory a bird outline and as many of the markings as they

can remember.

4. After #3 is attempted, hand the students back their original notes, and ask them to complete those things on their second sheet that they could not remember.

   Note: this is not meant to be a graded exercise, but rather a little short-term memory reinforcing trick for trying to remember as much as possible. Explain this to the students. They won't remember all the markings anyway, but they will remember some of them when you get out into the field, and at least they will be familiar with the standard marking names, such as 'crown' or 'wing-bar', that otherwise they have never heard before.

II. Finalize field trip logistics:

The bird identification activity should be completed in enough time to discuss the final plans for the field trips: exact logistics of where and when to meet, contingency plans related to the weather or other individual student activities (such as school orchestra, play rehearsals, tests, etc.), appropriate field gear, including pants, boots and hats, and arranging for bird identification books and binoculars.

If enough time is available, the students can be asked to find the location of the field trips on a local map.

PREPARATION:

Obtain a diagram of bird identification features from the introductory sections of your bird identification field guide. Review the diagram so that you will be familiar with it.

RESOURCES NEEDED:

1. Reference for bird identification marks, for the teacher to copy from;

2. Paper for each student, pencils, blackboard, overhead projector or large marker board;

3. Printed information sheets concerning the logistics and details of the field trips;

4. Local area map for pinpointing field trip locations.

HOMEWORK TO ASSIGN:

No specific Homework for this class.

FOLLOW-UP:

Make adjustments and final preparations for the field trips.

LINKS: Science and geography.

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SEGMENT C
DISCOVERING BIRDS AND BIODIVERSITY
FIRST-HAND

Class #11
Discovering Diversity

****

OBJECTIVE: Have students begin to discover for themselves the incredible diversity of life, as reflected in the many different types of birds.

THEME: The rich variety of bird life is fascinating for those who explore it.

CLASS ACTIVITY:

This class period is designed to consist primarily of unstructured individual exploration of a major bird field guide. The students, either individually or in teams of two, should be handed a bird field guide, and told they will have the class period to explore it.

This can be a very successful and fascinating exercise, because the diverse depictions of birds, and comparisons among them, are probably something that the students have never taken the time to explore before. The variety of bird life is itself amazing and extraordinary.

At first, the students may be a little sheepish about exploring the guides, but allow them enough time to really get started.

If necessary, the class can be prompted by challenges to find their favorite bird, or to try to locate birds that they have seen before, and read about them. Additionally, they can be challenged to find different types of features about birds, particularly their bills, and obviously their plumage. As the class to start thinking about why do birds have so many

different color feathers and types of bills?

Challenge the students also to find important features about the books, such as: how the index works; how the guide is organized; and the migratory mapping feature, and how to find the right map.

Be careful not to overwhelm the students with too much lecture at this time. They should be given enough time to explore the book productively themselves, without rushing. Features of the book that aren't covered during this class can be discussed during a field trip.

Discovering the diversity of bird life can be a good introduction to prompt the class the think about the importance and beauty of diversity in all forms of life.

Note: be sure to confirm the final details of a field trip, if it is planned for the next class. Remind the students to bring their field guides, if they have their own individual copies.

PREPARATION:

Obtain bird field guides.

RESOURCES NEEDED:

Obtain as many field guides as possible. (See discussion in Course Logistics, above, concerning selection of field guides). Ideally, there will be one identical field guide per student. However, this is not necessary, and students can be asked to share. If field guides are not identical, be sure to observe this and be prepared to help students in the field to locate birds in their particular guide.

HOMEWORK TO ASSIGN:

Ask the students to think and write about:

1. Why do birds have so many different color feathers?

2. Why do birds have different shapes and types of

bills?

3. What would the world be like if all the birds looked the same?

If the students have individual copies of the books, they can be asked to look through the books again, as much as possible, at their leisure.

FOLLOW-UP:

Collect field guides, unless they belong to the students, and bring them to next weeks' field trip.

LINKS: Science

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SEGMENT C
DISCOVERING BIRDS AND BIODIVERSITY
FIRST-HAND

Class #12
Field Trip

****

OBJECTIVE: Have students observe and begin to appreciate natural ecosystems and biodiversity first-hand, through direct observations of birds in their natural surroundings.

THEME: Explore a local area to discover the diversity of birds there, and find out about the types of ecosystems in which birds live.

CLASS ACTIVITY:

I. Field trip to local area to observe birds and our habitat. See in-depth discussion in Course Logistics, above.

In the field, help students learn field identification and observation techniques, including focusing on where particular birds are found (forest, field, wetland, suburban yard); behavior of the birds, and field markings (using identification techniques introduced in Class #10). Lead students to appreciate the wonderful variety of colors in the different birds they are seeing.

Also, it is important to focus on other components of the particular ecosystem visited. This can be done, for example, by finding out about the type of food eaten by the various birds, by observing their type of bill. Field identification of different types of bills is introduced in standard field guides, such as Birds, (Peterson, 4th ed), at p. 34. Focusing on the bills and the type of food eaten by each bird in the wild is

a key concept in helping to understand the importance of each bird in the natural cycles, and in observing other life forms of the particular ecosystem. Lead students to appreciate the rich variety of life and color throughout the ecosystem, using the birds as a focal point.

II. Record any birds observed on the students' individual life list.

III. Find out and discuss other areas in the Americas where the birds you have observed live. For example, for each bird observed, find out where it spends the winter months, and find out whether the bird is migrating through your area to a certain more northern territory, or is establishing itself in your locality for the summer. The bird field guides can be a start to this.

The National Geographic map referenced in General Preparation, Maps (III), can be a very valuable tool for referencing migratory routes of birds observed.

Students may have to do more research on this, which can be their homework for each field trip class. For each field trip class, locate on a map of the Americas the winter home of each type of bird observed, and its summer location. You can do this as each bird is observed, if you have the information available, or as a focused segment of each field trip class, using the homework research that the students have done.

When identifying the various areas, be sure to remember and discuss highlights of the individual habitat explorations from Classes #4 and #7.

PREPARATION:

See in-depth discussion under "Course Logistics", above.

RESOURCES NEEDED:

Field guides and binoculars. See in-depth discussion under "Course Logistics", above.

Map(s) to mark on.

HOMEWORK TO ASSIGN:

1. For each field trip, ask students to record their key first-hand observations about birds and habitat areas in a note-book. Encourage them to write about the things that they personally find interesting on the field trip. Explain that *scientists* need to record observations directly in the field as they are occurring, but that a daily journal can be useful as well.

2. As necessary, research the locations of the winter and summer territories of the birds observed in that class. Each student can be assigned to find out about one bird that was observed, and the findings can be shared with the class and plotted on a map during the next class.

3. Read and become familiar with a Glossary of Words the students will need to at least recognize in order to read the Homework to be assigned in Class #14.

FOLLOW-UP:

Write thank-you notes to any guest field leaders, or owners of the natural areas you have visited.

HANDOUTS:

Glossary of scientific terms

LINKS: Science, ecology, geography.

****

Class #12

HOMEWORK

This is a Glossary of Terms that it is useful to be familiar with in order to read the Homework text to be assigned in Class # 17. The Glossary can be introduced to students as Homework for this class, or for one of the several other field trip classes.

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GLOSSARY OF TERMS from THE DIVERSITY OF LIFE, copyright @ Edward O. Wilson, 1992.

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biodiversity The variety of organisms considered at all levels, from genetic variants belonging to the same species through arrays of species to arrays of genera, families, and still higher taxonomic levels; includes the variety of ecosystems, which comprise both the communities of organisms within particular habitats and the physical conditions under which they live.

biological diversity See *biodiversity*

biomass The total weight (usually, dry weight) of a designated group of organisms in a particular area, as of all the birds living in a woodlot or all the algae in a pond or all the organisms in the world.

biome A major category of habitat in a particular region of the world, such as the tundra of northern Canada or the rain forest of the Amazon basin.

bioregion A continuous natural area, such as a river system or mountain range, large enough to extend beyond political boundaries.

biota The combined flora, fauna, and microorganisms of a given region.

diversity See *biodiversity*

DNA Deoxyribonucleic acid. The fundamental hereditary material of all living organisms; the polymer composing the genes.

ecosystem The organisms living in a particular environment, such as a lake or a forest (or, in increasing scale, an ocean or the whole planet), and the physical part of the environment that impinges on them. The organisms alone are called the community.

endangered Near extinction. Referring to a species or ecosystem

so reduced or fragile that it is doomed or at least fatally vulnerable.

endemic A species or race native to a particular place and found only there.

environment The surroundings of an organism or a species: the ecosystem in which it lives, including both the physical environment and the other organisms with which it comes in contact.

equilibrium See *species equilibrium*.

extinction The termination of a ny lineage of organisms, from subspecies to species and higher taxonomic categories from genera to phyla. Extinction can be local, in which one or more populations of a species or other unit vanish but others survive elsewhere, or total (global), in which all the populations vanish. When biologists speak of the extinction of a particular species without further qualification, they mean total extinction.

extractive reserve A wild habitat from which timber, latex, and other natural products are taken on a sustained yield basis with minimal environmental damage and, ideally, without the extinction of native species.

fauna All the animals found in a particular place.

flora All the plants found in a particular place.

habitat An environment of a particular kind, such as lake shores or tall-grass prairie; also a particular environment in one place, such as the mountain forest of Tahiti.

keystone species A species, such as the sea otter, that affects the survival and abundance of many other species in the community in which it lives. Its removal or addition results in a relatively significant shift in the composition of the community and sometimes even in the physical structure of the environment.

species The basic unit of classification, consisting of a population or series of populations of closely related and similar organisms. In sexually reproducing organisms, the species is more narrowly defined by the biological-species concept: a population or series of populations of organisms that freely interbreed with one another in natural conditions but not with members of other species.

species equilibrium The steady-state number of species, or biodiversity, found on an island or isolated patch of habitat due to a balance between the immigration of new species and the extinction of old residents.

symbiosis The living together of two or more species in a prolonged and intimate ecological relationship, such as the incorporation of algae and cyanobacteria within fungi to create lichens.

systematics The scientific study of the diversity of life. Sometimes used synonymously with taxonomy to mean the procedures of pure classification and reconstruction of phylogeny (relationship among species); on other occasions it is used more broadly to cover all aspects of the origins and content of biodiversity.

taxonomy The science (and art) of the classification of organisms. See also *systematics*.

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SEGMENT C
DISCOVERING BIRDS AND BIODIVERSITY
FIRST-HAND

Class #13
Field Trip

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This class is scheduled for another field trip to a local natural area. It is set out separately here for schedule planning purposes.

****

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SEGMENT C
DISCOVERING BIRDS AND BIODIVERSITY
FIRST-HAND

Class #14
Listening to, and Hearing, Biodiversity

****

OBJECTIVE: Have students appreciate that biodiversity and the natural world is reflected in, and can be discovered by, listening to it.

THEME: Bird songs can be appreciated and learned by comparing their differences.

CLASS ACTIVITY:

I. Listen to, and diagram, bird songs:

Play a pre-recorded tape of a variety of bird songs. "Chart" the bird songs on the blackboard, and ask the students to make their own charts, to help them see the differences among the songs, and to help them learn to recognize them. Play the songs one at a time, chart each one and discuss it, and then go on to the next one.

PREPARATION:

Obtain and review a pre-recorded tape of bird songs. See "Course Logistics", above for a discussion of the type of tape to obtain. Be sure to consult any instructions accompanying the pre-recorded tape for assistance in learning how to chart the songs. The introduction to standard bird field guides also may contain this information.

RESOURCES NEEDED:

A pre-recorded bird song tape is needed, and a portable tape player is necessary to play the tape. See "Course Logistics", above for a discussion of the type of tape to obtain.

HOMEWORK TO ASSIGN:

At this point in the course, either for this class or at the end of one of the field trips, assign the students to read:

1. The booklet, "Birds over Troubled Forests", which is contained in the Migratory Bird Information Kit identified in "Course Logistics", above;

2. "Silence of the Songbirds", National Geographic, June 1993;

3. Wilson, Edward O., The Diversity of Life, pp. 228-231 (excerpts concerning endangered birds); and

4. The Diversity of Life, p. 265.

These articles will be discussed in Class #17.

FOLLOW-UP:

Continue keeping an eye out for interesting articles about local habitat conditions, or about the spring migration, in your local area.

LINKS: Science

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Class # 14

HOMEWORK

Excerpt from Wilson, Edward O., The Diversity of Life, pp. 311 - 351. Selections from Edward O. Wilson, The Diversity of Life are reprinted with the permission of W.W. Norton & Company, Inc., New York.

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CHAPTER FOURTEEN

Resolution

EVERY COUNTRY has three forms of wealth: material, cultural, and biological. The first two we understand well because they are the substance of our everyday lives. The essence of the biodiversity problem is that biological wealth is taken much less seriously. This is a major strategic error, one that will be increasingly regretted as time passes. Diversity is a potential source for immense untapped material wealth in the form of food, medicine, and amenities. The fauna and flora are also part of a country's heritage, the product of millions of years of evolution centered on that time and place and hence as much a reason for national concern as the particularities of language and culture.

The biological wealth of the world is passing through a bottleneck destined to last another fifty years or more. The human population has moved past 5.4 billion, is projected to reach 8.5 billion by 2025, and may level off at 10 to 15 billion by midcentury. With such a phenomenal increase in human biomass, with material and energy demands of the developing countries accelerating at an even faster pace, far less room will be left for most of the species of plants and animals in a short period of time.

The human juggernaut creates a problem of epic dimensions: how to pass through the bottleneck and reach midcentury with the least possible loss of biodiversity and the least possible cost to humanity. In theory at least, the minimization of extinction rates and the minimization of economic costs are compatible:

the more that other forms of life are used and saved, the more productive and secure will our own species be. Future generations will reap the benefit of wise decisions taken on behalf of biological diversity by our generation.

What is urgently needed is knowledge and a practical ethic based on a time scale longer than we are accustomed to apply. An ideal ethic is a set of rules invented to address problems so complex or stretching so far into the future as to place their solution beyond ordinary discourse. Environmental problems are innately ethical. They require vision reaching simultaneously into the short and long reaches of time. What is good for individuals and societies at this moment might easily sour ten years hence, and what seems ideal over the next several decades could ruin future generations. To choose what is best for both the near and distant futures is a hard task, often seemingly contradictory and requiring knowledge and ethical codes which for the most part are still unwritten.

If it is granted that biodiversity is at high risk, what is to be done? Even now, with the problem only beginning to come into focus, there is little doubt about what needs to be done. The solution will require cooperation among professions long separated by academic and practical tradition. Biology, anthropology, economics, agriculture, government, and law will have to find a common voice. Their conjunction has already given rise to a new discipline, biodiversity studies, defined as the systematic study of the full array of organic diversity and the origin of that diversity, together with the methods by which it can be maintained and used for the benefit of humanity. The enterprise of biodiversity studies is thus both scientific, a branch of pure biology, and applied, a branch of biotechnology and the social sciences. It draws from biology at the level of whole organisms and populations in the same way that biomedical studies draw from biology at the level of the cell and molecule. Where biomedical studies are concerned with the health of the individual person, biodiversity studies are concerned with the health of the living part of the planet and its suitability for the human species. What follows, then, is an agenda on which I believe most of those who have focused on biodiversity might agree. All the enterprises I will list are directed at the same goal: to save and use in perpetuity as much of earth's diversity as possible.

1. *Survey the world's fauna and flora.* In approaching diversity, biologists are close to traveling blind. They have only the faintest idea

of how many species there are on earth or where most occur; the biology of more than 99 percent remain unknown. Systematists are aware of the urgency of the problem but far from agreed on the best way to solve it. Some have recommended the initiation of a global survey, aimed at the discovery and classification of all species. Others, sensibly noting the shortage of personnel, funds, and time, think the only realistic hope lies in the rapid recognition of the threatened habitats that contain the largest number of endangered endemic species (the hot spots).

In order to move systematics into the larger role demanded by the extinction crisis, its practitioners have to agree on an explicit mission with a timetable and cost estimates. The strategy most likely to work is mixed, aiming at a complete inventory of the world's species, but across fifty years and at several levels, or scales in time and space, from hot-spot identification to global survey, audited and readjusted at ten-year intervals. As each decade comes to a close, progress to that point could be assessed and new directions identified. Emphasis from the outset would be placed on the hottest spots known or suspected.

Three levels can be envisioned. The first is the RAP approach, from the prototypic Rapid Assessment Program created by Conservation International, a Washington-based group devoted to the preservation of global biodiversity. The purpose is to investigate quickly, within several years, poorly known ecosystems that might be local hot spots, in order to make emergency recommendations for further study and action. The area targeted is limited in extent, such as a single valley or isolated mountain. Because so little is known of classification of the vast majority of organisms and so few specialists are available to conduct further studies, it is nearly impossible to catalog the entire fauna and flora of even a small endangered habitat. Instead a RAP team is formed of experts on what can be called the elite focal groups—organisms, such as flowering plants, reptiles, mammals, birds, fishes, and butterflies, that are well enough known to be inventoried immediately and can thereby serve as proxies for the whole biota around them.

The next level of inventory is the BIOTROP approach, from the Neotropical Biological Diversity Program of the University of Kansas and a consortium of other North American universities formed in the late 1980s. Instead of pinpointing brushfires of extinction at selected localities in the RAP manner, BIOTROP explores more systematically across broad areas believed to be major hot spots or at least

to contain multiple hot spots. Examples of such regions include the eastern slopes of the Andes and the scattered forests of Guatemala and southern Mexico. Beyond identifying critical localities, the larger goal is to set up research stations across the area that embrace different latitudes and elevations. The work begins with a few focal organisms. It expands to less familiar groups, such as ants, beetles, and fungi, as enough specimens are collected and experts in the groups are recruited to study them. In time, close studies of rainfall, temperature, and other properties of the environment are added to the species inventory. The most important and best equipped of the stations are likely then to evolve into centers of long-term biological research, with leadership roles taken by scientists from the host countries. They can also be used to train scientists from different parts of the world.

We now come to the third and highest stage of the biodiversity survey. From inventories at the RAP and BIOTROP levels in different parts of the world, accompanied by monographic studies of one group of organisms after another, the description of the living world will gradually coalesce to create a fine-grained image of global biodiversity. The growth of knowledge will inevitably accelerate, even given a constant level of effort, by producing its own economies of scale. Costs per species logged into the inventory fall as new methods of collecting and distributing specimens are devised and procedures for accessing information are improved. Costs are not simply additive when nonelite groups of organisms are included, but instead decline on a per-species basis. Botanists, for example, can collect insects living on the plants they study, while identifying these hosts for the entomologists, and entomologists can run the procedure in reverse, gathering plant specimens in company with the insects they collect. Groups such as reptiles, beetles, and spiders can be sampled across entire habitats, then distributed to specialists on each group in turn.

As biodiversity surveys proceed at the several levels, the knowledge gathered becomes an ever more powerful magnet for other kinds of science. Field guides and illustrated treatises open doors to the imagination, and networks of technical information draw geologists, geneticists, biochemists, and others into the enterprise. It will be logical to gather much of the activity into biodiversity centers, where data are gathered and new inquiries planned. The prototype is Costa Rica's National Institute of Biodiversity (Instituto Nacional de Biodiversidad), INBio for short, established on the outskirts of the capital city of San José in 1989 The aim of INBio is nothing less than

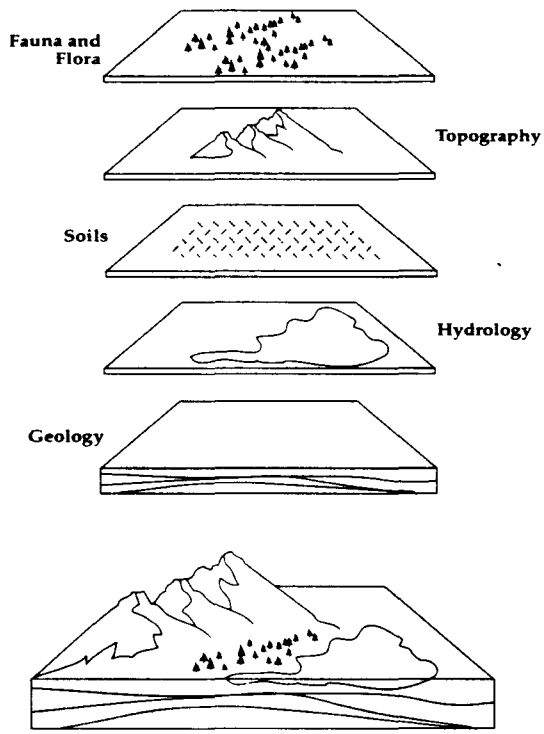
to account for all the plants and animals of this small Central American country, over half a million species in number, and to use the information to improve Costa Rica's environment and economy. It is perhaps odd that a developing nation should lead the way in such a concerted scientific enterprise, but others will follow. Detailed distribution maps of plants and many kinds of animals have been drawn up in Great Britain, Sweden, Germany, and other European countries under governmental and private auspices. As I write, plans for a national biodiversity center in the United States have been advanced by the Smithsonian Institution and are under wide discussion. Enabling legislation has been placed before Congress but is not yet passed.

The national center of the United States will not have to start from scratch. Many kinds of organisms have been already carefully studied and mapped. Several of the states, including Massachusetts and Minnesota, have undertaken programs to locate endangered species of plants and vertebrate animals within their borders. For fifteen years the Nature Conservancy, one of the premier private American foundations, has conducted a similar effort across all the states. The operation, setting up Natural Heritage Data Centers, has recently been extended to fourteen Latin American and Caribbean countries.

Another key element of biodiversity studies at all levels will be microgeography, the mapping of the structure of the ecosystem in sufficiently fine detail to estimate the populations of individual species and the conditions under which they grow and reproduce. A working technology already exists in the form of Geographic Information Systems, a collection of layers of data on topography, vegetation, soils, hydrology, and species distributions that are registered electronically to a common coordinate system. When applied to biodiversity and endangered species, the cartography is called *gap analysis*. Even though incomplete, gap analysis can reveal the effectiveness of existing parks and reserves. It can be used to help answer the larger questions of conservation practice. Do protected areas in fact embrace the largest possible number of endemic species? Are the surviving habitat fragments large enough to sustain the populations indefinitely? And what is the most cost-effective plan for further land acquisition?

The same information can be used to zone large regions. Parcels of land will have to be set aside as inviolate preserves. Others will be identified as the best sites for extractive reserves, for buffer zones used in part-time agriculture and restricted hunting, and for land

Geographic Information Systems



Geographic Information Systems combine information on physical and biological environments by joining layered data sets. These can be used to manage the landscape in a way that protects endangered species and ecosystems, including the designation of natural reserves.

convertible totally to human use. In the expanded enterprise, landscape design will play a decisive role. Where environments have been mostly humanized, biological diversity can still be sustained at high levels by the ingenious placement of woodlots, hedgerows, watersheds, reservoirs, and artificial ponds and lakes. Master plans will meld not just economic efficiency and beauty but also the preservation of species and races.

The layered data can further aid in defining "bioregions," areas such as watersheds and forest tracts that unite common ecosystems but often extend across the borders of municipalities, states, or even countries. A river may make economic or military sense in dividing two political units, but it makes no sense at all in organizing land-use management. Bioregionalism has had a long but inconclusive history within the United States. It dates back at least as far as John Muir's successful championing of national parks and the establishment of the national forest system in 1891. Since the 1930s it has received increasing governmental sanctions with variable specific agendas, from the Tennessee Valley Authority, which managed land and created hydroelectric power through a large part of the southeast, to the establishment of the Appalachian National Scenic Trail, federal and state management of the south Florida water system and the Everglades, and the multiple regulatory and promotional activities of the New England River Basins Commission during its tenure from 1967 to 1981.

Other examples of bioregionalism abound in the United Sates, but it cannot be said that the movement has coalesced around any single philosophy of land management. Nor has the preservation of biodiversity ranked as more than an auxiliary goal. In fact the great dams built by the Tennessee Valley Authority, while providing cheap electric power to an impoverished part of the nation, inadvertently wiped out a substantial part of the native river fauna. The lower priority given diversity has not been by deliberation but from incomplete knowledge of the faunas and floras of the affected regions.

Systematics, having emerged as a prerequisite for effective long-term zoning and bioregionalism, is a labor-intensive enterprise. Scientists who study the classification of particular organisms, such as centipedes and ferns, are often by default the only authorities on the general biology of those organisms. About 4,000 such specialists in the United States and Canada attempt to manage the classification of the many thousand species of animals, plants, and microorganisms living on the continent. To varying degree they are also responsible

for the millions of species occurring elsewhere in the world, since even fewer systematists are active in other countries. Probably a maximum of 1,500 trained professional systematists are competent to deal with tropical organisms, or more than half of the world's biodiversity. A typical case is the shortage of experts on termites, which are premier decomposers of wood, rivals of earthworms as turners of the soil, owners of 10 percent of the animal biomass in the tropics, and among the most destructive of all insect pests. There are exactly three people qualified to deal with termite classification on a worldwide basis. A second revealing case: the oribatid mites, tiny creatures resembling a cross between a spider and a tortoise, are among the most abundant animals of the soil. They are major consumers of humus and fungus spores, and therefore key elements of land ecosystems almost everywhere. In North America only one expert attends to their classification on a full-time basis.

With so few people prepared to launch it, a complete survey of earth's vast reserves of biological diversity may seem beyond reach. But compared with what has been dared and achieved in high-energy physics, molecular genetics, and other branches of big science, the magnitude of its challenge is not all that great. The processing of 10 million species is achievable within fifty years, even with the least efficient, old-fashioned methods. If one systematist proceeded at the cautious pace of ten species per year, including field trips for collecting, analysis of specimens in the laboratory, and publication, taking time out for vacations and family, about one million person-years of work would be required. Given forty years of productive life per scientist, the effort would consume 25,000 professional lifetimes. The number of systematists would still represent less than 10 percent of the current population of scientists active in the United States alone, and it falls well short of the number of enlisted men in the standing armed forces of Mongolia, not to mention the trade and retail personnel of Hinds County, Mississippi. The volumes of published work, one page per species, would fill 12 percent of the shelves of the library of Harvard's Museum of Comparative Zoology, one of the larger institutions devoted to systematics.

I have based these estimates on what is the least efficient procedure imaginable, in order to establish the plausibility of a total inventory of global biodiversity. Systematic work can be speeded up many times over by new techniques now coming into general use. The Statistical Analysis System (SAS), a set of computer programs already running in several thousand institutions worldwide, records taxo-

nomic identifications and localities of individual specimens and automatically integrates data in catalogs and maps. Other computer-aided techniques compare species automatically across large numbers of traits, applying unbiased measures of similarity, the procedure called *phenetics*. Still others assist in deducing the most likely family trees of species, the method called *cladistics*. Scanning-electron microscopy has accelerated the illustration of insects and other small organisms. Computer technology will in time include image scanning that can identify species instantly while flagging specimens that belong to new species. Biologists are also close to electronic publication, which will allow retrieval of descriptions and analyses of particular groups of organisms by desktop personal computers.

Every other form of biological information on species—ecology, physiology, economic uses, status as vectors, parasites, agricultural pests—can be layered in the databases. DNA and RNA sequences and gene maps can be added. GenBank, the genetic-sequence bank, has been chartered to provide a computer database for all known DNA and RNA sequences and related biological information. By 1990 it had accumulated 35 million sequences distributed through 1,200 species of plants, animals, and microorganisms. The rate of data accession is ascending swiftly with the advent of improved sequencing methods.

2. *Create biological wealth.* As species inventories expand, they open the way to bioeconomic analysis, the broad assessment of the economic potential of entire ecosystems. Every community of organisms contains species with potential commodity value—timber and wild-plant products to be harvested on a sustained basis, seeds and cuttings that can be transplanted to grow crops and ornamentals elsewhere, fungi and microorganisms to be cultured as sources of medicinals, organisms of all kinds offering new scientific knowledge that points to still more practical applications. And the wild habitats have recreational value, which will grow as a larger sector of the public travels and learns to enjoy natural history.

The decision to make bioeconomic analysis a routine part of land-management policy will protect ecosystems by assigning them future value. It can buy time against the removal of entire communities of organisms ignorantly assumed to lack such value. When local faunas and floras are better known, the decision can be taken on how to use them optimally—whether to protect them, to extract products from them on a sustainable yield basis, or to destroy their habitat for

full human occupation. Destruction is anathema to conservationists, but the fact remains that most people, lacking knowledge, regard it as perfectly acceptable. Somehow knowledge and reason must be made to intrude. I am willing to gamble that familiarity will save ecosystems, because bioeconomic and aesthetic values grow as each constituent species is examined in turn—and so will sentiment in favor of preservation. The wise procedure is for law to delay, science to evaluate, and familiarity to preserve. There is an implicit principle of human behavior important to conservation: *the better an ecosystem is known, the less likely it will be destroyed.* As the Senegalese conservationist Baba Dioum has said, "In the end, we will conserve only what we love, we will love only what we understand, we will understand only what we are taught."

A key enterprise in bioeconomic analysis is what Thomas Eisner has called *chemical prospecting*, the search among wild species for new medicines and other useful chemical products. The logic of prospecting is supported by everything we have learned about organic evolution. Each species has evolved to become a unique chemical factory, producing substances that allow it to survive in an unforgiving world. A newly discovered species of roundworm might produce an antibiotic of extraordinary power, an unnamed moth a substance that blocks viruses in a manner never guessed by molecular biologists. A symbiotic fungus cultured from the rootlets of a nearly extinct tree might yield a novel class of growth promoters for plants. An obscure herb could be the source of a sure-fire blackfly repellent—at last. Millions of years of testing by natural selection have made organisms chemists of superhuman skill, champions at defeating most of the kinds of biological problems that undermine human health.

Because chemical prospecting depends so heavily on classification, it is best conducted in tandem with biodiversity surveys. In order to succeed, investigators must also work in laboratories equipped with advanced facilities, which are usually available only in industrialized countries. In 1991 Merck and Company, the world's largest pharmaceutical firm, agreed to pay Costa Rica's National Institute of Biodiversity $1 million to assist in such a screening effort. The institute will collect and identify the organisms, sending chemical samples from the most promising species to the Merck laboratories for medicinal assay. If natural substances are marketed, the company is committed to pay the Costa Rican government a share of the royalties, which will then be earmarked for conservation programs. Merck has previously marketed four drugs from soil organisms originating

from other countries. One, derived from a fungus, is Mevacor, an effective agent for lowering cholesterol levels. In 1990 Merck sold $735 million worth of this substance alone. It follows that a single success in Costa Rica—a commercial product from, say, any one species among the 12,000 plants and 300,000 insects estimated to live in the country—could handsomely repay Merck's entire investment.

There are historical reasons why Merck and other research and commercial organizations are increasingly inclined to take on chemical prospecting. The search for naturally occurring drugs and other chemical products has been cyclical through the years. In the 1960s and 1970s pharmaceutical companies phased out the screening of plants on the grounds that it was too complicated and expensive. With only one in 10,000 species yielding a promising substance (by procedures then in use) and millions of dollars needed to bring a product fully on line, the eventual payoff seemed marginal. The companies turned to new technologies in microbiology and synthetic chemistry, hoping to design the magic bullets of the new medical age with chemicals taken from the shelf. To rely on human ingenuity rather than evolved natural chemistry in distant jungles seemed much more "scientific" and direct, and perhaps less expensive. Yet natural products remained a potential shortcut, a Columbus-like journey west, for those willing to acquire the essential skills. Now the pendulum has begun to swing back, again from advances in technology, because high-volume, robot-controlled biological assays allow larger companies to screen up to 50,000 samples a year using only bits of fresh tissue or extract flown to them from any part of the world.

The path from wild organism to commercial production can sometimes be shortened further by taking clues from the lore and traditional medicine of indigenous peoples. It is a remarkable fact that of the 119 known pure pharmaceutical compounds used somewhere in the world, 88 were discovered through leads from traditional medicine. The knowledge of all the world's indigenous cultures, if gathered and catalogued, would constitute a library of Alexandrian proportions. The Chinese, for example, employ materials from about 6,000 of the 30,000 plant species in their country for medicinal purposes. Among them is artemisinin, a terpene derived from the annual wormwood (*Artemisia annua*), which shows promise as an alternative to quinine in the treatment of malaria. Because the molecular structures of the two substances are entirely different, artemisinin would have been discovered much less quickly if not for its folkloric reputation.

Because the lives of people and the reputations of shamans have depended on it for generations, much of the traditional pharmacopoeia is reliable. Extraction procedures and dosage have been tested by trial and error countless times. But this preliterate knowledge, like so many of the plant and animal species to which it pertains, is disappearing rapidly as tribes move from their homelands onto farms and into cities and villages. When they take up new trades, their languages fall into disuse and the old ways are forgotten. During the 1980s, all but 500 of the 10,000 Penans of Borneo abandoned their centuries-old seminomadic life in the forests and settled in villages. Today their memories are fading quickly. Eugene Linden notes, "Villagers know that their elders used to watch for the appearance of a certain butterfly, which always seemed to herald the arrival of a herd of boar and the promise of good hunting. These days, most of the Penans cannot remember which butterfly to look for." On the other side of the world, 90 of Brazil's 270 Indian tribes have vanished since 1900, and two thirds of those remaining contain populations of less than a thousand. Many have lost their lands and are forgetting their cultures.

Small farms around the world are giving way to the monocultures of agrotechnology. The raised garden squares of the Incas have all but vanished; the densely variegated gardens of Mesoamerica and West Africa are threatened. The revitalization of local farming is another aim of biodiversity studies. The goal is to make the practice more economically practical, while conserving the genetic reserves that will contribute to crops of the future. Species and strains of high economic efficiency, from perennial corn to amaranth and iguanas, can be fed through research centers into the local regions best suited to use them. A successful prototype of such enterprises is the Tropical Agricultural Research and Training Center (CATIE) at Turrialba, Costa Rica. Created by the Organization of American States in 1942, CATIE maintains large samples of plant species, including disease-resistant strains of cacao and other tropical crops Its staff members experiment with propagation methods for crops and timber, design wildland preservation programs, search for new crop species and varieties, and train students in the new methods of agriculture and conservation. Institutions of the future can be profitably built to include not only these activities but also chemical prospecting and molecular techniques of gene transfer from wild to domestic species.

3. *Promote sustainable development.* The rural poor of the Third World are locked onto a downward spiral of poverty and the destruction of

diversity. To break free they need work that provides the basic food, housing, and health care taken for granted by a great majority of people in the industrialized countries. Without it, lacking access to markets, hammered by exploding populations, they turn increasingly to the last of the wild biological resources. They hunt out the animals within walking distance, cut forests that cannot be regrown, put their herds on any land from which they cannot be driven by force. They use domestic crops ill suited to their environment, for too many years, because they know no alternative. Their governments, lacking an adequate tax base and saddled with huge foreign debts, collaborate in the devastation of the environment. Using an accountant's trick, they record the sale of forests and other irreplaceable natural resources as national income without computing the permanent environmental losses as expense.

The poor are denied an adequate education. They cannot all move into the cities; in most countries, and especially those in the tropics, industrialization will be too slow to absorb more than a small fraction into the labor force. Their striving billions will, for the next century at least, have to be accommodated in rural areas. So the issue comes down to this: how can people in developing countries achieve a decent living from the land without destroying it?

The proving ground of sustainable development will be the tropical rain forests. If the forests can be saved in a manner that improves local economies, the biodiversity crisis will be dramatically eased. Within that "if" are folded technical and social difficulties of the most vexing kind. But many paths to the goal have been suggested, and some have successfully tested.

One of the most encouraging advances to date is the demonstration, cited in the last chapter, that the extraction of nontimber products from Peruvian rain forests can yield similar levels of income as logging and farming, even with the limited outlets available in existing local markets. The practice has been regularized by the rubber tappers of Brazil without a bit of theory or cost-benefit analysis. The tappers, or *seringueiros* as they are locally called, are the descendants of immigrants from northeastern Brazil who colonized portions of the Amazon during the late nineteenth century and found a steady living in latex harvesting. Half a million strong, they draw their principal income today not only from rubber but also from Brazil nuts, palm hearts, tonka beans, and other wild products. Each family owns a house in the midst of harvesting pathways shaped like clover leaves. In addition to harvesting natural products, rubber tappers also hunt, fish, and practice small-scale agriculture in forest clearings.

Because they depend on biological diversity, the tappers are devoted to the preservation of the forests as stable and productive ecosystems. They are in fact full members of the ecosystems. In 1987 the Brazilian government authorized the establishment of *seringueiro* extractive reserves on state land, with thirty-year renewable leases and a prohibition on the clear-cutting of timber.

Extractive reserves represent a major conceptual advance, but they are not enough to save more than a small portion of the rain forests. In 1980 rubber-tapper households occupied 2.7 percent of the area of the North Region of Brazilian Amazonia, including the states of Amazonas and Acre, while farms and ranches occupied 24 percent. Only a small fraction of the flood of new immigrants now pouring into the region can become extractivists. The rest will seek income wherever they find it, primarily by advancing the agricultural frontier. The key to the future of Amazonia and other forested tropical regions is whether employment made available to them saves or destroys the environment. "The real challenge," John Browder writes, "is not where to designate extractive reserves, but rather, how to integrate sustainable extraction and other natural forest management practices into the production strategies of those existing rural properties, small farms and large ranches alike, that are responsible for most of the devastation being visited upon Amazonian rainforests. Fundamentally, the problem is not where to sequester forests, but how to turn people into better forest managers."

It is possible to harvest timber from the Amazonian wilderness and other great remaining rain forests extensively and profitably with little loss of biodiversity. The method of choice, first suggested by Gary Hartshorn in 1979 and extended by other foresters, is strip logging. While lowland forested basins are not rugged in terrain, most are moderately rolling with well-defined slopes and dense systems of drainage streams. Strip logging imitates the natural fall of trees that create linear gaps through the forest, with the artificial gaps being aligned along the contours. The technique is described by Carl Jordan:

> In this scheme, a strip is harvested on the contour of a slope, parallel to the stream. Along the upper edge of the strip is a road used for hauling out the logs. After harvesting, the area is left for a few years until saplings begin to grow in the cut areas. Then the loggers clear-cut another strip, this time above the road. The advantages of this system are that the nutrients from the freshly cut second strip wash downslope

into the rapidly regenerating first strip, where the trees can quickly use the nutrients, and that seeds from the mature forest above the cut area will roll down into the recently cut strip. In contrast, in clear-cutting there are no saplings with well-developed roots capable of retaining nutrients in the system, nor is there a source of seed for regeneration of the forest.

So far so good, but how can governments and local peoples be persuaded to adopt such innovations as extractive reserves and strip logging? The shift to sustainable development will depend as much on education and social change as on science. Around the world modest projects are being advanced with one common result: if procedures tailored to the special case are used, economic development and conservation can both be served. People can be persuaded; they understand their own long-term interest and they can adapt. Here are three successful programs from Latin America.

• By Panama law, the Kuna Indians hold sovereign rights over the San Blas Islands and 300,000 hectares of adjacent mainland forest. The Kuna maintain "spirit sanctuaries," areas of primary forest in which only certain kinds of trees may be cut and no farming is allowed. Local communities depend on the sea for most of their protein, on the forests for wood, game, and medicine, and on limited patches of cleared land for domestic crops. When a spur of the Pan-American Highway was brought to the edge of their land, the Kuna established a forest reserve and guarded it with their own people. Well aware of the outside world, welcoming to visitors, the tribes have nevertheless chosen to discourage immigration and to preserve their own culture within the bountiful natural environment that has sustained them for centuries.

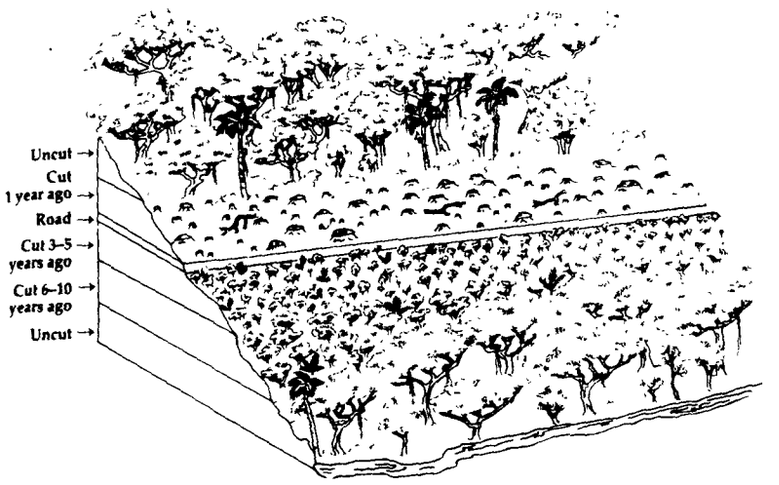
• Most of Central America, unlike the land of the Kuna, is plagued by soil erosion and nutrient loss owing to the excessive cultivation of maize and other crops, leading to the cutting of forests on ever steeper slopes, all driven in turn by overpopulation. As production declines, farmers invade the remaining natural areas in search of more arable land. The process is especially acute in the Güinope region of Honduras. In 1981 two private foundations, one international and one Honduran, commenced a pilot program in some of the Güinope villages under government auspices to raise productivity and restore the land. They introduced drainage ditches, contour furrows, grassy barriers, and intercropping with nitrogen-restoring legumes. The field labor and implementation costs were provided entirely by the farmers. Within several years, yields tripled and em-

igration nearly ceased. The new agricultural methods began to spread to surrounding areas.

• When a highway, the Carretera Marginal de la Selva, was cut into Peru's Palcazú Valley, 85 percent of the land was still clothed by rain forest. Like most of the eastern tropical slopes of the Andes, the valley is biologically rich, containing for example more than a thousand species of trees. The region also supported about 3,000 Amuesha Indians and an equal number of settlers who had established small landholdings over the previous fifty years. Once opened to outside commerce, the typical fate of a western Amazonian valley is to be clear-cut by new immigrants and logging companies, then used for cattle ranches and small farms. The thin, acidic soil soon loses most of its free phosphates and other nutrients, launching the next phase: erosion, poverty, partial abandonment. For this valley, however, an alternative plan was proposed by the U.S. Agency for International Development and approved by the Peruvian government. It is to extract timber by strip cutting, regulated to allow perpetual regeneration of the forest through thirty- to forty-year rotations. The plan permits limited permanent conversion of the most arable land to agriculture and livestock production. But it also calls for the establishment of a watershed reserve in the adjacent San Matias mountain range and the designation of the neighboring Yanachaga range as the Yanachaga-Chemillén National Park. With luck, the Palcazú will support a healthy human population and a slice of Peru's biodiversity into the next century.

Wildlands and biological diversity are legally the properties of nations, but they are ethically part of the global commons. The loss of species anywhere diminishes wealth everywhere. Today the poorest countries are rapidly decapitalizing their natural resources and unintentionally wiping out much of their biodiversity in a scramble to meet foreign debts and raise the standard of living. By perceived necessity they follow environmentally destructive policies that yield the largest short-term profits. The rich debt-holding nations aggravate the practice by encouraging a free market in poor countries while providing subsidies to farmers at home.

Consider the infamous "hamburger connection" between the United States and Central America. By 1983, in response to the excellent U.S. market for beef, Costa Rican landowners had accelerated the creation of new pastures until only 17 percent of the country's original forest cover was left. For a time it was the world's leading exporter of beef to the United States. When northern tastes



Strip logging allows a sustainable timber yield from forests, including the relatively fragile rain forests. A corridor is cleared along the contours of the land, narrow enough to allow natural regeneration within a few years. Another corridor is then cut above the first, and so on, through a cycle lasting many decades.

changed somewhat and the market fell, Costa Rica was left with a denuded landscape and widespread soil erosion. It had also lost part of its biological diversity.

Developing countries competing in an international free market have a strong incentive to transfer capital into single-money crops such as bananas, sugar cane, and cotton. To that end governments often subsidize the clearing of wildlands and the overuse of pesticides and fertilizers. The rush to maximize export income also concentrates ever more acreage in the hands of a relatively few, politically favored landowners. Small farmers are then forced to seek new land of marginal productivity, including natural habitats. Faced with ruin, they have no choice but to press into nutrient-poor tropical forests, steep hillside watersheds, coastal wetlands, and other final refuges of terrestrial diversity.

This journey to the precipice is hastened by the agricultural support

systems of the richest nations. At the present time subsidies to developed-world farmers total $300 billion a year, six times the official foreign aid to Third World countries. When European Community countries recently underwrote a large program of feedlot cattle raising, they created a huge artificial market for cassava. Landowners in Thailand responded by clearing more tropical forest to grow cassava, and in the process displaced large numbers of subsistence farmers into the deep forest and up the eroding hillsides. When the United States tightened import quotas of cane sugar to aid domestic growers, U.S. imports from the Caribbean countries dropped 73 percent in ten years, forcing many of the rural poor out of jobs in the plantations and into marginal habitats for subsistence farming. Japan's extravagant subsidy to its own rice farmers, intended to continue an ancient agricultural tradition (the Japanese written character for rice means "root of life"), has a depressing effect on the rice-growing populations of tropical Asia. Once again, the impact on natural environments is increased.

The richest countries set the rules for international trade. They provide the bulk of loans and direct aid and control technology transfer to the poor nations. It is their responsibility to use this power wisely, in a manner that both strengthens these trading partners and protects the global environment. They themselves will suffer if the wildlands and biological diversity are not entered into the calculus of trade agreements and international aid.

The raging monster upon the land is population growth. In its presence, sustainability is but a fragile theoretical construct. To say, as many do, that the difficulties of nations are not due to people but to poor ideology or land-use management is sophistic. If Bangladesh had 10 million inhabitants instead of 115 million, its impoverished people could live on prosperous farms away from the dangerous floodplains midst a natural and stable upland environment. It is also sophistic to point to the Netherlands and Japan, as many commentators incredibly still do, as models of densely populated but prosperous societies. Both are highly specialized industrial nations dependent on massive imports of natural resources from the rest of the world. If all nations held the same number of people per square kilometer, they would converge in quality of life to Bangladesh rather than to the Netherlands and Japan, and their irreplaceable natural resources would soon join the seven wonders of the world as scattered vestiges of an ancient history.

Every nation has an economic policy and a foreign policy. The time

has come to speak more openly of a population policy. By this I mean not just the capping of growth when the population hits the wall, as in China and India, but a policy based on a rational solution of this problem: what, in the judgment of its informed citizenry, is the *optimal* population, taken for each country in turn, placed against the backdrop of global demography? The answer will follow from an assessment of the society's self-image, its natural resources, its geography, and the specialized long-term role it can most effectively play in the international community. It can be implemented by encouragement or relaxation of birth control and the regulation of immigration, aimed at a target density and age distribution of the national population. The goal of an optimal population will require addressing, for the first time, the full range of processes that lock together the economy and the environment, the national interest and the global commons, the welfare of the present generation with that of future generations. The matter should be aired not only in think tanks but in public debate. If humanity then chooses to breed itself and the rest of life into impoverishment, at least it will have done so with open eyes.

4. *Save what remains.* Biodiversity can be saved by a mixture of programs, but not all the programs proposed can work. Consider one often raised in discussions by futurists. Suppose that we lost the race to save the environment, that all natural ecosystems were allowed to vanish. Could new species be created in the laboratory, after genetic engineers have learned how to assemble life from raw organic compounds? It is doubtful. There is no assurance that organisms can be generated artificially, at least not any as complex as flowers or butterflies—or amoebae for that matter. Even this godlike power would solve only half the problem, and the easy one at that. The technicians would be working in ignorance of the history of the extinct life they presumed to simulate. No knowledge exists of the endless mutations and episodes of natural selection that inserted billions of nucleotides into the now-vanished genomes, nor can it be deduced in more than tiny fragments. The neospecies would be creations of the human mind—plastic, neither historical nor adaptive, and unfit for existence apart from man. Ecosystems built from them, like zoos and botanical gardens, would require intensive care. But this is not the time for science-fiction dreams.

On then to the next technical remedy that springs up in scientific conferences and corridor arguments. Can extinct species be resur-

rected from the DNA still preserved in museum specimens and fossils? Again the answer is no. Fractions of genetic codes have been sequenced from a 2400-year-old Egyptian mummy and magnolia leaves preserved as rock fossils 18 million years ago, but they constitute only the smallest portion of the genetic codes. Even that part is hopelessly scrambled. To clone these organisms or a mammoth or a dodo or any other extinct organism would be, as the molecular biologist Russell Higuchi recently said, like taking a large encyclopedia in an unknown language previously ripped into shreds and trying to reassemble it without the use of your hands.

Consider the next possibility raised with regularity: why not just forget the problem and let natural evolution replace the species that are disappearing? It can be done if our descendants are willing to wait several million years. Following the five great extinction episodes of geological history, full recovery of biodiversity required between 10 and 100 million years. Even if *Homo sapiens* lasts that long, the recovery would require returning a large part of the land to its natural state. By appropriating or otherwise disturbing 90 percent of the land surface, humanity has already closed most of the theaters of natural evolution. And even if we did that much and waited that long, the new biota would be very different from the one we destroyed.

Then why not scoop up tissue samples of all living species and freeze them in liquid nitrogen? They could be cloned later to produce whole organisms. The method works for some microorganisms, including viruses, bacteria, and yeasts, as well as the spores of fungi. The American Type Culture Collection, located at Rockville, Maryland, contains over 50,000 species suspended in the deep sleep of absolute biochemical inactivity, ready for warming and reactivation as needed. The cultures are used in research, primarily in molecular biology and medicine. It is possible that many larger organisms could be similarly preserved in nitrogen sleep, at least as fertilized eggs, to be reared later into mature individuals. Even scraps of undifferentiated tissue might be stimulated into normal growth and development. It has been done for organisms as complex as carrots and frogs.

So let us suppose for argument that all kinds of plants and animals are salvageable by such means, that biologists will perfect the techniques of total inactivation and total recovery. The cryotorium in which they would rest, the new Noah's ark, must house tens of millions of species. The preservation of the content of even one

endangered habitat (say a mountain-ridge forest in Ecuador) would be an immense operation enveloping thousands of species, most of which are still unknown to science. Even if completed at the species level, only a small fraction of the genetic variability of each species could be practicably included. Unless the samples numbered into the millions, great arrays of naturally occurring genetic strains would be lost. And when the time comes to return the species to the wild, the physical base of the ecosystem, including its soil, its unique nutrient mix, and its patterns of precipitation, will have been altered so as to make restoration doubtful. Cryopreservation is at best a last-ditch operation that might rescue a few select species and strains certain to die otherwise. It is far from the best way to save ecosystems and could easily fail. The need to put an entire community of organisms in liquid nitrogen would be tragic. Its enactment would be, in a particularly piercing sense of the word, obscene.

I have spoken so far of the maintenance of species and genetic stocks away from their natural habitats. Not all such methods are fantastic or repugnant. One that works for many plants is the maintenance of seed banks: seeds are dried and kept in repositories over long periods. The banks are kept in cool temperatures (about −20°C is typical) but not in the suspended animation of liquid nitrogen. Botanists have proved the technique effective for preserving most strains of crop species. About a hundred countries maintain seed banks and are adding to them steadily by exchanges and new collecting expeditions. Their efforts are aided by the "Green Board," the International Board for Plant Genetic Resources (IBPGR), an autonomous scientific organization located in Rome that composes part of the network of the International Agricultural Research Centers. In 1990 over 2 million sets of seeds were on deposit, representing more than 90 percent of the known local geographic varieties—landraces, as they are called—of many of the basic food crops. Especially well represented are wheat, maize, oats, potatoes, rice, and millet. An effort has begun to include the wild relatives of existing crop species, such as the richly promising perennial maize of Mexico. The method can be extended to wild, noncrop floras of the world.

But there are serious problems with seed banks. Up to 20 percent of plant species, some 50,000 in all, possess "recalcitrant" seeds that cannot be stored by conventional means. Even if seed storage were perfected for all kinds of plants, an unlikely prospect for the immediate future, the task of collecting and maintaining many thousands of endangered species and races would be stupendous. All the efforts

of the existing seed banks to date have been barely enough to cover a hundred species, and even those are in many cases poorly recorded and of uncertain survival ability. Another difficulty: if reliance were placed entirely on seed banks, and the species then disappeared in the wild, the bank survivors would be stripped of their insect pollinators, root fungi, and other symbiotic partners, which cannot be put in cold storage. Most of the symbionts would go extinct, preventing the salvaged plant species from being replanted in the wild.

Other *ex situ* methods rely more realistically on captive populations that grow and reproduce. There are about 1,300 botanical gardens and arboretums in the world, many harboring plant species that are endangered or extinct in the wild. As of June 1991, twenty such institutions in the United States that subscribe to the registry of the National Collection of Endangered Plants contained seeds, plants, and cuttings of 372 species native to the United States. Some of the gardens in North America and Europe are more global in their reach. Harvard's Arnold Arboretum, for one, is famous for its collection of Asiatic trees and shrubs. England's magnificent Kew Gardens is engaged in a bold attempt to preserve and cultivate the last remnants of the nearly vanished tree flora of St. Helena.

Animals are vastly more difficult than plants and microorganisms to maintain *ex situ*. Zoos and other animal facilities have attempted the task in heroic fashion. By the late 1980s, those around the world whose stocks are known had gathered breeding populations of 540,000 individuals belonging to more than 3,000 species of mammals, birds, reptiles, and amphibians. The collections include roughly 13 percent of the known land-dwelling species of vertebrate animals. The better-financed zoos, including those in London, Frankfurt, Chicago, New York, San Diego, and Washington, D.C., conduct basic and veterinarian research with results that are applied to both captive and wild populations. The rosters of 223 zoos in Europe and North America are tracked by the International Species Inventory System (ISIS), which uses the data to coordinate preservation and cross-breeding. The ISIS zoos and research institutions aim not only to save endangered animals but to reintroduce species into their native habitats when land is made available. They have been successful with three species, the Arabian oryx, the black-footed ferret, and the golden lion tamarin. Attempts are underway or planned for at least four other species, the California condor, the Bali starling, the Guam rail, and the Przewalski horse, the ancestor of all domestic horses. The ISIS facilities are trying to get ready if the giant panda, the

Sumatran rhinoceros, and the Siberian tiger, now on the brink, should go extinct in the wild.

The best efforts by zoos, zooparks, aquariums, and research facilities, however, slow the tide of extinction by a barely perceptible amount. Even the groups of animals most favored by the public cannot be completely served. Conservation biologists estimate that as many as 2,000 species of mammals, birds, and reptiles can only be salvaged if they are bred in captivity, a task beyond reach with the means at hand. William Conway, director of the comprehensive zoo maintained by the New York Zoological Society, believes that existing facilities worldwide can sustain viable populations of no more than 900 species. At best these survivors would contain only a small fraction of their species' original genes. And far worse: no provision at all has been made for the many thousands of species of insects and other invertebrates that are equally at risk.

The dreams of scientists come to this: *ex situ* conservation is not enough and will never be enough. Some of the methods are invaluable as safety nets for the fraction of endangered species that biology best understands and the lay public is willing to support. But even if countries everywhere chose to finance greatly enlarged cryobiological vaults, seed banks, botanical gardens, and zoos, the facilities could not be assembled quickly enough to save a majority of species close to extinction from habitat destruction alone. Biologists are hampered by lack of knowledge of more than 90 percent of the species of fungi, insects, and smaller organisms on earth. They have no way to ensure a reasonable sampling of genetic variation even in the species rescued. They have only the faintest idea of how to reassemble ecosystems from salvaged species, if indeed such a feat is possible. Not least, the entire process would be enormously expensive.

All these considerations converge to the same conclusion: *ex situ* methods will save a few species otherwise beyond hope, but the light and the way for the world's biodiversity is the preservation of natural ecosystems. If that is accepted, we must face two realities squarely. The first is that the habitats are disappearing at an accelerating rate and with them a quarter of the world's biodiversity. The second is that the habitats cannot be saved unless the effort is of

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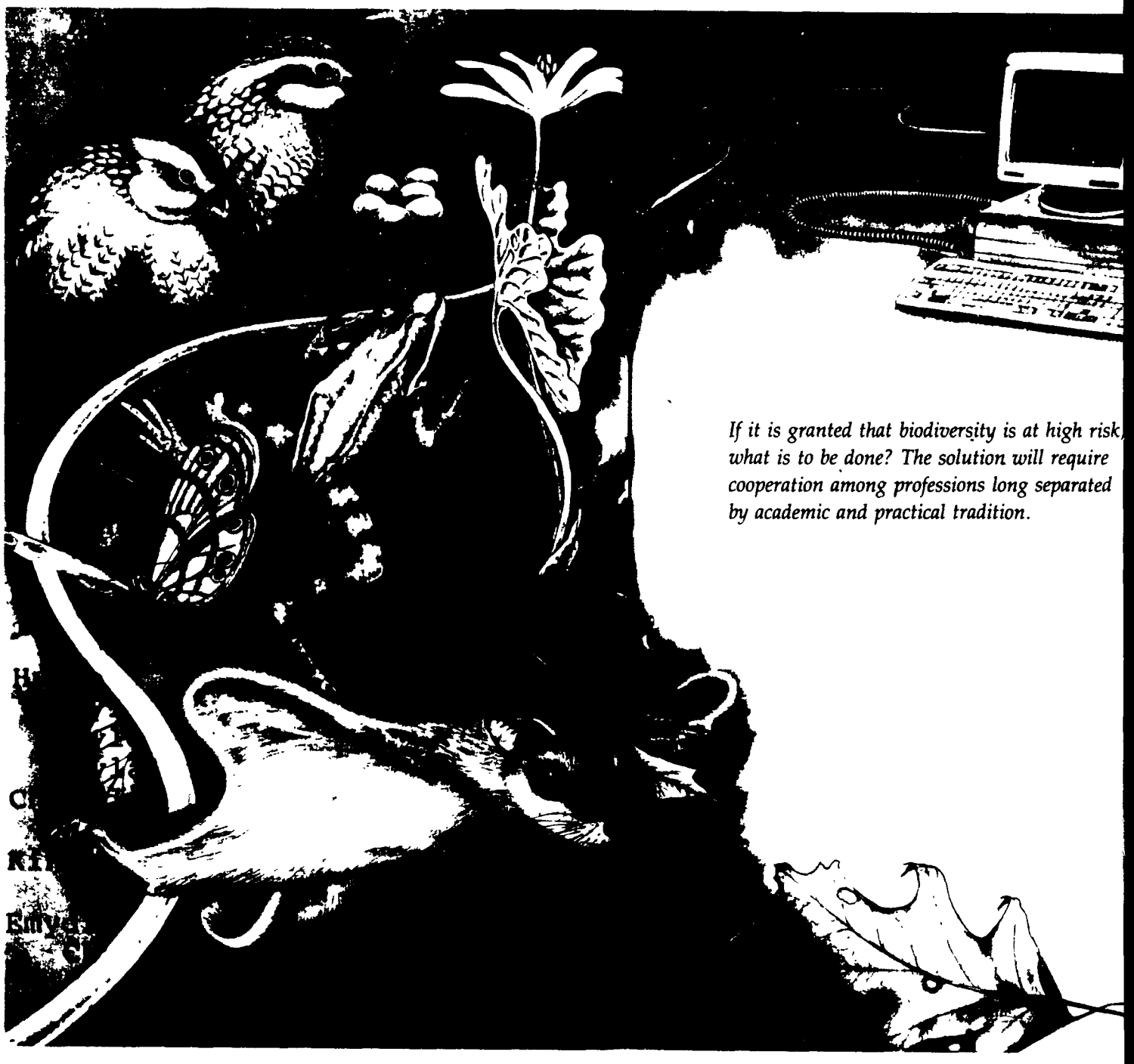
Overleaf: **The fauna and flora of New England are being recorded and analyzed with the aid of increasingly sophisticated computer programs.**



If it is granted that biodiversity is at high risk, what is to be done? The solution will require cooperation among professions long separated by academic and practical tradition.

immediate economic advantage to the poor people who live in and around them. Eventually idealism and high purpose may prevail around the world. Eventually an economically secure populace will treasure their native biodiversity for its own sake. But at this moment they are not secure and they, and we, have run out of time.

The rescue of biological diversity can only be achieved by a skillful blend of science, capital investment, and government: science to blaze the path by research and development; capital investment to create sustainable markets; and government to promote the marriage of economic growth and conservation.

The primary tactic in conservation must be to locate the world's hot spots and to protect the entire environment they contain. Whole ecosystems are the targets of choice because even the most charismatic species are but the representatives of thousands of lesser-known species that live with them and are also threatened. The most inclusive federal legislation in the United States is the Endangered Species Act of 1973, which throws a protective shield around species of "fish, wildlife, and plants" that are "endangered and threatened" by human activities; as amended in 1978, the act also includes subspecies. A bold and creative advance, the legislation is nevertheless destined to be an arena of rising litigation. As any natural environment is reduced in area, the number of species that can live in it indefinitely is also reduced. In other words, some species are doomed to extinction even if all of the remaining habitat were to be preserved from that time on. One of the principles of ecology, as I have stressed, is that the number of species eventually declines by an amount roughly equal to the sixth to third root of the area already lost. Because the great majority of species of microorganisms, fungi, and insects are not well known, it follows that they have been slipping unnoticed through the cracks in the Endangered Species Act. Conflicts between developers and conservationists over birds, mammals, and fishes are already commonplace. As ecosystems are better explored, less-conspicuous endangered species will come to light and the number of clashes will grow.

There is a way out of the dilemma, other than abandoning legal protection of America's fauna and flora altogether. As biodiversity surveys are improved, the hot spots will come more sharply into focus. Well-documented examples already include the embattled coral reef of the Florida Keys and the rain forests of Hawaii and Puerto Rico. As other local habitats are pinpointed, they can be assigned the highest priority for conservation. This means, in most

cases, that they will be set aside as inviolate reserves. Warm spots, areas less threatened or containing fewer species not found elsewhere, can be zoned for partial development, with core preserves centered on endemic species and races and buffer strips around the preserves kept partly wild. Agricultural landscapes and harvested forest tracts can be better designed to harbor rare species and races.

All these actions together, wisely administered, will be effective. But the Endangered Species Act or an equivalent is also needed to serve as a safety net for threatened forms of life in all environments, whether harbored in reserves or not. Finally, in those rare cases where the costs are perceived as intolerable by the electorate, a compromise can be sought by means of population management. This means transplantation of the species to suitable habitats nearby, or restoring its environment in places where it was previously extinguished outside the zone of conflict, or—when all else fails—exile to botanical gardens, zoos, or other *ex situ* preserves.

The area-species relation governing biodiversity shows that maintenance of existing parks and reserves will not be enough to save all the species living within them. Only 4.3 percent of the earth's land surface is currently under legal protection, divided among national parks, scientific stations, and other classes of reserves. These fragments represent recently shrunken habitat islands, whose faunas and floras will continue to dwindle until a new, often lower equilibrium is reached. Over 90 percent of the remaining land surface, including most of the surviving high-diversity habitats, has been altered. If the disturbance continues until most of the natural outside reserves are swept away, a majority of the world's terrestrial species will be either extinguished or put at extreme risk. And more: even the existing reserves are in harm's way. Poachers and illegal miners invade them, timber thieves work their margins, developers find ways to convert them in part. During recent civil wars in Ethiopia, Sudan, Angola, Uganda, and other African countries, many of the national parks were left to ruin.

So we should try to expand reserves from 4.3 percent to 10 percent of the land surface, to include as many of the undisturbed habitats as possible with priority given to the world's hot spots. One of the more promising means to attain this goal is by debt-for-nature swaps. As currently practiced, conservation organizations such as Conservation International, the Nature Conservancy, and the World Wildlife Fund (U.S.) raise funds to purchase a portion of a country's commercial debt at a discount, or else they persuade creditor banks to

donate some of it. This first step is easier than it sounds because so many developing countries are close to default. The debts are then exchanged in local currency or bonds set at favorable rates. The enlarged equity is used to promote conservation, especially by the purchase of land, environmental education, and the improvement of land management. By early 1992 a total of twenty such agreements totaling $110 million had been arranged in nine countries, including Bolivia, Costa Rica, Dominican Republic, Ecuador, Mexico, Madagascar, Zambia, the Philippines, and Poland.

In February 1991, to take one example, Conservation International was authorized to buy $4 million in debt from Mexico's creditors After discounting on secondary markets, the actual cost is expected to be as little as $1.8 million. The conservation organization has agreed to forgive the full amount in return for the expenditure of $2.6 million by the Mexican government on a broad range of conservation projects. The most important initiative will be to preserve the Lacandan tract in the extreme south of Mexico, the largest rain forest in North America.

The debt of Third World countries has been reduced so far by only one part in 10,000 through debt-for-nature swaps. Nor are the arrangements without risk for the receiving country, notably in the crowding out of domestic expenditures and a sparking of local inflation. But these temporary effects are offset by the immense gain, dollar for dollar, in the stabilization of the environment.

More potent still are unencumbered contributions from wealthier nations channeled and carefully targeted through international assistance organizations. The most important enterprise of this kind is the Global Environment Facility (GEF), established in 1990 by the World Bank, the United Nations Environmental Program, and the United Nations Development Program At this writing, $450 million has been committed to set up national parks, promote sustainable forestry, and establish conservation trust funds in developing countries. Under consideration or already approved are proposals from Bhutan, Indonesia, Papua New Guinea, the Philippines, Vietnam, and the Central African Republic Two principal difficulties have appeared within the GEF agenda. One is the limited absorptive power of the recipient nations. With limited trained personnel and expert knowledge, national leaders find it difficult to select the best projects and initiate them effectively. Of much greater significance, the brief terms of funding leave little prospect for the proper management and protection of reserves when the money runs out. Fearing loss of

employment, the brightest professionals are likely to look to other activities to ensure their futures. The solution to both problems may lie in the establishment of national trust funds, producing income that can be fed into the conservation programs gradually and over a period of many years. One such fund has recently been established for Bhutan with the help of the World Wildlife Fund.

We come then to the design of the reserves themselves. As land is set aside, the primary goal is to place the reserves in the regions of highest diversity and to make them as large as possible. Another goal is to design their shape and spacing for retaining efficiency. In approaching that secondary end, a debate has arisen in conservation circles on the so-called SLOSS problem: whether to invest allotted land into a Single Large reserve Or into Several Small reserves. A single large reserve, to put the matter as simply as possible, possesses larger populations of each species, but they all fit into one basket. A single catastrophic fire or flood could extinguish a large part of the diversity of the region. Breaking the reserve into several pieces reduces that problem, but it also diminishes the size of the constituent populations and hence threatens each with extinction. All might easily decline in the face of widespread stress, such as drought or unseasonable cold.

Some biologists have suggested a compromise solution to the SLOSS problem, which is to create small reserves connected by corridors of natural habitat. For example, several forest patches (say 10 kilometers square each) might be joined by strips of forest 100 meters across. Then if a species vanishes from one of the patches, it can be replaced by colonists immigrating along the forest corridor from another patch. The disadvantage that critics of the compromise have been quick to identify is that disease, predators, and exotic competitors can also use corridors to move through the network. Since populations in the patches are small and vulnerable, all might fall like a row of dominoes. I doubt that any general principle of population dynamics exists that can resolve the SLOSS controversy, at least not in the clean manner suggested by its simple geometric imagery. Instead each ecosystem must be studied in turn to decide the best design, which will depend on the species the system contains and the year-by-year fluctuation of its physical environment. For the time being, conservation biologists will agree on the cardinal rule: to save the most biodiversity, make the reserves as large as possible.

5. *Restore the wildlands.* The grim signature of our time has been the reduction of natural habitats until a substantial portion of the

kinds of plants and animals, certainly more than 10 percent, have already vanished or else are consigned to early extinction. The toll of genetic races has never been estimated, but it is almost certainly much higher than that of species. Yet there is still time to save many of the "living dead"—those so close to the brink that they will disappear soon even if merely left alone. The rescue can be accomplished if natural habitats are not only preserved but enlarged, sliding the numbers of survivable species back up the logarithmic curve that connects quantity of biodiversity to amount of area. Here is the means to end the great extinction spasm The next century will, I believe, be the era of restoration in ecology.

In haphazard manner, largely through the abandonment of small farms, the area of coniferous and hardwood forests in the eastern United States has increased during the past hundred years. Deliberate efforts to enlarge wild areas are also underway. In 1935 a pioneering effort resulted in the planting of 24 hectares of tall-grass prairie at the University of Wisconsin Arboretum. The arboretum has also served as the headquarters of the Center for Restoration Ecology, devoted to research and the collation of information from projects in other parts of the country. Elsewhere in the United States, small restoration projects by the hundreds have been initiated, all devoted to the increase in area of natural habitats and the return of degraded ecosystems to full health. They range broadly in ecosystem types, from the ironwood groves of Santa Catalina Island to the Tobosa grassland of Arizona, the oakland understory of California's Santa Monica Mountains, the magnificent open mountain woodlands of Colorado, and last savanna remnants of Illinois. They include fragments of salt and freshwater wetlands from California to Florida and Massachusetts.

In Costa Rica an audacious effort by the American ecologist Daniel Janzen and local conservation leaders has led to the establishment of Guanacaste National Park, a 50,000-hectare reserve in the northwestern corner of the country. The park will be created—literally created—by the regrowth of dry tropical forest planted on cattle ranches. The Guanacaste dream was born of recognition that in Central America dry forest is even more threatened than rain forest, down to only 2 percent of its original cover The plan is to use existing patches of the original forest to seed a steadily growing area of ranchland. The conversion will be made easier by the low density of the human population in the area The regenerating woodland will provide a protected watershed, an income from tourism expected to

reach $1 million or more annually, and a net increase in employment of the area's residents. Most important in the long run, it will save a significant part of Costa Rica's natural heritage.

I have spoken of the salvage and regeneration of existing ecosystems. There will come a time when even more is possible with the aid of scientific knowledge. The return to biology's Eden might also include the creation of synthetic faunas and floras, assemblages of species carefully selected from different parts of the world and introduced into impoverished habitats. The idea struck home for me one late afternoon as I sat at the edge of the artificial lake near the center of the University of Miami campus, surrounded by the densely urbanized community of Coral Gables. At least six species of fishes swarmed in the clear brackish water within 2 meters of shore, some as solitary foragers, others in schools. Most were exotics Their unusual diversity and beauty reminded me of a newly created coral reef. As the sun set and the water darkened, a large predator fish, probably a gar, broke the surface in the middle of the lake. A small alligator glided out from reeds across the way and cruised into open water. Well beyond the far shore, a flock of parrots returned noisily to their palm-top evening roost. They belonged to one of more than twenty exotic species that breed or occur in the Miami area, all originating from individuals that escaped or were deliberately released from captivity. Thus has the parrot family, the Psittacidae, returned to Florida with a vengeance, only decades after the extermination of the Carolina parakeet, last of the endemic North American species. With flashing wings they salute the vanished native.

It is dangerous, I must quickly add, to think too freely of introducing exotics anywhere. They might or might not take to the new environment—between 10 and 50 percent of bird species have succeeded, depending on the part of the world and the number of attempts made to introduce them. Exotics might become economic pests or force out native species. A few, like rabbits, goats, pigs, and the notorious Nile perch are capable not only of extinguishing individual species but of degrading entire habitats Ecology is still too primitive a science to predict the outcome of the synthesis of predesigned biotas. No responsible person will risk dumping destroyers into the midst of already diminished communities. Nor should we delude ourselves into thinking that synthetic biotas increase global diversity. They only increase local diversity by expanding the ranges and population sizes of selected species.

Yet the search for the safe rules of biotic synthesis is an enterprise

of high intellectual daring. If the effort is successful, regions already stripped of their native biotas can be restored to places of diversity and environmental stability. A wilderness of sorts can be reborn in the wasteland. Species already extinct in the wild, those now maintained in zoos and gardens, deserve high priority. Transplanted into impoverished or synthetic biotas, they can endure as orphan species in foster ecosystems. Even though their original home has been closed to them, they will regain security and independence. They will repay us by attaining one criterion of wilderness—that we are allowed to lay down the burden of their care and visit them as equal partners, on our own time. A few species will be prosthetic. As keystone elements, such as a tree able to grow rapidly and shelter many other plant and animal species, they will play a disproportionate role in holding the new communities together.

Finally, the question of central interest is how much of the world's biodiversity we can expect to carry with us out of the bottleneck fifty or a hundred years hence. Let me venture a guess. If the biodiversity crisis remains largely ignored and natural habitats continue to decline, we will lose at least one quarter of the earth's species. If we respond with the knowledge and technology already possessed, we may hold the loss to 10 percent. At first glance the difference may seem bearable. It is not; it amounts to millions of species.

I feel no hesitance in urging the strong hand of protective law and international protocols in the preservation of biological wealth, as opposed to tax incentives and marketable pollution permits. In democratic societies people may think that their government is bound by an ecological version of the Hippocratic oath, to take no action that knowingly endangers biodiversity. But that is not enough. The commitment must be much deeper—to let no species knowingly die, to take all reasonable action to protect every species and race in perpetuity. The government's moral responsibility in the conservation of biodiversity is similar to that in public health and military defense. The preservation of species across generations is beyond the capacity of individuals or even powerful private institutions. Insofar as biodiversity is deemed an irreplaceable public resource, its protection should be bound into the legal canon

CHAPTER FIFTEEN

The Environmental Ethic

THE SIXTH GREAT extinction spasm of geological time is upon us, grace of mankind. Earth has at last acquired a force that can break the crucible of biodiversity. I sensed it with special poignancy that stormy night at Fazenda Dimona, when lightning flashes revealed the rain forest cut open like a cat's eye for laboratory investigation. An undisturbed forest rarely discloses its internal anatomy with such clarity. Its edge is shielded by thick secondary growth or else, along the river bank, the canopy spills down to ground level The nighttime vision was a dying artifact, a last glimpse of savage beauty.

A few days later I got ready to leave Fazenda Dimona: gathered my muddied clothes in a bundle, gave my imitation Swiss army knife to the cook as a farewell gift, watched an overflight of Amazonian green parrots one more time, labeled and stored my specimen vials in reinforced boxes, and packed my field notebook next to a dog-eared copy of Ed McBain's police novel *Ice*, which, because I had neglected to bring any other reading matter, was now burned into my memory

Grinding gears announced the approach of the truck sent to take me and two of the forest workers back to Manaus. In bright sunlight we watched it cross the pastureland, a terrain strewn with fire-blackened stumps and logs, the battlefield my forest had finally lost. On the ride back I tried not to look at the bare fields. Then, abandoning my tourist Portuguese, I turned inward and daydreamed. Four splendid lines of Virgil came to mind, the only ones I ever memorized, where the Sibyl warns

Aeneas of the Underworld:

> The way downward is easy from Avernus.
> Black Dis's door stands open night and day.
> But to retrace your steps to heaven's air,
> There is the trouble, there is the toil . .

For the green prehuman earth is the mystery we were chosen to solve, a guide to the birthplace of our spirit, but it is slipping away. The way back seems harder every year. If there is danger in the human trajectory, it is not so much in the survival of our own species as in the fulfillment of the ultimate irony of organic evolution: that in the instant of achieving self-understanding through the mind of man, life has doomed its most beautiful creations. And thus humanity closes the door to its past.

The creation of that diversity came slow and hard: 3 billion years of evolution to start the profusion of animals that occupy the seas, another 350 million years to assemble the rain forests in which half or more of the species on earth now live. There was a succession of dynasties. Some species split into two or several daughter species, and their daughters split yet again to create swarms of descendants that deployed as plant feeders, carnivores, free swimmers, gliders, sprinters, and burrowers, in countless motley combinations. These ensembles then gave way by partial or total extinction to newer dynasties, and so on to form a gentle upward swell that carried biodiversity to a peak—just before the arrival of humans. Life had stalled on plateaus along the way, and on five occasions it suffered extinction spasms that took 10 million years to repair. But the thrust was upward. Today the diversity of life is greater than it was a 100 million years ago—and far greater than 500 million years before that.

Most dynasties contained a few species that expanded disproportionately to create satrapies of lesser rank. Each species and its descendants, a sliver of the whole, lived an average of hundreds of thousands to millions of years. Longevity varied according to taxonomic group. Echinoderm lineages, for example, persisted longer than those of flowering plants, and both endured longer than those of mammals.

Ninety-nine percent of all the species that ever lived are now extinct. The modern fauna and flora are composed of survivors that somehow managed to dodge and weave through all the radiations and extinctions of geological history. Many contemporary world-

dominant groups, such as rats, ranid frogs, nymphalid butterflies, and plants of the aster family Compositae, attained their status not long before the Age of Man. Young or old, all living species are direct descendants of the organisms that lived 3.8 billion years ago. They are living genetic libraries, composed of nucleotide sequences, the equivalent of words and sentences, which record evolutionary events all across that immense span of time. Organisms more complex than bacteria—protists, fungi, plants, animals—contain between 1 and 10 billion nucleotide letters, more than enough in pure information to compose an equivalent of the *Encyclopaedia Britannica*. Each species is the product of mutations and recombinations too complex to be grasped by unaided intuition. It was sculpted and burnished by an astronomical number of events in natural selection, which killed off or otherwise blocked from reproduction the vast majority of its member organisms before they completed their lifespans. Viewed from the perspective of evolutionary time, all other species are our distant kin because we share a remote ancestry. We still use a common vocabulary, the nucleic-acid code, even though it has been sorted into radically different hereditary languages.

Such is the ultimate and cryptic truth of every kind of organism, large and small, every bug and weed. The flower in the crannied wall—it is a miracle. If not in the way Tennyson, the Victorian romantic, bespoke the portent of full knowledge (by which "I should know what God and man is"), then certainly a consequence of all we understand from modern biology. Every kind of organism has reached this moment in time by threading one needle after another, throwing up brilliant artifices to survive and reproduce against nearly impossible odds.

Organisms are all the more remarkable in combination. Pull out the flower from its crannied retreat, shake the soil from the roots into the cupped hand, magnify it for close examination. The black earth is alive with a riot of algae, fungi, nematodes, mites, springtails, enchytraeid worms, thousands of species of bacteria. The handful may be only a tiny fragment of one ecosystem, but because of the genetic codes of its residents it holds more order than can be found on the surfaces of all the planets combined. It is a sample of the living force that runs the earth—and will continue to do so with or without us.

We may think that the world has been completely explored. Almost all the mountains and rivers, it is true, have been named, the coast and geodetic surveys completed, the ocean floor mapped to the

deepest trenches, the atmosphere transected and chemically analyzed. The planet is now continuously monitored from space by satellites; and, not least, Antarctica, the last virgin continent, has become a research station and expensive tourist stop. The biosphere, however, remains obscure. Even though some 1.4 million species of organisms have been discovered (in the minimal sense of having specimens collected and formal scientific names attached), the total number alive on earth is somewhere between 10 and 100 million. No one can say with confidence which of these figures is the closer. Of the species given scientific names, fewer than 10 percent have been studied at a level deeper than gross anatomy. The revolution in molecular biology and medicine was achieved with a still smaller fraction, including colon bacteria, corn, fruit flies, Norway rats, rhesus monkeys, and human beings, altogether comprising no more than a hundred species.

Enchanted by the continuous emergence of new technologies and supported by generous funding for medical research, biologists have probed deeply along a narrow sector of the front. Now it is time to expand laterally, to get on with the great Linnean enterprise and finish mapping the biosphere. The most compelling reason for the broadening of goals is that, unlike the rest of science, the study of biodiversity has a time limit. Species are disappearing at an accelerating rate through human action, primarily habitat destruction but also pollution and the introduction of exotic species into residual natural environments. I have said that a fifth or more of the species of plants and animals could vanish or be doomed to early extinction by the year 2020 unless better efforts are made to save them. This estimate comes from the known quantitative relation between the area of habitats and the diversity that habitats can sustain. These area-biodiversity curves are supported by the general but not universal principle that when certain groups of organisms are studied closely, such as snails and fishes and flowering plants, extinction is determined to be widespread. And the corollary: among plant and animal remains in archaeological deposits, we usually find extinct species and races. As the last forests are felled in forest strongholds like the Philippines and Ecuador, the decline of species will accelerate even more. In the world as a whole, extinction rates are already hundreds or thousands of times higher than before the coming of man. They cannot be balanced by new evolution in any period of time that has meaning for the human race.

Why should we care? What difference does it make if some species

are extinguished, if even half of all the species on earth disappear? Let me count the ways. New sources of scientific information will be lost. Vast potential biological wealth will be destroyed. Still undeveloped medicines, crops, pharmaceuticals, timber, fibers, pulp, soil-restoring vegetation, petroleum substitutes, and other products and amenities will never come to light. It is fashionable in some quarters to wave aside the small and obscure, the bugs and weeds, forgetting that an obscure moth from Latin America saved Australia's pasture-land from overgrowth by cactus, that the rosy periwinkle provided the cure for Hodgkin's disease and childhood lymphocytic leukemia, that the bark of the Pacific yew offers hope for victims of ovarian and breast cancer, that a chemical from the saliva of leeches dissolves blood clots during surgery, and so on down a roster already grown long and illustrious despite the limited research addressed to it.

In amnesiac revery it is also easy to overlook the services that ecosystems provide humanity. They enrich the soil and create the very air we breathe. Without these amenities, the remaining tenure of the human race would be nasty and brief. The life-sustaining matrix is built of green plants with legions of microorganisms and mostly small, obscure animals—in other words, weeds and bugs. Such organisms support the world with efficiency because they are so diverse, allowing them to divide labor and swarm over every square meter of the earth's surface. They run the world precisely as we would wish it to be run, because humanity evolved within living communities and our bodily functions are finely adjusted to the idiosyncratic environment already created. Mother Earth, lately called Gaia, is no more than the commonality of organisms and the physical environment they maintain with each passing moment, an environment that will destabilize and turn lethal if the organisms are disturbed too much. A near infinity of other mother planets can be envisioned, each with its own fauna and flora, all producing physical environments uncongenial to human life. To disregard the diversity of life is to risk catapulting ourselves into an alien environment. We will have become like the pilot whales that inexplicably beach themselves on New England shores.

Humanity coevolved with the rest of life on this particular planet; other worlds are not in our genes. Because scientists have yet to put names on most kinds of organisms, and because they entertain only a vague idea of how ecosystems work, it is reckless to suppose that biodiversity can be diminished indefinitely without threatening humanity itself. Field studies show that as biodiversity is reduced, so

is the quality of the services provided by ecosystems. Records of stressed ecosystems also demonstrate that the descent can be unpredictably abrupt. As extinction spreads, some of the lost forms prove to be keystone species, whose disappearance brings down other species and triggers a ripple effect through the demographies of the survivors. The loss of a keystone species is like a drill accidentally striking a powerline. It causes lights to go out all over.

These services are important to human welfare. But they cannot form the whole foundation of an enduring environmental ethic. If a price can be put on something, that something can be devalued, sold, and discarded. It is also possible for some to dream that people will go on living comfortably in a biologically impoverished world. They suppose that a prosthetic environment is within the power of technology, that human life can still flourish in a completely humanized world, where medicines would all be synthesized from chemicals off the shelf, food grown from a few dozen domestic crop species, the atmosphere and climate regulated by computer-driven fusion energy, and the earth made over until it becomes a literal spaceship rather than a metaphorical one, with people reading displays and touching buttons on the bridge. Such is the terminus of the philosophy of exemptionalism: do not weep for the past, humanity is a new order of life, let species die if they block progress, scientific and technological genius will find another way. Look up and see the stars awaiting us.

But consider: human advance is determined not by reason alone but by emotions peculiar to our species, aided and tempered by reason. What makes us people and not computers is emotion. We have little grasp of our true nature, of what it is to be human and therefore where our descendants might someday wish we had directed Spaceship Earth. Our troubles, as Vercors said in *You Shall Know Them*, arise from the fact that we do not know what we are and cannot agree on what we want to be. The primary cause of this intellectual failure is ignorance of our origins. We did not arrive on this planet as aliens. Humanity is part of nature, a species that evolved among other species The more closely we identify ourselves with the rest of life, the more quickly we will be able to discover the sources of human sensibility and acquire the knowledge on which an enduring ethic, a sense of preferred direction, can be built.

The human heritage does not go back only for the conventionally recognized 8,000 years or so of recorded history, but for at least 2 million years, to the appearance of the first "true" human beings,

the earliest species composing the genus *Homo*. Across thousands of generations, the emergence of culture must have been profoundly influenced by simultaneous events in genetic evolution, especially those occurring in the anatomy and physiology of the brain. Conversely, genetic evolution must have been guided forcefully by the kinds of selection rising within culture.

Only in the last moment of human history has the delusion arisen that people can flourish apart from the rest of the living world. Preliterate societies were in intimate contact with a bewildering array of life forms. Their minds could only partly adapt to that challenge. But they struggled to understand the most relevant parts, aware that the right responses gave life and fulfillment, the wrong ones sickness, hunger, and death. The imprint of that effort cannot have been erased in a few generations of urban existence. I suggest that it is to be found among the particularities of human nature, among which are these:

• People acquire phobias, abrupt and intractable aversions, to the objects and circumstances that threaten humanity in natural environments: heights, closed spaces, open spaces, running water, wolves, spiders, snakes. They rarely form phobias to the recently invented contrivances that are far more dangerous, such as guns, knives, automobiles, and electric sockets.

• People are both repelled and fascinated by snakes, even when they have never seen one in nature. In most cultures the serpent is the dominant wild animal of mythical and religious symbolism. Manhattanites dream of them with the same frequency as Zulus. This response appears to be Darwinian in origin. Poisonous snakes have been an important cause of mortality almost everywhere, from Finland to Tasmania, Canada to Patagonia; an untutored alertness in their presence saves lives. We note a kindred response in many primates, including Old World monkeys and chimpanzees: the animals pull back, alert others, watch closely, and follow each potentially dangerous snake until it moves away. For human beings, in a larger metaphorical sense, the mythic, transformed serpent has come to possess both constructive and destructive powers: Ashtoreth of the Canaanites, the demons Fu-Hsi and Nu-kua of the Han Chinese, Mudamma and Manasa of Hindu India, the triple-headed giant Nehebkau of the ancient Egyptians, the serpent of Genesis conferring knowledge and death, and, among the Aztecs, Cihuacoatl, goddess of childbirth and mother of the human race, the rain god Tlaloc, and Quetzalcoatl, the plumed serpent with a human head who reigned

as lord of the morning and evening star. Ophidian power spills over into modern life: two serpents entwine the caduceus, first the winged staff of Mercury as messenger of the gods, then the safe-conduct pass of ambassadors and heralds, and today the universal emblem of the medical profession.

• The favored living place of most peoples is a prominence near water from which parkland can be viewed. On such heights are found the abodes of the powerful and rich, tombs of the great, temples, parliaments, and monuments commemorating tribal glory. The location is today an aesthetic choice and, by the implied freedom to settle there, a symbol of status. In ancient, more practical times the topography provided a place to retreat and a sweeping prospect from which to spot the distant approach of storms and enemy forces. Every animal species selects a habitat in which its members gain a favorable mix of security and food. For most of deep history, human beings lived in tropical and subtropical savanna in East Africa, open country sprinkled with streams and lakes, trees and copses. In similar topography modern peoples choose their residences and design their parks and gardens, if given a free choice. They simulate neither dense jungles, toward which gibbons are drawn, nor dry grasslands, preferred by hamadryas baboons In their gardens they plant trees that resemble the acacias, sterculias, and other native trees of the African savannas. The ideal tree crown sought is consistently wider than tall, with spreading lowermost branches close enough to the ground to touch and climb, clothed with compound or needle-shaped leaves.

• Given the means and sufficient leisure, a large portion of the populace backpacks, hunts, fishes, birdwatches, and gardens. In the United States and Canada more people visit zoos and aquariums than attend all professional athletic events combined. They crowd the national parks to view natural landscapes, looking from the tops of prominences out across rugged terrain for a glimpse of tumbling water and animals living free. They travel long distances to stroll along the seashore, for reasons they can't put into words.

These are examples of what I have called *biophilia*, the connections that human beings subconsciously seek with the rest of life. To biophilia can be added the idea of wilderness, all the land and communities of plants and animals still unsullied by human occupation. Into wilderness people travel in search of new life and wonder, and from wilderness they return to the parts of the earth that have been humanized and made physically secure. Wilderness settles peace on the soul because it needs no help; it is beyond human contrivance.

Wilderness is a metaphor of unlimited opportunity, rising from the tribal memory of a time when humanity spread across the world, valley to valley, island to island, godstruck, firm in the belief that virgin land went on forever past the horizon.

I cite these common preferences of mind not as proof of an innate human nature but rather to suggest that we think more carefully and turn philosophy to the central questions of human origins in the wild environment. We do not understand ourselves yet and descend farther from heaven's air if we forget how much the natural world means to us. Signals abound that the loss of life's diversity endangers not just the body but the spirit. If that much is true, the changes occurring now will visit harm on all generations to come.

The ethical imperative should therefore be, first of all, prudence. We should judge every scrap of biodiversity as priceless while we learn to use it and come to understand what it means to humanity. We should not knowingly allow any species or race to go extinct. And let us go beyond mere salvage to begin the restoration of natural environments, in order to enlarge wild populations and stanch the hemorrhaging of biological wealth. There can be no purpose more enspiriting than to begin the age of restoration, reweaving the wondrous diversity of life that still surrounds us.

The evidence of swift environmental change calls for an ethic uncoupled from other systems of belief. Those committed by religion to believe that life was put on earth in one divine stroke will recognize that we are destroying the Creation, and those who perceive biodiversity to be the product of blind evolution will agree. Across the other great philosophical divide, it does not matter whether species have independent rights or, conversely, that moral reasoning is uniquely a human concern. Defenders of both premises seem destined to gravitate toward the same position on conservation.

The stewardship of environment is a domain on the near side of metaphysics where all reflective persons can surely find common ground. For what, in the final analysis, is morality but the command of conscience seasoned by a rational examination of consequences? And what is a fundamental precept but one that serves all generations? An enduring environmental ethic will aim to preserve not only the health and freedom of our species, but access to the world in which the human spirit was born.

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SEGMENT C
DISCOVERING BIRDS AND BIODIVERSITY
FIRST-HAND

Class #15
Field Trip

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This class is scheduled for another field trip to a local natural area. It is set out separately here for schedule planning purposes.

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SEGMENT C
DISCOVERING BIRDS AND BIODIVERSITY
FIRST-HAND

Class #16
Field Trip

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This class is scheduled for another field trip to a local natural area. It is set out separately here for schedule planning purposes.

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SEGMENT D
PROBLEMS AND PARTNERSHIP
IN BIODIVERSITY

Class #17
Threats to Survival of Migratory Birds

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OBJECTIVE: Challenge students to begin thinking about some of the problems faced by migratory birds, and the reasons behind those problems.

THEME: Neotropical migratory birds currently face serious problems to their survival.

CLASS ACTIVITY:

I. Discuss reasons for recent declines in Neotropical migratory bird populations, using the articles assigned as Homework reading in Class #14:

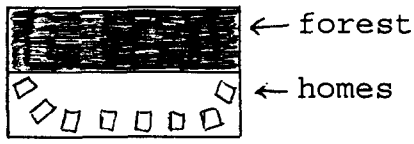
1. "Birds Over Troubled Forests", focusing on discussion on the concepts in pages 24-32;

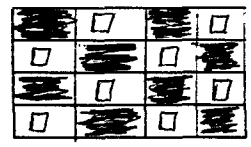
2. "Silence of the Songbirds"; National Geographic, June 1993;

3. Wilson, Edward O., The Diversity of Life, pp. 228-231 (excerpts concerning endangered birds); and

4. The Diversity of Life, p. 265 (forest diagram).

II. Focus on the key concept of forest fragmentation. Illustrate this by drawing two areas, classified as 50% forest, but with different patterns of use, as follows:





□ = home

■ = forest

"Checkerboard" pattern

Discuss the advantages and disadvantages of each pattern, for survival of birds, biodiversity and forest ecosystems. Discuss common patterns of human land use, such as that depicted in "Birds Over Troubled Forests", p. 28, and 'Silence of the Songbirds", pp. 70, 82-90. Discuss which pattern has more forest edge, which poses threats to survival of forest birds, and which area contains more deep forest. Explain key research into biodiversity, such as Edward O. Wilson, who reports in The Diversity of Life, that "[a]s a rule of thumb, a tenfold increase in area results in a doubling of the number of species" (p. 205).

PREPARATION:

Carefully review the articles to be discussed, in preparation for coordinating the discussion.

RESOURCES NEEDED:

Blackboard, projector or flip-chart pad to illustrate the forest fragmentation concept.

HOMEWORK TO ASSIGN:

Read excerpts from the Environmental Protection Agency's 1990 Science Advisory Board report, provided in "Handouts", below.

Read chapter 14 in The Diversity of Life, pp. 311 - 351. (See "Course Logistics", above)

FOLLOW-UP:

Make note of discussion themes that need to be picked up in the several remaining classes.

HANDOUTS:

"Reducing Risk: Setting Priorities and Strategies for Environmental Protection", U.S. Environmental Protection Agency, Science Advisory Board, September 1990. (excerpts)

LINKS: Biology, sociology, geography, land use and political science.

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Class #17

HANDOUT

Excerpt from:

National Geographic magazine, Vol. 183, No. 6, June 1993, "Silence of the Songbirds", by Les Line.

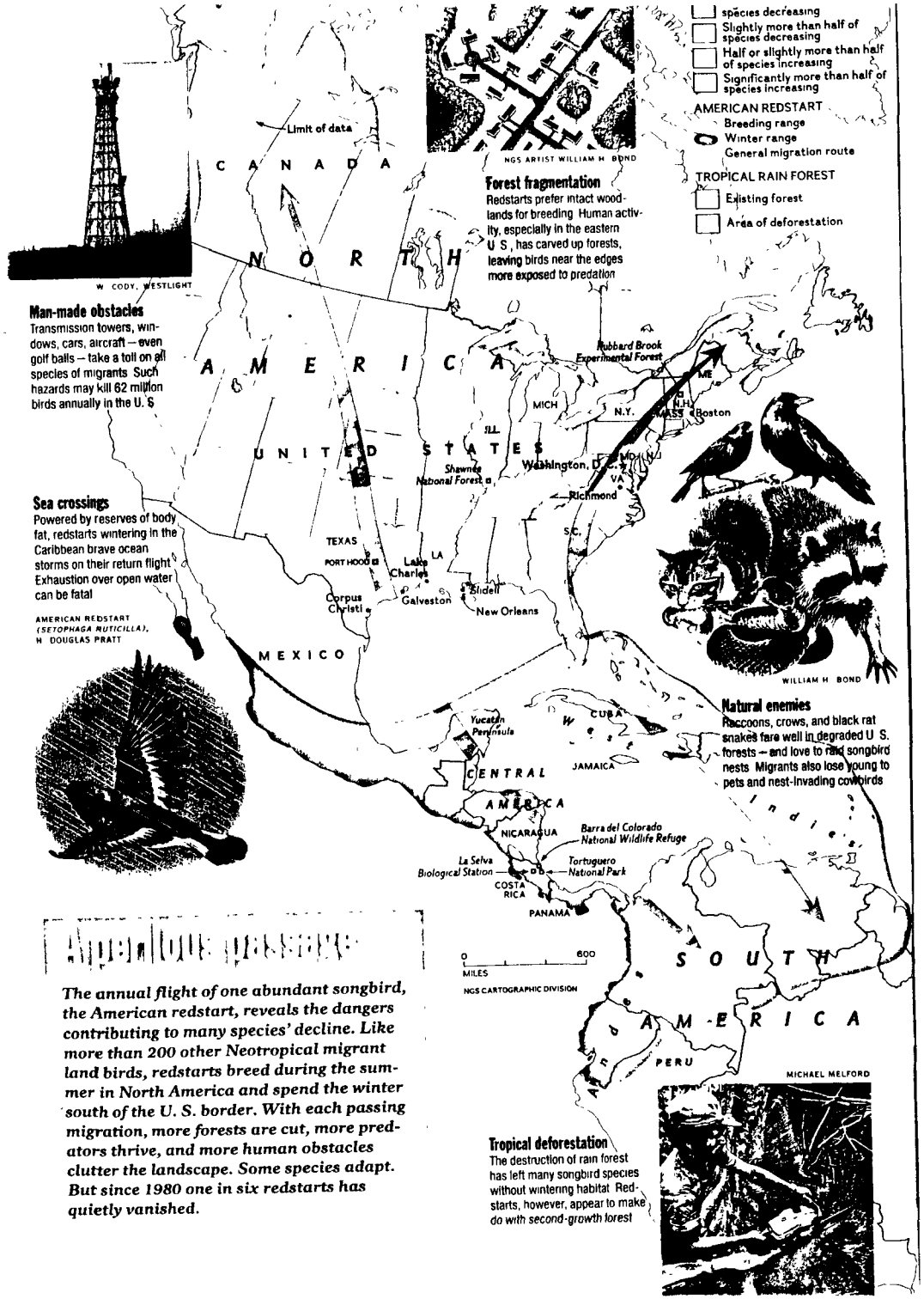
Silence of the Songbirds

By LES LINE
Photographs by
SCOTT GOLDSMITH

"THIS IS THE ROBIN STOP," says biologist Sam Droege as we unfold from his subcompact at 5:19 a.m. and are greeted by a clamor from North America's best known songbird "They're so noisy at this time of the morning, you can't hear anything else."

Well, not exactly. Over the insistent caroling of robins claiming possession of the shadowy lawns and churchyards in a still slumbering community, Droege's keen ears register a mourning dove, house finch, catbird, mockingbird, and chipping sparrow And one second before the three-minute alarm sounds on his chronometer, a drowsy cardinal chirps a halfhearted call note

Singing a sweet solo, a prairie warbler adds to the chorus of migrant songbirds in decline across the United States. As the scale of losses comes to light, alarmed experts ask: Can we save our birds of summer?



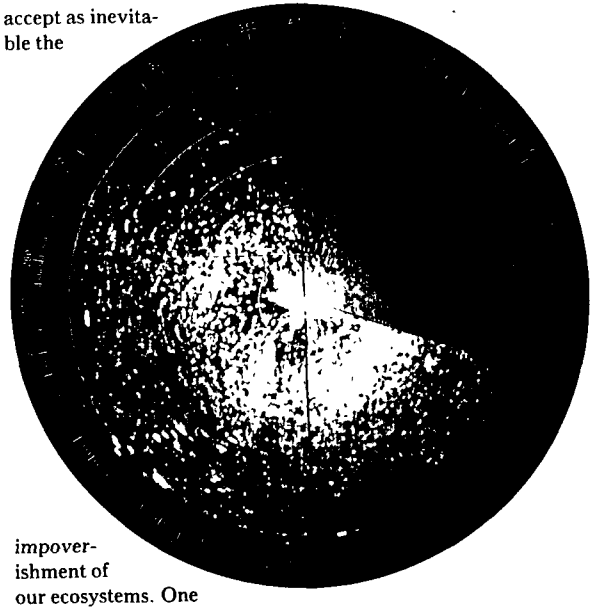
The annual flight of one abundant songbird, the American redstart, reveals the dangers contributing to many species' decline. Like more than 200 other Neotropical migrant land birds, redstarts breed during the summer in North America and spend the winter south of the U. S. border. With each passing migration, more forests are cut, more predators thrive, and more human obstacles clutter the landscape. Some species adapt. But since 1980 one in six redstarts has quietly vanished.

We pile into the car and dash for the next of 50 stops on our 24½-mile-long circuit of Calvert County, wedged in the tidewater region of Maryland between the Chesapeake Bay and the lower reaches of the Patuxent River. What a difference a half mile makes! Woodlots and meadows have replaced suburbia, and the wood thrush with its boldly spotted chest has overshadowed its red-breasted cousin. "The thrush alone declares the immortal wealth and vigor that is in the forest," proclaimed Thoreau. Few who have heard its ethereal song would disagree.

It is June 18, height of the nesting season hereabouts, and this is the month when 2,200 amateur ornithologists—from desert borderlands to treeless tundra—join in the annual North American Breeding Bird Survey (BBS). Organized in 1966 by the U. S. Fish and Wildlife Service, the BBS tracks changes in bird populations by yearly roadside counts along permanent routes. And if a sense of urgency now attends the exercise, it springs in large part from recent readings of BBS data showing major population decreases of migratory songbirds that nest in forests east of the Mississippi but winter in Mexico, Central and South America, and the Caribbean. Many of our birds of summer appear to be in decline.

To find out why they are disappearing and what is being done to save them, I traveled to their summer homes in the deciduous forests of northern New England and the Midwest and to their winter haunts in the mangrove swamps and rain forests of the Caribbean and Central America. For several months I spoke with people who are studying the lives of songbirds and searching for ways to slow the most destructive influence on them—loss of habitat. I would come to know the black-throated blue warbler as intimately as the everyday cardinal that nests in my front-yard spruce, and I would discover many other causes for the birds' decline but no simple way to stop it.

Saving our migratory songbirds may be the most daunting task ever faced by American conservationists. But everyone I met agreed that the effort must be made, even if success is elusive, because to allow them to decline further is to accept as inevitable the impoverishment of our ecosystems. One might reasonably ask whether we couldn't live without these birds. But why would we want to? They are worth attempting to save for no other reason than the pleasure people find in watching them, listening to them, studying them.



Reflecting fowl weather, a National Weather Service radar in S[illegible] Louisiana, picks up clouds of songbirds migrating across the Gulf of Mexico in April. Each dot represents about 20 birds. Analyses of 25 years of radar data show dramatically emptier skies over the Gulf.

A lifelong passion for ornithology often begins with an encounter with a special bird. Roger Tory Peterson, the bird-watching legend, calls it "the spark." He tells a story about John Burroughs, one of the 19th century's most famous naturalists. One spring day in the late 1840s when Burroughs was a boy, he spied a tiny bird neatly patterned in blue, black, and white. It was a black-throated

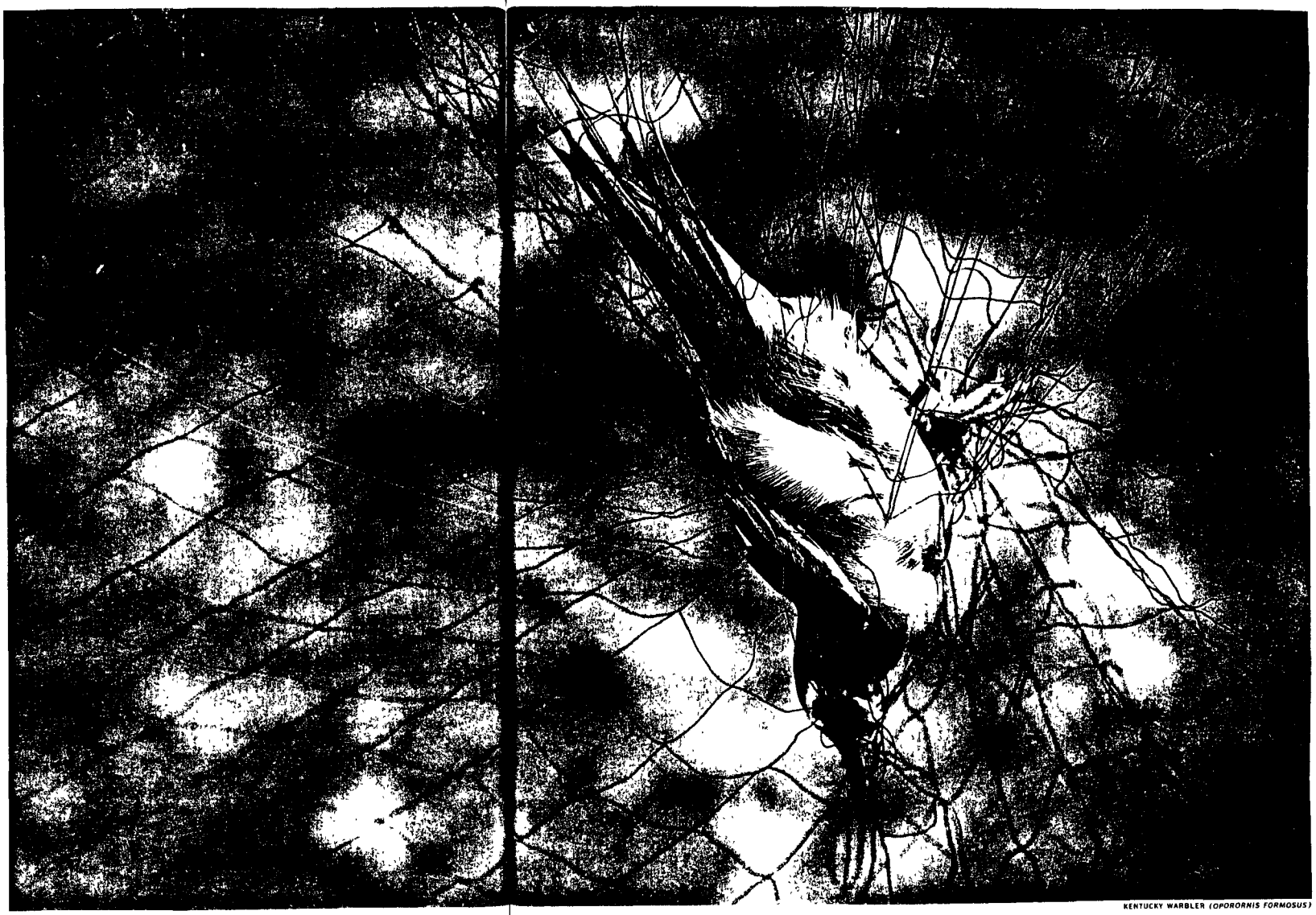
LES LINE was the editor of *Audubon* for 25 years. He has written, photographed, or edited some 30 books on natural history and conservation. SCOTT GOLDSMITH's photographs have illustrated several Society books and TRAVELER articles.

blue warbler, as he would later learn "How the thought of it clung to me, afterward!" Burroughs remembered "It was the first intimation I had had that the woods we knew so well held birds that we knew not at all."

My spark happened more than 40 years ago as I grew up with a pair of Baltimore (northern) orioles that nested each spring in the great elm shading our yard in Michigan. On Saturday mornings when schoolmates were choosing sides for sandlot baseball, I would lie on my back and watch the male's spirited defense of his kingdom with flashing colors and melodious song. Meanwhile, his mate—hanging upside down from a slender branch—wove horsehair, strips of bark, sundry plant fibers, and bits of yarn and string into a soft but incredibly strong bag, eight inches deep, that would soon hold a quintet of nestlings My passion for birds has never waned.

SCIENTISTS call them Neotropical migrants They are the more than 200 species that fill our city parks, suburban yards, rural woodlands and grasslands, and wilderness forests with melody and color. Among the true songbirds, or oscines, are the thrushes, orioles, tanagers, grosbeaks, catbirds, vireos, buntings, and warblers Especially the multitude of wood warblers, many of them with vivid nuptial plumage that is mirrored in names like bay-breasted, chestnut-sided, golden-winged, and black-throated green. But if you consider a songbird any bird that sings, then also count flycatchers, cuckoos, whip-poor-wills, and hummingbirds.

Each spring, from mid-March to mid-May, they come north across the Gulf of Mexico in great waves, riding flows of warm humid air on a flight launched shortly after sunset from staging areas like the Yucatán Peninsula Under the best conditions the vanguard—larger, faster fliers like tanagers, thrushes, and kingbirds—will reach the coast by mid-morning after a 600-mile journey; smaller birds like warblers lag behind. The travelers' goal is to make a rest stop in the first line of extensive forest on the mainland, perhaps 30 miles inland. But if they are buffeted by head winds or storms en route, they will drop exhausted into remnant scrub woodlands along the coast, festooning groves of live oak and hackberry like bright Christmas ornaments



KENTUCKY WARBLER (OPORORNIS FORMOSUS)

Snared for science, a Kentucky warbler dangles from a "mist" net set by ornithologists in Illinois All but invisible, the delicate mesh gently traps forest birds for banding. Sometimes live decoys or taped bird songs act as lures. Since the 1960s, experts have cast the nets of research far and wide to explain the growing scarcity of scores of U. S. species. So far, simple answers remain as elusive as the birds that get away

Sidney Gauthreaux, a biologist at Clemson University, has monitored the trans-Gulf migration I asked him to calculate the number of birds in one wave, or "pulse," at peak migration in late April. Jotting figures on an envelope, he told me that 30,000 migrants would cross a given mile of coast between Corpus Christi, Texas, and Lake Charles, Louisiana, every hour for five hours. "That's 150,000 per mile along a 300-mile front, or 45 million songbirds. I'd call that a conservative estimate. And in the 1960s there was a major pulse every day!"

Not a few bird-watchers fly south as the birds fly north, to witness the spectacle at landfalls like High Island near Galveston or Grand Isle south of New Orleans. While others travel, I stay at home by my postage-stamp wood in the Hudson Valley of New

waiting anxiously for flights that are delayed by cold, wind, and rain. Will the wood thrush return this spring? Where are my Baltimore orioles?

Then one sunny morning around the first of May the air, gently scented by flowering spicebush, is filled with song. And the budding maples and birches overhanging my brook are alive with black-and-white warblers creeping over tree trunks to glean larvae burrowed in the bark and yellow-rumped warblers darting from twig to twig in a frantic search for early insects.

OVENBIRD (SEIURUS AUROCAPILLUS)

Bird biologist Tony Leukering (above, at right) checks an ovenbird's breeding status at New Hampshire's Hubbard Brook Experimental Forest, one of the few U. S. woodlands not losing songbirds. "It's painful," Leukering says, "seeing all the birds you know replaced by house sparrows and starlings."

Day by day the cast changes as some birds stay to nest and others depart, their energy recharged, for more distant places. A catbird mews from the barberry hedge. *Drink-your-tea-ee-ee-ee-ee,* demands a rufous-sided towhee, rattling parchment leaves. A rose-breasted grosbeak shows off its red-white-and-black plumage against a curtain of cherry blossoms. And perhaps a week after my first birds arrive, I am awakened by the glorious piping song of a male oriole that has repossessed the sugar maple by the lane.

But this May there is an essential character missing from the cast: the wood thrush, of whom Thoreau it he is young, and Nature is in her spring." The thrush has not returned, and my spring is an unfinished symphony.

There were warnings in the 1980s of a calamity in the making, notably the well-documented disappearance or increasing rarity of once abundant birds—among them the Kentucky warbler, American redstart, ovenbird, hooded warbler, and red-eyed vireo—from such densely wooded sites as Rock Creek and Glover-Archbold Parks in the heart of Washington, D. C. Over the past ten years BBS reports reveal a sizable decrease in three-fourths of Neotropical migrants in the eastern U. S.

WITH THE exception of a very few, very rare species, no one has hazarded an estimate of the continental population of any forest migrant. But among the many birds perceived to be in distress, wood thrush numbers have dropped by 40 percent in 25 years according to BBS data, the olive-sided flycatcher by 48 percent, golden-winged warbler by 46 percent, eastern wood-pewee by 33 percent, orchard oriole by 29 percent. This trend is often confirmed by local studies. Moreover, Sidney Gauthreaux's comparison of radar images from National Weather Service stations in Louisiana and Texas suggests a 50 percent falloff since the 1960s in waves of spring migrants.

Thus an army of ornithologists has taken to the wilds of North, Central, and South America and the Caribbean, probing the lives of songbirds whose auras are well-known to birdwatchers but whose natural histories have only been sketched.

There is an air of crisis that has not

the indiscriminate use of pesticides such as DDT decimated fish-eating birds like the bald eagle, osprey, and brown pelican. When robins by the thousands died trembling on lawns after shade trees were sprayed to combat Dutch elm disease. When Rachel Carson, an eloquent scientist and author of the best-selling book *The Sea Around Us,* stunned the nation with images of a silent spring.

"The tradition of wildlife management in this country is to wait until the critters are a basket case before doing anything," says Amos Eno, a seasoned conservationist at the National Fish and Wildlife Foundation. "By taking action early, we hope to come up with management options that will avoid the legal conflicts of a spotted owl." (That endangered bird has become the focus of a battle between loggers fighting for jobs and environmentalists trying to save old-growth forests in the Northwest.)

There might appear to be clear explanations for the plight of our birds of summer—loss and fragmentation of breeding habitat in North America to suburban sprawl, for one. And destruction of the Latin American forests where many species winter.

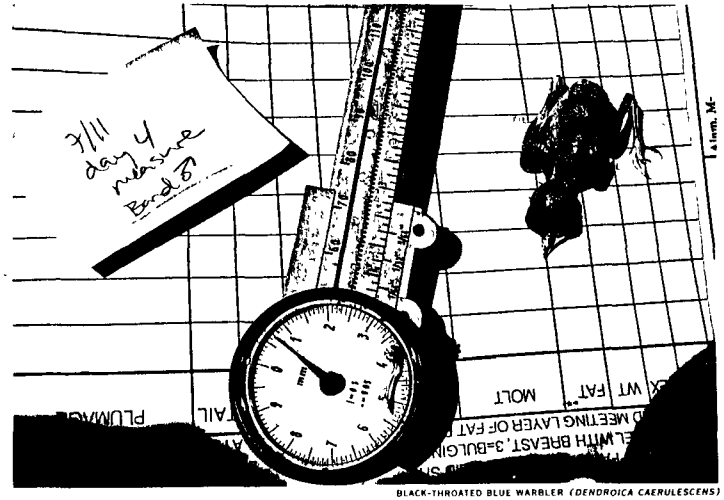
Consider the cerulean warbler, whose population has plunged by 49 percent in just ten years. This sky-blue inhabitant of mature floodplain forests is of special interest to Chandler Robbins, the veteran Fish and Wildlife Service biologist who conceived the Breeding Bird Survey. "We've lost thousands of square miles of cerulean warbler habitat to reservoirs, stream channelization, highways, power lines, housing, and commercial development," Robbins says. "If that weren't enough, now its wintering ground—is being cleared for coca plantings."

Take the case of the painted bunting of the Sunbelt, a favorite visitor at bird feeders because of the male's dazzling purple-green-and-scarlet plumage. "A lot of people think the painted bunting's scrubby habitat is wasteland, so it's being turned into pine plantations or cleared for beachside condominiums," said Sam Droege, a researcher with Fish and Wildlife's Office of Migratory Bird Management and former national coordinator of the BBS. And every winter thousands of these gaudy finches disappear into Mexico's cagebird trade. Their numbers have plunged by 58 percent in less than 30 years, reports Droege.

But as the scientists reiterate, explanations for the decline often are far more complex and elusive than simply loss of habitat. Each species, they emphasize, occupies its special niche in both summer and winter and is vulnerable to natural or human-caused changes in its surroundings. "There could be 20 different reasons why 20 Neotropical migrants are declining," says Droege.

What that means is that two different species of forest-nesting songbirds could flourish or fail, depending on

Life in miniature, a four-day-old warbler awaits measurement at the Hubbard Brook study site. By checking changes in leg and wing lengths, researchers can assess the chick's food intake—a gauge of survival in a world increasingly hostile to songbirds.



BLACK-THROATED BLUE WARBLER (DENDROICA CAERULESCENS)

Birds of a feather rest in peace together at the Smithsonian Institution's 600,000-specimen collection in Washington, D C. "Research here saves hours in the field," says ecologist Mercedes Foster, noting that biological data accompany many specimens Another collection includes a palette of painted buntings (left), birds now vanishing into Mexico's pet trade.

the needs of each Dan Niven, an energetic doctoral student at the University of Illinois, has been studying the hooded warbler, which nests in dark, dank lowland woods where its golden feathers sparkle like a firefly on a black June night. "For a tract of forest to be right for hooded warblers," Niven explains, "it must have tree-fall openings, like those caused by a windstorm, which encourage dense vegetation. That's where the parent birds will tend their fledglings." Yet when aging or diseased trees topple and create sunlit gaps in the forest canopy, the least flycatcher, a diminutive scourge of insects and spiders, will abandon a favored breeding site.

To further complicate matters, several Neotropical migrants are segregated by sex on their wintering grounds. Niven has followed the hooded warbler to Yucatán, where males occupy mature forests while their mates prefer open scrubland. "We can't expect to save all these places in pristine condition," he says. "We need to find out what impact different levels of disturbance, like logging, will have on the birds' survival rates over winter."

Many factors also influence whether birds raise their young successfully. As Vickie McDonald has discovered in her studies of Kentucky warblers at the National Zoo's Conservation and Research Center in Virginia, overbrowsing by white-tailed deer destroys critical cover for birds that nest on the ground or in the forest understory, leaving them vulnerable to predators or even homeless Survival of nestlings can be jeopardized by insect shortages or by an increase of nest-plundering blue jays And always lurking is the brown-headed cowbird, a vagabond of the blackbird tribe that furtively leaves its eggs in another bird's nest, where its young are raised by unwitting surrogate parents.

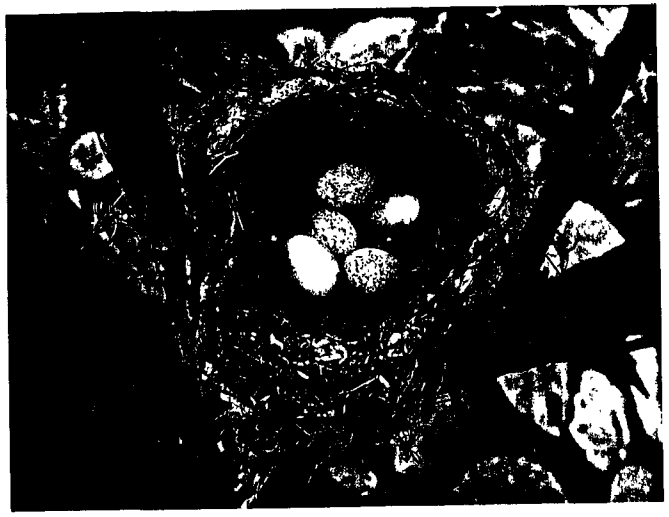
Because the situation is so complex, there is no quick fix such as regulations banning the use of persistent pesticides, which eased the earlier crisis. As I was told time and again, staying or reversing the decline of the songbirds calls for profound changes in how we manage our public and private landscapes—plus a *major* effort to restore lost habitat.

Although no one predicts mass extinctions in the foreseeable future, ornithologists say that many Neotropical migrants like the cerulean warbler and wood thrush will continue to fade from places where they had been common Some believe a few species could become exceedingly rare John Terborgh, director of Duke University's Center for Tropical Conservation, warns that the last unprotected rain forest in Central and South America could disappear within 40 years, with grave consequences for birds tied to mature habitat. Terborgh claims, "We are as helpless as bystanders at a car crash."

SAM DROEGE cocks his head from side to side like a great horned owl listening for scurrying mice. "Three wood thrushes, at least," he says, jotting numbers on his clipboard. A pewee whistles its name A field sparrow trills. The watch beeps. Time to move on There are strict rules for Breeding Bird Survey participants. Starting time, for example, is exactly 30 minutes before sunrise. Stops are exactly one-half mile apart, and the observer counts every bird heard or seen from a stationary point in exactly three minutes.

Drive, stop, count birds. Drive, stop, count birds. Four hours of driving, stopping, counting birds. Boring? Not to serious birders, who crave the challenge of identifying hundreds of species from snippets of song or a flash of color.

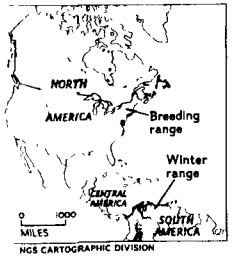
Droege navigates by detailed topographic maps with landmarks noted in orange. At stop 18, for instance, nature is reclaiming an old drive-in movie theater, and trumpet vines twining about rusting lampposts have lured our *(Continued on page 82)*



Blinded by instinct, a mother blue-winged warbler feeds a brown-headed cowbird chick that has hijacked the nest (facing page). Brazen imposters, cowbirds foist their fast-hatching eggs on the unattended nests of other species, duping countless songbirds whose own young then suffer from neglect and starvation. Surveys show cowbirds are on the rise. In some Illinois forests, virtually every wood thrush nest has been saddled with their telltale speckled eggs (above). At Fort Hood, Texas, biologists have killed thousands of captured cowbirds with auto fumes (below) in a bid to save the heavily parasitized black-capped vireo from extinction

BROWN-HEADED COWBIRD (*MOLOTHRUS ATER*)

BLUE-WINGED WARBLER (*VERMIVORA PINUS*) FEEDING COWBIRD CHICK, STEVE AND DAVE MASLOWSKI

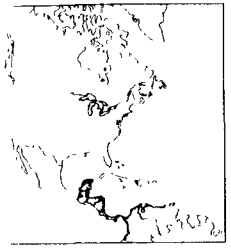


NGS CARTOGRAPHIC DIVISION

1 Olive-sided flycatcher

CONTOPUS BOREALIS

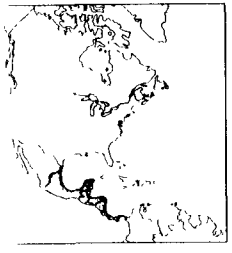
Widespread in North American coniferous forests and bogs, the olive-sided flycatcher may face its greatest human threat in the heavily logged foothills of the Peruvian Andes, where some populations winter In the U S , sightings of this acrobatic insectivore have dropped by 22 percent since 1980



2 Golden-winged warbler

VERMIVORA CHRYSOPTERA

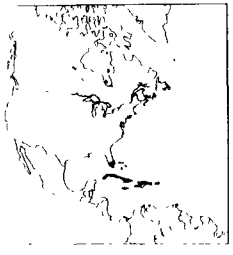
After expanding into abandoned U S farmlands for more than a century, the golden-winged warbler has retreated as northeastern forests retake the shrubby fields and clear-cuts it prefers for breeding The species is also declining through interbreeding with genetically similar blue-winged warblers



3 Wood thrush

HYLOCICHLA MUSTELINA

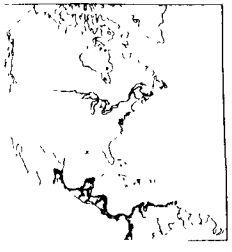
Its honeyed song has inspired poets—and made the wood thrush among the most beloved of Neotropical migrants Cowbirds have invaded patchwork forests in the Midwest, sabotaging its nests With Middle American wintering grounds also under pressure, numbers have shrunk 23 percent nationwide since 1980



4 Cape May warbler

DENDROICA TIGRINA

This migrant winters in the remnant rain forests of the West Indies and breeds in black spruce forests in the U S and Canada, where it feasts on budworms Though U S statistics show a sharp drop, budworm infestations can boost numbers locally; Maine sightings have more than doubled since the 1960s.



5 Rose-breasted grosbeak

PHEUCTICUS LUDOVICIANUS

This fruit-and-insect-eater can tolerate disturbance in its Latin American wintering grounds, so its decline may result from factors in the U S Aging New England forests, for example, could be squeezing it out of second-growth breeding habitat Sightings in the U. S have slumped by a third since 1980

PAINTING BY H DOUGLAS PRATT

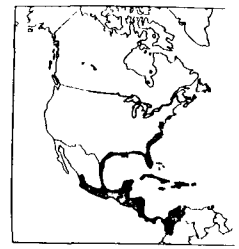
Bird species at risk, a tell-tale medley of song

"It was a spring without voices," naturalist Rachel Carson wrote some 30 years ago, warning of the dangers of pesticides. "On the mornings that had once throbbed with the dawn chorus of robins, catbirds, doves, jays, wrens and scores of other bird voices there was now no sound. . . ." Today the waning melody of many migrant birds—including the sampling above—suggests that habitat disruption is an even greater culprit than toxics. Measuring bird declines is a complex and imperfect art. But a recent survey of a hundred migrant species confirms what avid birdwatchers have been saying for years: Most of the nation's losses involve forest birds, mainly in the East during the past decade.

6 Northern oriole (Baltimore)

ICTERUS GALBULA GALBULA

This plumed dandy of the nation's backyards adapts well to human disruption in its nesting grounds While the northern oriole is declining only slightly, the eastern subspecies—the Baltimore oriole—has dropped 27 percent in ten years Little is known of its sojourn in Latin America.



7 Yellow-billed cuckoo

COCCYZUS AMERICANUS

A sharp *kuk-kuk-kuk* announces the yellow-billed cuckoo in woodlands across the U S , but it has grown increasingly rare in the East This bird tolerates various breeding habitats, so its decline could be linked to predators or disturbance to its winter range in South America

8 Cerulean warbler

DENDROICA CERULEA

At risk in both its northern and southern ranges, this blue-jacketed migrant requires large, mature forests for breeding and wintering Its bottomland woods have been replaced by farms in the Midwest, while in the Andes, climax forests are under siege Declines since the 1960s have been severe.

9 Summer tanager

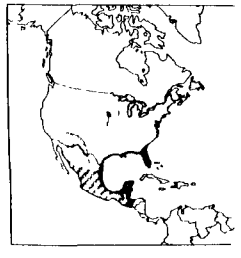
PIRANGA RUBRA

This fire-feathered tanager is plagued by cowbirds in the Midwest. Though found in a variety of breeding habitats, the bird winters in the tropical woodlands of Mexico and Central and South America—regions undergoing extensive development Populations have diminished 17 percent since 1980

10 Whip-poor-will

CAPRIMULGUS VOCIFERUS

Famous for its namesake lyric, the whip-poor-will is a shy ground nester acutely vulnerable to predation when humans cut into its woodland strongholds. Though statistics show a long-term national decline, reliable data are scarce because most bird surveys overlook nocturnal species.



first ruby-throated hummingbird.

Today, however, there's a new landmark at stop 23 a sign proclaiming the residential community of Deerfield II. Eighty-three acres of forest carved into 32 lots of varying sizes It's not that all the trees will be felled Homeowners, after all, have paid to live in the woods. But as

Exporting bananas—not birds—is a priority for plantation workers toiling near Costa Rica's border with Panama The region once pulsed with a tropical salsa of forest-dwelling orioles, vireos, and tanagers About 60 songbirds that nest in the U S prefer undisturbed rain forest for their wintering grounds.

driveways are bulldozed and understory is cleared—for lawns, swimming pools, tennis courts, or simply for the sake of neatness—the songbird habitat deteriorates.

New developments pop up like mushrooms along this Maryland survey route every year, Droege tells me, and like much of the Northeast corridor from Boston to Richmond, the area is fast becoming what he bluntly terms a "Neotropical desert "

But how do you weigh the value of bird habitat against the profits from developing a tract of forest for a subdivision? There will always be birds around, but greening woods where no song is heard except the voices of cardinals, chickadees, and robins would be a desolate place indeed. And the silence would be further evidence, if any were needed, of the rapid deterioration of the natural world.

One could also stress the role of songbirds in controlling destructive [illegible] to humankind is largely aesthetic To hear the mellow song of a rose-breasted grosbeak or to glimpse the fiery plumage of a scarlet tanager gladdens the heart and heightens one's appreciation of nature.

I asked Sam Droege for his plan of action if he were made national songbird czar "We've got to identify and limit development of landscapes that these birds need for long-term survival," he responds without hesitation, "areas like the New Jersey Pine Barrens that will soon succumb to population pressures. Forestry practices can be changed to leave large, unbroken tracts to accommodate Neotropical migrants. Agricultural lands can be bought and left to revert to scrubland or forest. But once you've built houses, it's lost!"

Hubbard Brook Experimental Forest is a 7,800-acre natural laboratory in the White Mountain National Forest of New Hampshire, embracing a valley that has been largely undisturbed since it was logged between 1905 and 1915. Richard Holmes, professor of biology at Dartmouth College, leads a scramble up a steep slope shaded by 90-foot beeches, sugar maples, and great yellow birches with their jagged plates of burnished-bronze bark. Holmes is tall and lean and accustomed to this vertical landscape, leaving me huffing to catch up He stops by a hobblebush where a wicker nest, the kind used by cage-bird fanciers, is filled with quail eggs. A trip wire leads to a flash camera, which catches nest robbers in the act, providing researchers with mug shots of the offenders.

For more than a decade Holmes and Tom Sherry, a Tulane University ecologist, have studied the population dynamics of American redstarts both at Hubbard Brook and on their wintering ground in Jamaica. The redstart is one of the most abundant warblers in North America (The male is a black-and-orange bundle of animation that countryfolk from Canada to the Caribbean call the butterfly bird)

Holmes and Sherry are outspoken in arguing that some of their peers as well as the popular press have been too hasty in blaming events in Third World countries for declines of forest migrants. For most species, they insist, the more immediate problems lie in our own backyard. "When you fragment forests into small islands surrounded by logging clear-cuts, farmland, and suburbs," explains Holmes, "nesting songbirds are left vulnerable to predatory grackles, raccoons, snakes, and house cats that haunt the woodland edge. Plus, of course, cowbirds." Cause and effect Fewer nests succeed, fewer young birds return the next spring to replace adults lost to natural mortality, the population declines and may eventually crash.

"It's a rare event to see a cowbird in the deep forests of Hubbard Brook," says Sherry. Still, redstart numbers there have fallen by 48 percent in 25 years Most of the blame, Holmes and Sherry say, falls on a host of predators They show me color photographs of a blue jay with a quail egg in its mouth and a black bear with its snout in a nest. There are snapshots of raids by fishers (large relatives of the weasel) and by flying squirrels, red squirrels, and chipmunks. "Most losses," Holmes emphasizes, "are to mammals, although it's not clear which is the worst culprit "

Predator numbers rise and fall from year to year, and destruction of redstart eggs and broods in pristine Hubbard Brook has soared as high as 70 percent in a summer

The implication is this In landscapes where habitat has been severely altered by human activities, it is a small miracle whenever a pair of songbirds fledges a complement of nestlings under relentless pressure from predators—and the intrusions of parasitic cowbirds.

THESE NATIVE buffalo birds, as they were called long ago, followed those immense herds of wild bovines over plain and prairie—and then accompanied the cattle drives that replaced the roaming bison. Ever on the move, feasting on insects stirred by thousands of hoofs and undigested seeds in piles of dung, the pregnant females left their eggs in whatever unattended nests were handy. Then the mother cowbirds hit the trail, leaving their young to be tended by the owners of the nests.

A homesteader's fire sends a grim smoke signal to the birds of Costa Rica: Flee for your lives. Some 160 square miles of Costa Rican jungles are cut each year. "In five years the last exploitable forests outside of our national parks will be gone," says a government biologist.

As the country was settled, and farms, pastures, and ranches (with their inviting livestock) replaced forests, marshes, and native grasslands, cowbirds abandoned their nomadic ways. Expanding their

range east and west, they invaded the breeding grounds of many birds that had never been duped by alien eggs and were often defenseless The number of cowbirds exploded; more than 200 species have had cowbird eggs foisted on them But not every songbird is a pushover Yellow warblers will build two, three, as many as five stories of nests to bury cowbird eggs, even when that means laying a new clutch of eggs in each

Scott Robinson of the Illinois Natural History Survey has been studying the impact of forest fragmentation on the birds of summer, and nest parasitism by cowbirds in particular, for more than ten years "Forest" in Illinois usually means a small woodlot in a sea of corn and soybeans—a patch of scarce habitat with an extensive agricultural edge that provides easy access to songbird nests for skulking cowbirds and abundant predators like the black rat snake. "We don't have large parks and preserves in Illinois," says Robinson. "Our research provides a warning for other parts of the country. This is what could happen to your birds."

Pioneering conservationist Shirley Briggs watched as Glover-Archbold Park in Washington, D C., lost three-quarters of its original Neotropical migrant bird species over three decades Now the urban oasis is being crowded by a new housing development. "They've just scalped a whole hillside," sighs Briggs.

What has happened to the birds in the Shawnee National Forest of southernmost Illinois is sobering. Robinson found that 90 percent of the wood thrush nests are commandeered by cowbirds, and the output of thrush fledglings has fallen far below the level needed to sustain the local population. "The wood thrush is remarkably defenseless," Robinson tells me with a measure of awe. "They have blue eggs. Cowbird eggs are white with brown speckles. Yet they can't recognize a cowbird egg in their nest and chuck it out. It's perfectly normal for a wood thrush to sit on a clutch of five or six cowbird eggs with none of her own left."

There is more bad news. In the Shawnee research area, 80 percent of the nests of scarlet tanagers, summer tanagers, and other canopy-nesting species such as the yellow-throated warbler contain cowbird eggs or young. A notable exception is the eastern wood-pewee, which is aggressive in defending its lofty nest.

ALTHOUGH the Shawnee spreads from the Mississippi River on the west to the Ohio River on the east, it hardly fits the popular image of a national forest as a blanket of green. What Robinson calls his "laboratory of fragmentation" consists of hundreds of small woodland tracts splintered by private inholdings—farms, pastures, pig feedlots, orchards, backyards, all places where cowbirds congregate to feed. "The area is utterly saturated with cowbirds," Robinson laments, "and there is no forest here that is large enough for songbirds to escape them "

He describes his project as "brute-force science—inelegant, labor-intensive. I hire skilled bird-watchers to find every nest, and undergraduates to check them every two days. And then I get graduate students to study the species of greatest interest, like the wood thrush."

Brute-force science, as I learned one morning following two students, also means crashing through grasping brambles and tangles of poison ivy in sopping heat, with a sharp eye for

BLUE JAY (*CYANOCITTA CRISTATA*), TERRENCE DUFFY

"How many little dramas are enacted in the depth of the woods at which man is not present," Henry David Thoreau wrote while pondering blue jays—the roguish robbers of oriole young (left). Predation is a violent hurdle to successful nesting in the U. S., where jays, crows, raccoons, and squirrels all feed on migrant songbird eggs and hatchlings. Forest fragmentation only worsens the carnage. Fattened on birdseed or garbage, predators boom wherever suburbia meets woodlands. "Nice cuddly chipmunks can be aggressive raiders," notes ornithologist Richard Holmes, who has placed decoy nests in New Hampshire forests to study predators such as the mink-like fisher (above). His work shows that nesting losses for one migratory songbird, the American redstart, can reach 70 percent. Resident birds like woodpeckers or chickadees fare better against nest piracy—they fight off attackers more often, and they lodge in safer tree holes.

both nests and venomous snakes But Robinson's students seem oblivious to the dangers as they keep note of cowbird eggs and chicks in the nests of other species

By the end of this summer—their fifth season in Shawnee National Forest—Robinson's team will have compiled data on the impact of cowbirds and predators on more than 2,000 nests The next phase of the study will try to answer some specific questions "Why," Robinson asks, "are there wood thrushes in some ravines and not others?" Another riddle. Do foster parents expend so much extra energy feeding larger cowbird young that it leaves them so weakened that they die?

Altruistic arson· A forester in Michigan burns a plot to promote the growth of young jack pines—crucial nesting trees for the endangered Kirtland's warbler. The warblers faced habitat loss and cowbird parasitism until biologists intervened—a rare reprieve for songbird survival

Is there any relief in sight from the cowbird? On the jack pine plains of Michigan a cowbird-control program helped save the Kirtland's warbler, perhaps North America's rarest songbird, from extinction Each nesting season more than 7,000 cowbirds are trapped and humanely killed The rate of nest parasitism has dropped from 69 percent to 5 percent since 1972, and the Kirtland's warbler breeding population has rebounded from a low of 167 pairs to 397 pairs in the latest census.

But trapping on a national scale would be impractical "The cowbird population in the U S is at least 50 million at the start of the nesting season and 125 million by midsummer," says Richard Dolbeer, a blackbird expert at the U. S Department of Agriculture

I ask Scott Robinson for his solution to the cowbird conundrum, and he gives a familiar response "We've got to manage our landscapes properly," he says "In an area like the Shawnee that means buying inholdings to pull together the forest fragments "

Robinson and I drive into an empty Forest Service campground. Wood thrushes harmonize in the treetops while their nemeses search for seeds in the close-cropped grass. I glance up at the branch of a hickory and see a female thrush, ever dutiful, bringing a juicy caterpillar to a plump cowbird chick.

IT IS 1,800 MILES, as the warbler flies, from the cool mountain forests of New Hampshire to a steamy swamp on the southeastern coast of Jamaica. It is late October, the rainy season on this tropical island is nearing its end, and beaches soon will be crowded with tourists from the north Songbirds from the north, however, already are ensconced for a long winter stay, and it is disorienting to see familiar species doing familiar things in this exotic setting An ovenbird scuffles through leaves beneath a thorny logwood tree, and a northern parula warbler gleans insects from a scarlet bromeliad

There is an occasional burst of melody from a Jamaican oriole, and the wheezing of local bananaquits, but the prevalent sounds this morning are the sharp call notes of assorted warblers whose courtship songs are rarely heard in winter. Jamaicans call them, collectively, "chip-chips " Or simply "Christmas birds," to distinguish the winter visitors from their familiar resident species

Tom Sherry, whom I last saw at Hubbard Brook in New Hampshire, sloshes from the swamp with a male redstart in hand Using a stuffed redstart and taped songs of the species, it had taken him only minutes to lure the bird—outraged at the idea of a competitor for its turf—into a "mist" net virtually invisible to birds. As in previous years, Sherry and colleague Richard Holmes aim to capture and band every redstart and mark its territory on this 13-acre study plot at the edge of one of the few large stands of mangroves left on the island

"Many Neotropical migrants are aggressive in defending their winter living space," Sherry explains, "and individuals will occupy the same territories year after year. If you destroy their habitat, displaced birds may not be able to find suitable places to forage in an ever-shrinking and increasingly crowded environment.

"The good news, at least for the redstarts, is that they will remain in their territories even after slash-and-burn agriculture, providing some trees are left " Here, then, is more evidence that the ebb of redstarts and other songbirds is linked to problems in the north.

Across the Caribbean Sea, more than 600 miles southwest of Sherry's study area, ornithologists in the forests of Costa Rica are also searching for clues to the decline of songbirds

"Nube loca," says Daniel Hernández, a scientist from the National Museum of Costa Rica. "Crazy cloud " One cloud the size of a silver dollar hangs overhead in an otherwise unblemished sky, and for the past three minutes rain has been pouring on us and nowhere else along this reach of Caribbean coastline.

The deluge ends as unexpectedly as it began, and a trogon celebrates the sun's return with a prettily whistled song. We are on the bank of Caño Palma, a canal whose flow is so imperceptible that its surface is an uncracked black mirror Buttresses of silk-cotton trees and the massive fronds of yolillo palms, real and reflected, merge in perfect symmetry. I am reminded of a cypress and tupelo swamp in South Carolina, and to complete the picture there is a flash of gold as a prothonotary warbler, a summer resident of those more northerly watercourses, flits from one green wall of the canal to the other.

The trail beyond is submerged, and we retreat to a corridor cut through the forest edge where mist nets are strung Hernández is one of the half dozen Costa Ricans who are working ornithologists. And this site near Tortuguero National Park, on the northeast coast, is the first of three banding stations recently established to monitor habitat use and behavior of migrants. "The breeding

Back from the brink, Kirtland's warblers (below) have doubled their ranks to 397 mating pairs since the mid-1980s. Few other migrants face extinction —yet—although one species, the Bachman's warbler, is already thought to be doomed, partly because of Cuban sugarcane farming.

KIRTLAND'S WARBLER (DENDROICA KIRTLANDII), RON AUSTING

are well documented, but we know very little about the other half of their lives," says Chris Wille, representative in Central America for the Rainforest Alliance, an organization dedicated to saving tropical forests and their wildlife "It's like trying to understand the human race by reading the Kinsey Report."

Tortuguero National Park together with Barra del Colorado National Wildlife Refuge to the north on the Nicaraguan border encompasses 428 square miles of tropical wet forest, where the annual rainfall exceeds 150 inches In species it is one of the richest areas in the country, and probably the most threatened—by banana growers, loggers, ranchers, family farmers, and squatters

Dazzling our eye with the hues of a painted bunting (facing page) or enchanting our ear with the silver music of a thrush, migrants face a destiny as fragile as their song "Try to imagine a world that's silent," says Carlos Quijano, a Bethesda, Maryland, bird-watcher (above, at center) "I'm not sure I'd like to live in a world like that "

The country's thriving banana-growing industry employs 100,000 workers and is consuming more and more rain forest—prime habitat for Neotropical migrants. Some Costa Ricans are pessimistic about their countrymen coming to the forest's defense "Nobody loves a woman he doesn't know," says Julio Sánchez, curator of ornithology at the National Museum of Costa Rica "Costa Ricans don't even know our own parks full of jaguars and snakes."

NOT ALL COSTA RICANS. At La Selva Biological Station, a rain forest reserve along the roaring Río Sarapiquí, Alexander Martínez rumbles up on his pride and joy, a beautifully restored 1940s Harley-Davidson motorcycle Martínez is a fruit grower and grass-roots activist who is eager to tell me about his organization, the Association for the Environmental Well-being of Sarapiquí He describes many of its members, himself included, as "ex-poachers who have abandoned their bad habits" to protect the forest and its wildlife, especially the spectacular birdlife that lures busloads of foreign tourists to the region.

"It is dangerous being a conservationist in Costa Rica," Martínez says "I have been threatened with a machete, and my dog was poisoned," so he packs a pistol He and his colleagues are gadflies to the banana growers, demanding that they comply with seldom enforced regulations, writing letters to newspapers, protesting on television. He slaps the handlebar of his Harley. "We must awaken the people Bananas are not the best thing to happen to Costa Rica There must be a limit "

It is a week before Christmas and my last day in the rain forest As I near the end of La Selva's trail, elated to have seen the elusive rufous motmot with its long racket-tipped tail, there is a familiar burst of flame in the canopy. I focus my binoculars on an old friend from home, a male Baltimore oriole

That flash of color sent me back to my boyhood in Michigan I cannot imagine a summer without orioles □

Class # 17

CLASS DISCUSSION
ITEMS

Excerpts from Wilson, Edward O., The Diversity of Life, pp. 228 - 231 and 265. Selections from Edward O. Wilson, The Diversity of Life are reprinted with the permission of W.W. Norton & Company, Inc., New York.

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Bachman's warbler. A species is endangered if it occurs over a wide area but is scarce throughout its range. Such is the case of Bachman's warbler *(Vermivora bachmanii)*, which is the rarest bird in North America in numbers of individuals per square kilometer of its geographical range. Small, yellow-breasted, olive-green on the back, and black-throated in the male, the warbler once bred in thicket-grown river swamps from Arkansas to South Carolina. Its present breeding range and population size are unknown, and it appears to be close to extinction if not already lost.

Kirtland's warbler. A species is rare if it is densely concentrated but limited to a few small populations restricted to tiny ranges. Kirtland's warbler *(Dendroica kirtlandii)*, with lemon-yellow breast, bluish-gray back streaked with black, and dark mask in the male, is such a case. It is loosely colonial, with a breeding range restricted to jack-pine country in the north-central part of the lower peninsula of Michigan. Between 1961 and 1971 the known population plunged from 1,000 to 400 birds. The decline was apparently due to increased nest parasitism by brown-headed cowbirds *(Molothrus ater)*, which place their eggs in the warbler's nest. Kirtland's warblers are as dense as ever in the localities where they occur, but the progressive restriction of their range has brought them close to extinction.

Red-cockaded woodpecker. A species can be rare even if it has a broad range and is locally numerous, but is specialized to occupy a scarce niche. The red-cockaded woodpecker *(Picoides borealis)*, with zebra back, white breast speckled with black, and each white cheek touched by a carmine speck, is the outstanding example. It ranges across most of the southeastern United States but requires pine forests at least eighty years old. The birds live in small societies composed of a breeding pair and up to several offspring, with the latter helping their parents to protect and rear the younger siblings. Each group requires an average of 86 hectares of woodland to produce an adequate harvest of insect prey. To nest, red-cockaded woodpeckers hollow out cavities in living, mature longleaf pines eighty to one hundred and twenty years old, in which the heartwood has already been destroyed by fungus. These exacting conditions are no longer easy to find in the piney woods of the south. The total size of the woodpecker breeding population was estimated in 1986 to be only 6,000. It was falling steadily, by as much as 10 percent a year in Texas and probably just as fast elsewhere. The species appears doomed unless the cutting of the oldest pine forests is stopped immediately.

Species trapped by specialization and pressed by shrinking habitat form the largest endangered class. The scarcity of Bachman's warbler across the southern United States is no mystery, despite the abundance of riverine swampland in which it can breed. It winters (or wintered) exclusively in the forests of western Cuba and the nearby Isle of Pines, where virtually all the forests have been cleared to grow sugar cane. The bottleneck is the loss of wintering ground and starvation for even the remnant of warblers produced in the lusher summer environment of the United States.

John Terborgh has given a poignant account of his own experience with one of the last Bachman's warblers. In May 1954, as an eighteen-year-old birder (now a foremost ornithologist), he [illegible] of the

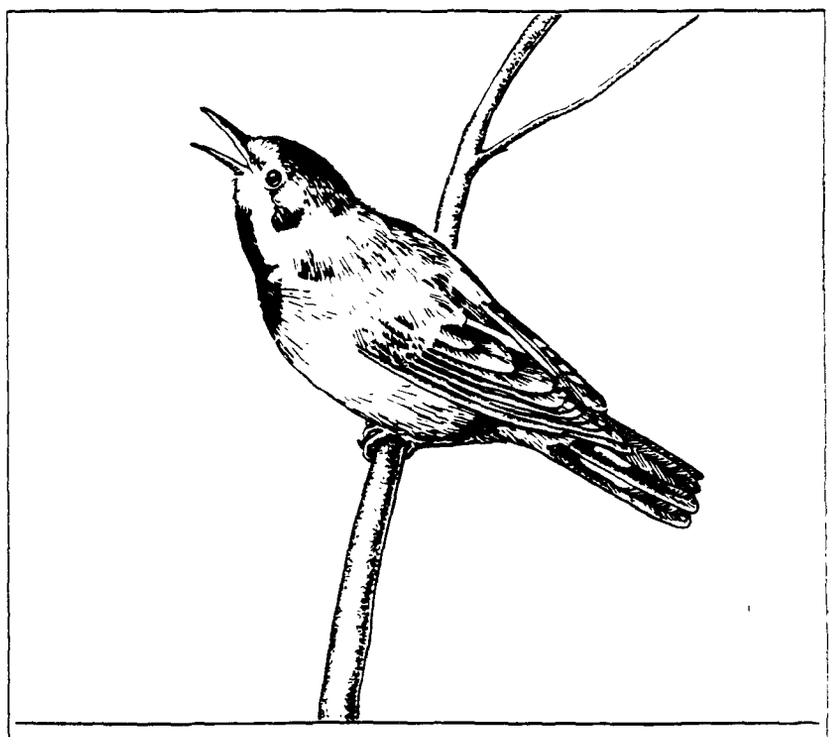
sighting of a male Bachman's on Pohick Creek in Virginia not far from his home. The song of the Bachman's had been described to him as resembling that of a black-throated green warbler with a downward sweep at the end: *zee-zee-zee-zee-tsew.*

> To my astonishment I walked up to the place that had been described to me and heard it! I had no trouble seeing the bird. A full-plumaged male, it sat on an open branch about 20 feet up and gave me a perfect view while it sang. It hardly stopped singing during the two hours I spent there. Reluctantly, I pulled myself away, wondering whether this was an experience I would ever repeat. It was not.

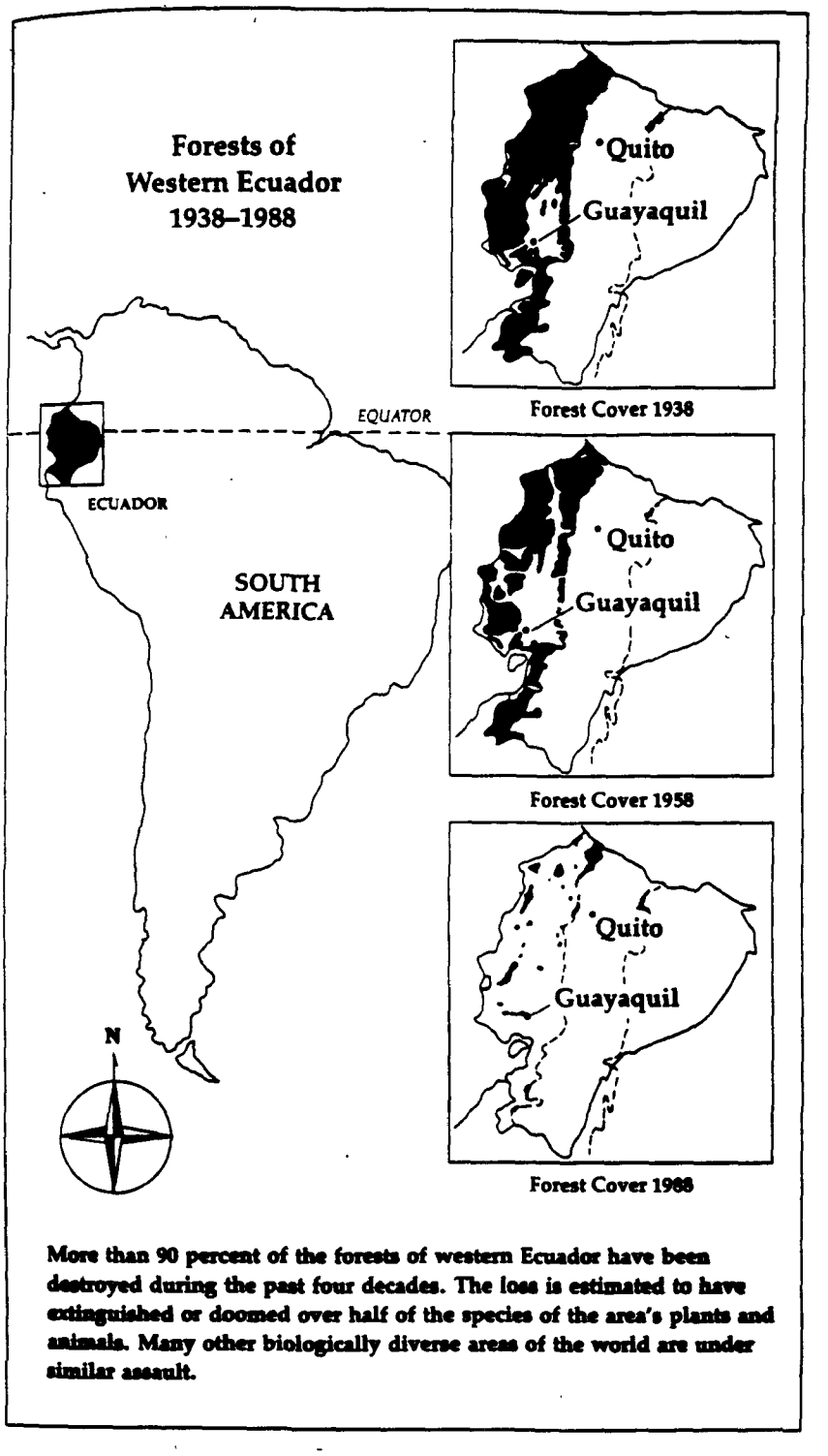
As other birders were to testify, the male returned to the same spot the next two springs. No female ever joined him. The extraordinary exertions of the Bachman's male were a sign that he was in prime breeding condition, but he was destined to go undiscovered by any female of the same species.

> I imagine that each spring a tiny remnant of birds crossed the Gulf of Mexico and fanned out into a huge area in the Southeast, where they became, so to speak, needles in a haystack. Toward the end, it is likely that most of the males in the population, like the one at Pohick Creek, were never discovered by females. Once this situation developed, there could have been no possible salvation for the species in the wild.

In parallel manner, Kirtland's warbler winters in the pine woodland of two islands in the northern Bahamas, Grand Bahama and Abaco. Terborgh has written that, however zealously the Kirtland's warbler and its habitat may be protected in Michigan, its fate probably lies at the mercy of commercial interests in the Bahamas. Migratory birds as a whole are declining across the United States from the same environmental malady that afflicts the warblers: wintering grounds are being demolished by logging and burning. The prospects are especially grim for species that depend on the rapidly shrinking forests of Mexico, Central America and the West Indies.



The rarest songbird: Bachman's warbler of the southeastern United States is on the brink of extinction, if not already gone. This drawing of a singing male is based on one of the last photographs taken.



More than 90 percent of the forests of western Ecuador have been destroyed during the past four decades. The loss is estimated to have extinguished or doomed over half of the species of the area's plants and animals. Many other biologically diverse areas of the world are under similar assault.

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SEGMENT D
PROBLEMS AND PARTNERSHIP
IN BIODIVERSITY

Class #18
Biodiversity and Natural Ecosystems Are Basic to Our Survival

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OBJECTIVE: Encourage students to realize that natural ecosystems and the present era biodiversity of this planet, of which migratory birds are a key part, are fundamental requirements for the long-term survival of people.

THEME: People rely on the natural systems of the present era for all our human enterprises. Protecting and maintaining the existing biodiversity of such ecosystems helps ensure a future and opportunity for us all.

CLASS ACTIVITY:

I. Discuss the EPA Science Advisory Board report excerpts assigned as Homework from Class #17, focusing on the recognition that maintaining the present era biodiversity of this planet helps to preserve the ecosystems on which our own survival depends.

II. Discuss the opportunities for helping to preserve the present era biodiversity of this planet that <u>The Diversity of Life</u> chapter 14 recommends.

III. Discuss how Neotropical migratory birds are one component of the larger world-wide issue, problem and challenge of maintaining the biodiversity of the

present era, and how the decline in their numbers reflects a general decline in the extent of present era biodiversity and destruction of ecosystems.

PREPARATION:

Read and become familiar with the materials assigned as Homework reading from Class #17.

RESOURCES NEEDED:

Blackboard, overhead projector or flip-chart pad for writing down students ideas.

HOMEWORK TO ASSIGN:

Read:

"Carving Up Tomorrow's Planet", Interview with John G. Robinson, International Wildlife, Vol. 24, No. 1 (Jan./Feb. 1994), pp. 29 - 37 (published by National Wildlife Federation).

FOLLOW-UP:

Make note of discussion themes that may need to be picked up in the remaining classes.

HANDOUTS:

Article identified in Homework, above.

LINKS: Biology, sociology, geography, land use and political science.

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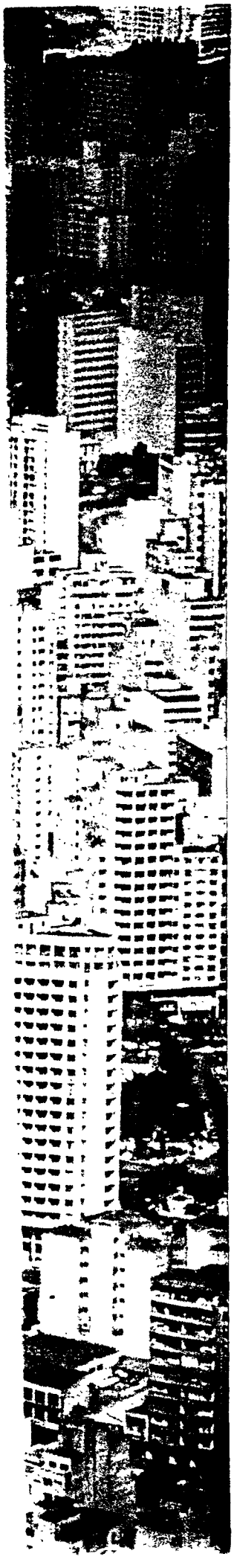
Class #18

HANDOUT

(for discussion
in Class #19)

Article: "Carving Up Tomorrow's Planet
Interview with John G. Robinson",
International Wildlife, published by National
Wildlife Federation, Jan./Feb. 1994, vol. 24,
no. 1. Reprinted with permission.



One expert's strategy for saving species: fashion a "sustainable landscape"

Carving Up Tomorrow's Planet

Interview with John G. Robinson

WITH EACH NEW HUMAN IMPACT *on wilderness, survival prospects for Earth's other species decline. In recent years scientists, conservationists, ethicists and others have wrestled with a new set of ideas—a kind of big-picture strategy—for deciding how to respond. One of the most promising is called sustainable use: using today's resources in ways that assure they will be around to benefit future generations. How to protect plants and wildlife while exploiting them for human needs is a particularly thorny aspect of this idea, especially since the "rules" of biology are different for each kind of ecosystem.*

For a fresh perspective on what's involved, International Wildlife *turned to conservation strategist John G. Robinson, who oversees 160 conservation projects in 44 countries for a newly named entity called NYZS The Wildlife Conservation Society (formerly the New York Zoological Society and its conservation division, Wildlife Conservation International). Here are some of his views, as presented in a conversation with* International Wildlife *Editor Jonathan Fisher:*

International Wildlife: Our planet is losing species faster than at any time since the extinction of the dinosaurs. As you look ahead—say, to the year 2020—

For conservation strategist Robinson, our world is a mosaic of four vastly different land uses (left and right). Not all four preserve natural systems, but together they may form a sustainable whole, saving wild species while meeting human needs. How much land we set aside for wildlife depends on our resolve.

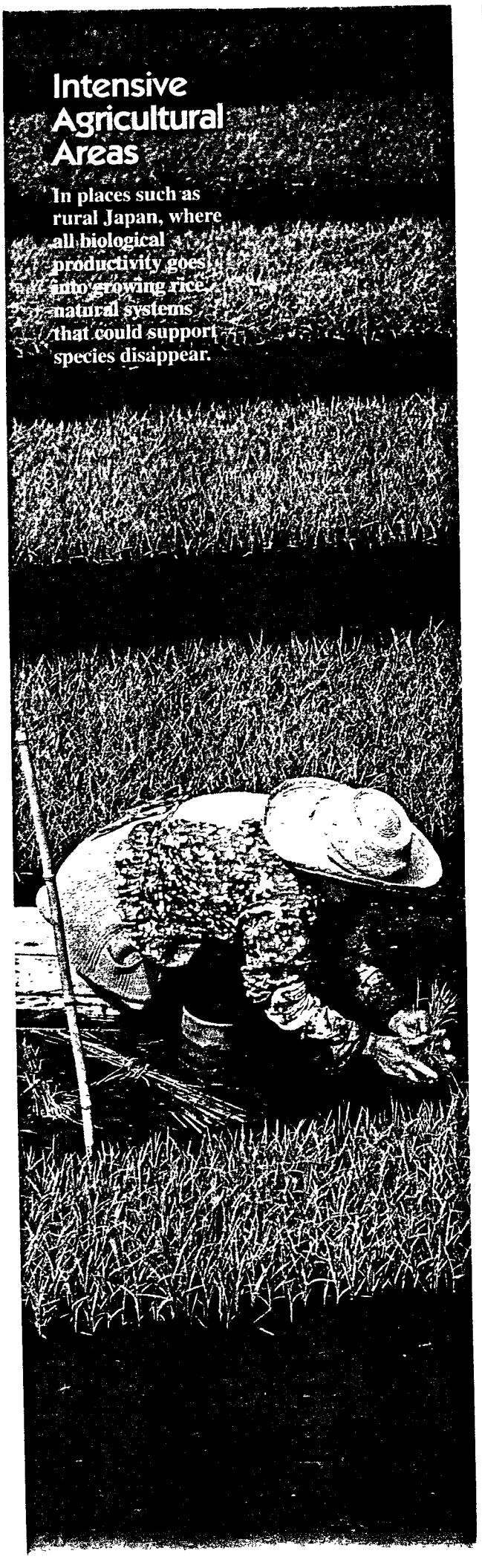
Published by National Wildlife Federation. Reprinted with permission.

Extractive Reserves

Some natural areas can stay virtually intact and still provide products for human use. One example: buffalo meat from South African savannas.

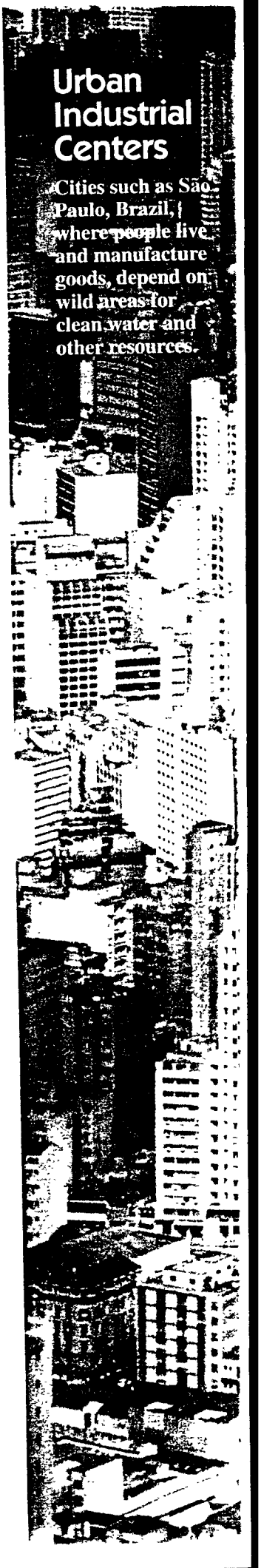
Intensive Agricultural Areas

In places such as rural Japan, where all biological productivity goes into growing rice, natural systems that could support species disappear.



Urban Industrial Centers

Cities such as São Paulo, Brazil, where people live and manufacture goods, depend on wild areas for clean water and other resources.



MEETING PEOPLES' NEEDS

"We're trying to raise the quality of life of all people. Simple mathematics will tell you that there is not enough biological potential to support that kind of aspiration."

what kind of world do you think we will be living in?

John Robinson: The world I would like to see out there is what might be called a sustainable landscape. It has wilderness. It has areas where people extract natural resources. It has areas with intensive agriculture. And it has urban and industrial areas. Overall, it is a mosaic of different land uses, but taken as a whole, it would protect natural systems and it would allow people to live sustainably.

IW: Can our world really be sustainable? Will it be here tomorrow in the same form—for use by our children and our children's children?

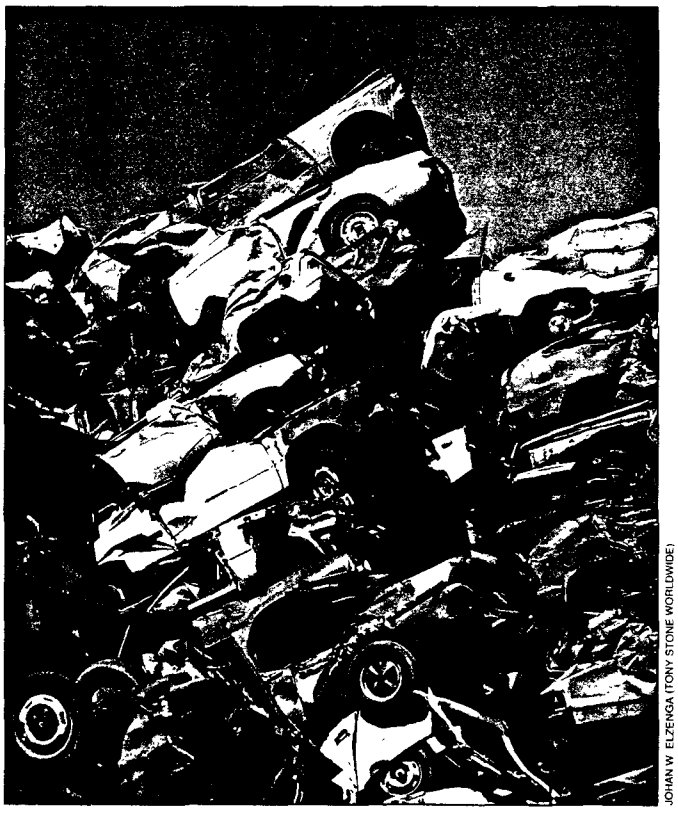
Robinson: Every day people take a larger chunk of resources at the expense of other species. Some of Earth's landscapes will have to be used exclusively to meet peoples' needs. Some can be used to perpetuate other species. Some can do both. How we allocate those uses is our biggest challenge. Will the world look the same? No. But we can fashion a sustainable planet.

IW: Some parts of your landscape don't seem very sustainable.

Robinson: Think of a jigsaw puzzle. Each piece has different activities with differing levels of sustainability. But all the pieces relate together to work as one sustainable whole. If those pieces don't fit together, the whole thing doesn't work.

IW: How do the pieces fit together?

Robinson: Wilderness areas would be sanctuaries for wildlife. Agricultural and industrial areas would be productive for people, driving the engines of national economies. Extractive areas would allow natural resources—timber, wildlife, nontimber products—to be harvested. Wilderness and extractive areas would not be as productive as agricultural or industrial areas, but they would subsidize those areas with raw materials and genetic resources. They would provide the essential ecosystem functions—cleaning the air and water, buffering local climates—that would keep the whole system working. So even if the agricultural and urban centers, by themselves, would not be sustainable, the landscape as a whole would be.



JOHAN W. ELZENGA (TONY STONE WORLDWIDE)

Used and cast aside, autos in a Swedish junkyard (above) illustrate profligate consumption in the developed world. In the main market of Dhaka, Bangladesh (right), people jam together, their sheer numbers a strain on resources. Both overconsumption and overpopulation pose threats to Earth's other species.

IW: Does this mean our future world will have room for only swatches of wild land?

Robinson: That's right. To save species, we need to preserve reservoirs of wild land, from cloud forests in the Andes to coral reefs off Australia. To feed growing numbers of pec ple, we will need areas of in tense agriculture—which wi never be sustainable per se What we've got to think abou is how to integrate the differ ent swatches.

IW: What about those ex tractive areas you mentioned?

Robinson: These parts o the sustainable landscap would still be recognizable a natural systems. They, too would help preserve species and they would maintain eco logical integrity and serve eco logical functions like protect ing watersheds. But extractiv areas—which might includ sections of rain forest wher indigenous people gather nut and other forest products, fo instance—might be degradec and they wouldn't be as pro ductive for humans as areas o intensive agriculture.

IW: If we don't come t terms with your carved-u world, what will that mean fo wildlife? What are we going to lose b the year 2020?

Robinson: We are losing species at very fast rate at the present time, but th average person probably couldn't nam many of them. Most of those species ten to be relatively small with limited geo graphic ranges and restricted to very spe cific types of habitat. Within the next 2(or 30 years, many species which peopl are more familiar with will be gone o very close to extinction. My guess is tha many of the big charismatic animals— elephants and grizzly bears—will still b around, but their role in their ecosyster will have long since gone.

IW: And tigers? Would they be anoth er example?

Robinson: Exactly. With large carni vores—tigers, jaguars—you are dealing with species which naturally tend to live at relatively low densities. To survive they need big areas. They also compete with human beings, and probably they will be restricted to only a few preserves

"Sustainable use doesn't work for all species or in all habitats....We need to focus our activity on those systems which people can best harness for their needs."

IW: What about pandas?

Robinson: Pandas are habitat specialists. They require forest habitats with a lot of bamboo, and it is very very difficult to maintain such forests in China, where they live.

IW: And rhinos? The same situation?

Robinson: Every species has different pressures on it. In the case of rhinos, you're dealing with hunting for their horns. Probably within 20 to 30 years, the only rhinos left will be in highly protected sanctuaries. For all intents and purposes, their role in natural habitats will no longer exist.

IW: How about people by the year 2020? There are likely to be eight and a half billion of us, or more. Shouldn't our species be the beneficiary of whatever we decide about the wilderness?

Robinson: We do have an obligation to our fellow human beings. We also have an obligation to our fellow species. What we are striving for is to reach a balance between human resource consumption and the need to preserve our world's biodiversity. We're not just concerned with supporting the greatest number of human beings at the greatest quality of life; we're seeking to preserve the rest of the biota for its own sake and for the sake of future generations of people.

IW: When we're making trade-offs and balancing off different uses, are we limited in our choices by what natural systems are capable of producing?

Robinson: Areas of high biological diversity—tropical forests, for instance—are generally not very productive for people. If you look at savannas, you're talking about habitats which are much more productive and can be more easily exploited. But there are also global limits. At the minute, we are already sequestering 40 percent of the world's net primary productivity—the total production of all forests, all cropland, all pasture, all plants—to support human beings. At the same time, we're trying to raise, not just maintain, the quality of life of all people. Simple mathematics will tell you that there is not enough biological potential to support that kind of aspiration. There are not enough resources to go around.

ROLAND SEITRE (PETER ARNOLD)

Cowboys lasso a capybara, the world's largest rodent, in Venezuela (above). Harvesting animals is more feasible in simple ecosystems than complex ones. At Tokyo's Tsukiji Market (left), fish inspectors check frozen tuna. Using the sea's resources makes sense, but people have overexploited most fish species.

IW: What happens when people increase their use of a biological system?

Robinson: You lose some of the diversity of plants and animals. Look at tropical forests. People tend to cut down the trees in them to create pasture or cropland. The forest then becomes a system which is much less biologically diverse but much more productive for human beings. But many ecosystems, even if altered by people, still have limited productivity. Tropical forests, for example, exist on very thin soils, and most of the biomass is tied up in the forest itself. Yes, you can convert a tropical forest to pasture, but it is a pretty poor pasture.

IW: If systems like tropical forests are biologically diverse and also less productive for people, doesn't that suggest that we ought to protect them rather than exploit them?

Robinson: First, let me say that we should aim to protect representative pieces of all ecosystems. But then I would also argue that highly diverse systems with many species—like tropical forests and coral reefs—should get the greatest protection. Protection will tend to be the best use of those systems.

IW: So some systems—grasslands, for example—can be exploited more economically and are therefore better suited for human use?

Robinson: Yes. We need to focus our developmental activity on those systems which people can best harness for their needs.

IW: Are you arguing that the popular idea of sustainable use of wildlife—using excess animals to benefit people—doesn't always work?

Robinson: It doesn't work for all species or in all habitats. Sustainable use is more likely where you have a high biological potential. Many marine systems, for instance, support highly productive fisheries. Ocean currents form great centers of nutrients, which support great concentrations of fish. Those can be exploited by people.

IW: Can you provide other examples?

Robinson: In many of the African savannas and deciduous forest areas in

"We're not just concerned with supporting the greatest number of human beings at the greatest quality of life; we're seeking to preserve the rest of the biota for its own sake...."

southern Africa, people have developed a system to crop wildlife. They're exploiting those wildlife systems, and they're doing it in a way which has the potential to be sustainable.

IW: You're talking about harvesting meat for local people?

Robinson: I'm talking about harvesting meat for local people, about safari hunting, about commercial harvesting of certain species. In theory, elephant populations could be harvested sustainably for meat, hides and ivory.

IW: What about outside Africa?

Robinson: The Russian steppes are highly productive. The saiga antelope has been sustainably harvested there for a thousand years, all the way back to Genghis Khan. Here is a system where much of the biomass, or total living matter, is tied up in a high-density species. If properly managed and regulated, this is a species that can be managed sustainably.

IW: What about capybara, the big rodents of Venezuela?

Robinson: A number of species can be harvested sustainably in the llanos of Colombia and Venezuela. Small crocodiles called caiman, which exist in very high density there, have been exploited for hundreds of years. In addition, the productivity of these systems is sufficient to maintain both subsistence and commercial harvests of anaconda, tegu lizards and the capybara you mentioned.

IW: So using wildlife may work in some areas but not in others?

Robinson: Right. Developing sustainable-use systems in Asia, for example, has proven to be extremely difficult. Wildlife densities in many Asian tropical forest areas are very, very low, and sustainable-use systems have not tended to work well in that part of the world.

NORBERT WU

Mirrors of their vibrant backdrops, a longnose hawkfish (above) flits past a gorgonian coral on a reef in Fiji, and a poison-dart frog rests in a Costa Rican rain forest (right). Coral reefs and rain forests warrant protection because both are biologically diverse and of limited economic use to people.

IW: And certain kinds of species lend themselves more to human use?

Robinson: If you are interested in harvesting animals, you are more likely to succeed if you are working with grass-eaters, which occur at much higher densities than do meat-eating animals and in less diverse systems. Harvesting antelopes on an African savanna may be very sustainable. But exploitation of spotted cat skins from tropical forests is going to be very difficult.

IW: If you're right that our future will include a fragmented landscape that provides a balance between resource protection and resource use, the aren't we really definir that balance right now?

Robinson: That's rigl We would all like to i crease the standard of li ing and quality of life of a the peoples in the wor while at the same tir maintaining our natural r sources for future gener tions. The question is: ' what extent will we have sacrifice some of our ec nomic aspirations to su port some of our ecologic aspirations? What we nee to strive for is neither con plete utilization nor prese vation. What we need the mosaic.

IW: And how do we d cide precisely how th pieces in your mosaic a best split up?

Robinson: The answ to that question depen on how much we valu wilderness areas, and ho much future generations will depend c those areas. Do we value them enough actually pay to preserve them? If peop are willing, then we will have a landsca which will contain significant wildernes If we are content to lose our lions ar tigers and bears, we will lose them.

John G. Robinson, vice president for I ternational Conservation of NYZS Th Wildlife Conservation Society, is also c the steering committee of the Species Su vival Commission for the IUCN—Th World Conservation Union. A zoologi he received a doctorate from the Unive sity of North Carolina and has worke extensively with primates.

For a complete text of Robinson's i terview—which includes thoughts abo how the big decisions of conservatio should be made and how individuals ca make a difference—send a self-addresse business envelope to: Interview, Intern tional Wildlife, *8925 Leesburg Pike, V enna, Virginia 22184.*

PROTECTING BIODIVERSITY

BY BRUCE BABBITT

Arizona Democrat Bruce Babbitt is Secretary of the Interior. He has served as Attorney General and Governor of his native state, and President of the League of Conservation Voters.

How can we best protect this nation's treasure of biodiversity—forested mountains, mineral-rich lands of the West, tumbling rivers and the creatures that inhabit these varied landscapes? Perhaps the answer is best revealed in our mistakes.

Remember the conflict over the endangered snail darter in the 1970s? In 1973, opponents of the Tellico Dam on the Little Tennessee River saw this 3-inch fish as a cudgel to bring down the dam. After snail darters were discovered near the dam site, opponents persuaded the United States Supreme Court in 1978 that finishing the project would spell doom for the fish. The court ordered work stopped on the nearly complete, $137-million project—angering supporters of the dam and providing ammunition to opponents of the Endangered Species Act.

Two years later, determined Tennessee legislators convinced Congress to exempt the dam from the Endangered Species Act, and thousands of acres were flooded. In an ironic twist to this bitter drama, the snail darter was not obliterated, and was taken off the endangered-species list in 1984.

The snail darter battle left a bitter taste in everyone's mouth and a lingering impression in the public consciousness that protecting endangered species means conflict and disruption. What we learned from this experience is that, ultimately, nobody wins in "us-versus-them,

all-or-nothing" environmental confrontations.

If we truly want to protect biological diversity, we need to avoid crisis and confrontation. We can't afford to drag our feet until a species is at the brink of extinction and then argue about protecting its last small corner of habitat. We need a new approach: one that encourages us to think ahead and plan for the future; one that encourages us to look at whole ecosystems and not just tiny parcels of land; one that stresses compromise and balance between people and nature.

We don't need new laws to do this. Congress has passed impressive environmental legislation. We've got to start using these laws to resolve conflicts.

The protracted slugfest in the Pacific Northwest over timber production and the northern spotted owl is another example of futile confrontation and lack of foresight. Many believe that this fight is about one creature in trouble. But it is really about a crisis in forest management that foreshadowed a much broader breakdown in the region's ecological balance and economy. It took a federal judge's injunction to get everyone to sit down together and talk about the issue.

That's what the Clinton administration's forest conference last spring was all about. During three days of hearings in April, timber industry representatives testified that restrictions on logging in the Pacific Northwest forest would cost tens of thousands of jobs. Environmentalists stated that the 3 million acres of old-growth trees not yet cut should be preserved as one of the last remnants of this country's ancient forests.

In an effort to reach a balance, the administration issued a plan last summer to permit timber harvesting in old-growth forests while protecting the ecosystem. This plan should have been hammered out 20 years ago. Instead, the players waited until the crisis was white-hot.

The Endangered Species Act often has been at the center of these maelstroms. Critics charge the act is an eco-weapon out of control, but I consider this legislation an extraordinary achievement, probably the most revolutionary environmental law of this century. It explicitly says that when a species begins the downward slide toward extinction, the response will be a habitat protection plan that will make it a criminal offense to take that species or its habitat.

Eco-showdowns get most of the publicity, but we've had some great successes with this law: the bald eagle, the peregrine falcon, the American alligator and more. My take on the Endangered Species Act is that we haven't even come close to working with the authority, the concepts and the flexibility contained in the Act to avoid environmental crises.

One place where we're trying to do better is southern California. There, a small blue-gray songbird, the gnatcatcher, is struggling to keep a foothold. Developers view the 250,000 acres of coastal sage scrub where the bird lives as some of the best unbuilt real estate left in southern California. But the gnatcatcher prizes it, too. The bird rarely ventures more than a few acres away from its nesting site, and when it's threatened, it hides deep in the brush. It will stay in its habitat even if it means getting bulldozed.

To avoid a "people-versus-songbird" conflict, the state of California is working with developers and conservationists in a novel approach called the Natural Communities Conservation Planning Program. Since 1991, government officials have been meeting with all sides to identify and preserve enough of the coastal sage habitat to support the gnatcatcher and other rare species.

While the planning effort is under way, the state program allows developers to build on a small part of the land as long as they agree to set aside preserves or restore portions of habitat when they're identified. An added benefit to this approach is that it can help species such as the cactus wren that share gnatcatcher habitat—before they, too, start sliding towards extinction.

To assist California's effort, the federal government last March listed the gnatcatcher as threatened, rather than endangered. In that way, strict federal regulations for endangered species do not overwhelm the planning process. If the California groups fail to reach scientifically sound agreements or lag behind timetables to complete their work, the federal government will take over the process.

This is the first time in the history of the Endangered Species Act that we have listed a species and then stepped back to defer to the state's planning process. The outcome is by no means clear, but we want to make it work.

There is another example where cooperation can promote both biodiversity and jobs. The federal government and Georgia-Pacific Corporation—the nation's biggest forest products company—have reached a precedent-setting agreement to help the endangered red-cockaded woodpecker. Georgia-Pacific has devised plans to protect the 300 to 400 woodpeckers that reside and forage on about 56,000 of the 4.2 million acres of company-owned pine forests in the South.

The company will halt logging on land that contains colonies of woodpeckers, which live in cavities hammered into old living pine trees. In addition, Georgia-Pacific will establish buffer zones around each colony where timber will be selectively harvested, and will prevent road-building near the birds' colonies.

In return for taking steps to protect the woodpecker, the company can continue logging without restrictions imposed by the Endangered Species Act. The agreement is a demonstration that it's possible to find a balance between the imperative to create jobs in forest production and the imperative to protect the environment.

If we're going to protect whole ecosystems, rather than just single species or pieces of habitat, we need a base of rigorous, comprehensive science. Strong research will help us see more clearly what the problems are and give us flexibility to act before a crisis. To help accomplish this, we are establishing a new bureau at the Interior Department: The National Biological Survey.

Modeled after the century-old U.S. Geological Survey, the biological survey will draw scientists from the department's different bureaus to coordinate ongoing studies and to avoid duplicate or fragmented research projects. The survey's emphasis will be basic research and will focus on areas already found in existing Department of Interior programs.

For example, the survey will oversee studies on the loss of wetlands in coastal Louisiana, how to manage streams and riparian habitats in the Pacific Northwest and the impact of offshore oil drilling. In addition, the survey will examine how to save declining species from extinction, and how to curtail the destructive impacts of nonnative organisms that have invaded an ecosystem.

A new mission for the survey and one of its most important tasks will be to examine the status and trends for all U.S. wildlife habitats. The survey then could report regularly on the abundance, distribution and health of the nation's ecosystems.

Besides bolstering our scientific base, we need to reform our specific missions in resource management at the Department of Interior. For instance, the Bureau of Reclamation, responsible for much of the dam construction in the West, should look at how to allocate water without turning to big new construction projects.

We also need to institute more realistic market pricing of our resources. Those who graze cattle on grasslands, or extract hard rock minerals, or use water from a federal reservoir, or cut timber in a national forest should pay their fair share to use those resources and restore the land. Market pricing encourages conserva-

tion and wise use of limited resources.

The American conservation movement has been through two important eras. The first was in the time of Teddy Roosevelt, who helped create the land management ethic. Roosevelt summed up this ethic by saying, "The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased and not impaired in value."

The second era was in the 1960s and 1970s—a period of heightened concern about the unchecked use of toxic chemicals and industrial pollution. Stimulated in part by Rachel Carson's book *Silent Spring*, a clarion call about the dangers of pesticides such as DDT, the government assumed a greater role in regulating and limiting pollutants in our soil and water.

Now, on the eve of the millennium, we are entering a third era that is infinitely more complex because it demands that we strike a balance, that we make peace with the natural environment.

As the one species that dominates the world, we must make space for the rest of creation to play its assigned role on this planet. It can't be "us versus them." Ultimately, we'll all lose. But if we learn to live more lightly on the land, we'll all win.

EPA

Reducing Risk:

Setting Priorities And Strategies For Environmental Protection

Class #18

HANDOUT

Excerpt from:

EPA's 1990 Science Advisory Board report:

"Reducing Risk: Setting Priorities and Strategies for Environmental Protection"

NOTICE

This report has been written as a part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced expert assessment of scientific matters related to problems facing the Agency; hence the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency or of other Federal agencies.

This particular project was conducted at the request of the EPA Administrator and addresses a broader range of issues and concerns than most SAB reports. Consequently, many of the findings and recommendations in this report have more of a policy orientation than is usually the case.

Cover Photo by Steve Del

REDUCING RISK:

SETTING PRIORITIES AND STRATEGIES FOR ENVIRONMENTAL PROTECTION

The Report of The Science Advisory Board:
Relative Risk Reduction Strategies Committee

to

William K. Reilly
Administrator
United States Environmental Protection Agency

September 1990

Science Advisory Board
U.S. Environmental Protection Agency
Washington, DC 20460
September 25, 1990

Mr. William K. Reilly
Administrator
U.S. Environmental Protection Agency
Washington, DC 20640

Dear Mr. Reilly:

Over a year and a half ago, you asked the Science Advisory Board to review 1987 report, *Unfinished Business: A Comparative Assessment of Environmenta lems*, and then assess and compare different environmental risks in light of th recent scientific data. You also asked us to examine strategies for reducing maj and to recommend improved methodologies for assessing and comparing ri risk reduction options in the future. This report and its three appendices hav prepared in response to your request.

To undertake this project, the Science Advisory Board created a special R Risk Reduction Strategies Committee composed of 39 distinguished scienti other experts from academia, state government, industry, and public interest g The Committee carefully considered the reports written by each of its thre committees, and the findings and recommendations contained in Reducing Ri from the work of the Subcommittees and reflect study, discussion, and synthesi Committee as a whole. This report has been reviewed by the SAB Executiv mittee and has been formally approved as an SAB document.

As you are aware, the Science Advisory Board normally reviews scientific rep the Agency and evaluates them on the basis of scientific and engineerin However, in this case our review of *Unfinished Business* and our analysis reduction options have led us to make findings and recommendations that ar policy-oriented than is usually the case. We have done this at your request

This report, together with its three appendices, suggests steps that the Enviror Protection Agency should take to improve its own efforts — and to involve C and the rest of the country in a collective effort — to reduce environmental r strongly believe that the Agency should take steps to ensure that this nation use tools at its disposal in an integrated, targeted approach to protecting human welfare, and the ecosystem.

This report is only a step along a long road. We encourage you to lead the A taking the necessary further steps as soon as possible.

Sincerely,

Raymond Loehr
Chair, Science Advisory Board, and Co-Chair, Relative Risk Reduction Strategies Committee

Jonathan Lash
Co-Chair, Relative Risk Reduction Strategies Committee

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One—Executive Summar

The Concept of Risk

Over the past 20 years this country has put in place extensive and detailed government policies to control a number of environmental problems. Smog in heavily populated areas, the eutrophication of lakes, elevated levels of lead in the blood of millions of children, the threat of cancer from exposure to pesticide residues in food, and abandoned drums of hazardous wastes are a few of the problems that have driven the enactment of more than a dozen major Federal laws and the current public and private expenditure of about $100 billion a year to protect the environment.

Those efforts have led to very real national benefits. The staggering human health and ecological problems apparent throughout eastern Europe suggest the price this country would be paying now had it not invested heavily in pollution controls.

Yet despite the demonstrable success of past national efforts to protect the environment, many national environmental goals still have not been attained. Factors like the growth in automobile use and common agricultural practices have caused national efforts to protect the environment to be less effective than intended.

Furthermore, with hindsight it is clear that in many cases those efforts have been inconsistent, uncoordinated, and thus less effective than they could have been. The fragmentary nature of U.S. environmental policy has been evident in three ways:

- *In Laws.* As different environmental problems were identified, usually because the adverse effects — smog in major cities, lack of aquatic life in stream segments, declining numbers of bald eagles — were readily apparent, new laws were passed to address each new problem. However, the tactics and goals of the different laws were neither consistent nor coordinated, even if the pollutants to be controlled were the same. Many laws not passed primarily for environmental purposes also had major effects on the environment.

- *In Programs.* The Environmental Protection Agency (EPA) was established as the primary Federal agency responsible for implementing the nation's environmental laws. EPA then evolved an administrative structure wherein each program was primarily responsible for implementing specific laws. Consequently, the efforts of the different programs rarely were coordinated, even if they were attempting to control different aspects of the environmental problem. This problem is compounded by the fact that EPA is not the c agency whose activities affect the environmen

- *In Tools.* The primary tools used to protect environment have been controls designed to pollutants before they escape from smokestac tailpipes, or sewer outfalls, and technologies designed to clean up or destroy pollutants af have been discharged into the environment. so-called "end-of-pipe" controls and remedia technologies almost always have been applie because of Federal, State, or local legal requi

For a number of reasons, this kind of fragr approach to protecting the environment will as successful in the future as it has been in t In this country the most obvious controls alr have been applied to the most obvious probl complex and less obvious environmental pro remain, and the aggregate cost of controlling problems one-by-one is rising.

Moreover, this country — and the rest of world — are facing emerging environmental problems of unprecedented scope. Populatio growth and industrial expansion worldwide straining global ecosystems. Never before in have human activities threatened to change atmospheric chemistry to such an extent tha climate patterns were altered.

Given the diversity, complexity, and scop environmental problems of concern today, it critically important that U.S. environmental evolves in several fundamental ways. Essen national policy affecting the environment mu become more integrated and more focused c opportunities for environmental improveme has been in the past.

The environment is an interrelated whole, society's environmental protection efforts sh integrated as well. Integration in this case m government agencies should assess the ran environmental problems of concern and the protective efforts at the problems that seem most serious. It means that society should u tools — regulatory and non-regulatory alike are available to protect the environment. It that controlling the end of the pipe where p enter the environment, or remediating prob caused by pollutants after they have entere environment, is not sufficient. Rather,

waste-generating activities have to be modified to minimize the waste or to prevent the waste from being generated at all. Most of all, integration is critically important because significant sources of environmental degradation are embedded in typical day-to-day personal and professional activities, the cumulative effects of which can become serious problems. Thus protecting the environment effectively in the future will require a more broadly conceived strategic approach, one that involves the cooperative efforts of all segments of society.

One tool that can help foster the evolution of an integrated and targeted national environmental policy is the concept of environmental risk. Each environmental problem poses some possibility of harm to human health, the ecology, the economic system, or the quality of human life. That is, each problem poses some environmental risk. Risk assessment is the process by which the form, dimension, and characteristics of that risk are estimated, and risk management is the process by which the risk is reduced.

The concept of environmental risk, together with its related terminology and analytical methodologies, helps people discuss disparate environmental problems with a common language. It allows many environmental problems to be measured and compared in common terms, and it allows different risk reduction options to be evaluated from a common basis. Thus the concept of environmental risk can help the nation develop environmental policies in a consistent and systematic way.

Scientists have made some progress in developing quantitative measures for use in comparing different risks to human health. Given sufficient data, such comparisons are now possible within limits. Although current ability to assess and quantify ecological risks is not as well developed, an increased capacity for comparing different kinds of risks more systematically would help determine which problems are most serious and deserving of the most urgent attention. That capacity would be even more valuable as the number and seriousness of environmental problems competing for attention and resources increase.

An improved ability to compare risks in common terms would have another value as well: it would help society choose more wisely among the range of policy options available for reducing risks. There are a number of ways to reduce the automobile emissions that contribute to urban smog; there are a number of ways to decrease human exposure to lead. The evaluation of relative risks can help identify the relative efficiency and effectiveness of different risk reduction options.

There are heavy costs involved if society fails to set environmental priorities based on risk. If finite resources are expended on lower-priority problems at the expense of higher-priority risks, then society will face needlessly high risks. If priorities are established based on the greatest opportunities to reduce risk, total risk will be reduced in a more efficient way, lessening threats to both public health and local and global ecosystems.

The Ten Recommendations

1. EPA should target its environmental protection efforts on the basis of opportunities for the greatest risk reduction. Since this country already has taken the most obvious actions to address the most obvious environmental problems, EPA needs to set priorities for future actions so the Agency takes advantage of the best opportunities for reducing the most serious remaining risks.

2. EPA should attach as much importance to reducing ecological risk as it does to reducing human health risk. Because productive natural ecosystems are essential to human health and to sustainable, long-term economic growth, and because they are intrinsically valuable in their own right, EPA should be as concerned about protecting ecosystems as it is about protecting human health.

3. EPA should improve the data and analytical methodologies that support the assessment, comparison, and reduction of different environmental risks. Although setting priorities for national environmental protection efforts always will involve subjective judgments and uncertainty, EPA should work continually to improve the scientifc data and analytical methodologies that underpin those judgments and help reduce their uncertainty.

4. EPA should reflect risk-based priorities in its strategic planning processes. The Agency's long-range plans should be driven not so much by past risk reduction efforts or by existing programmatic structures, but by ongoing assessments of remaining environmental risks, the explicit comparison of those risks, and the analysis of opportunities available for reducing risks.

5. EPA should reflect risk-based priorities in its budget process. Although EPA's budget priorities are determined to a large extent by the different environmental laws that the Agency implements, it should use whatever discretion it has to focus budget resources at those environmental problems that pose the most serious risks.

6. EPA — and the nation as a whole — sho greater use of all the tools available to redu Although the nation has had substantial suc reducing environmental risks through the government-mandated end-of-pipe controls, extent and complexity of future risks will re the use of a much broader array of tools, inc market incentives and information.

7. EPA should emphasize pollution prevent the preferred option for reducing risk. By encouraging actions that prevent pollution f being generated in the first place, EPA will h reduce the costs, intermedia transfers of pol and residual risks so often associated with end-of-pipe controls.

8. EPA should increase its efforts to integra environmental considerations into broader public policy in as fundamental a manner a economic concerns. Other Federal agencies affect the quality of the environment, e.g., t the implementation of tax, energy, agricultu international policy, and EPA should work t that environmental considerations are integr where appropriate, into the policy deliberati such agencies.

9. EPA should work to improve public understanding of environmental risks and t professional workforce to help reduce them improved environmental literacy of the gen public, together with an expanded and bett technical workforce, will be essential to the success at reducing environmental risks in t

10. EPA should develop improved analytic methods to value natural resources and to for long-term environmental effects in its e analyses. Because traditional methods of ec analysis tend to undervalue ecological resou fail to treat adequately questions of interger equity, EPA should develop and implemen innovative approaches to economic analysis address these shortcomings.

Chapter Two—Findings

1. The Importance of *Unfinished Business*

H-3.0; H-6.0
E-3.0; E-5.0
S-4.2

With the publication of *Unfinished Business* early in 1987, EPA took a bold and much-needed step: it compared the relative residual risks posed by a range of different environmental problems, and thus suggested an important shift in national environmental policy. With that report EPA took the first step toward relative risk reduction; that is, a policy that attempts to match Agency and societal resources to risk.

To produce *Unfinished Business* EPA brought together staff from all its program offices for the explicit purpose of comparing the relative risks of different environmental problems, regardless of individual programmatic priorities or responsibilities. To do that, the EPA staff had to assess environmental risk in a context broader than programmatic structure or legislated activities. In short, they had to put aside considerations of bureaucratic "turf" in order to rank the problems they believed most needed society's attention. EPA should be applauded for the courage and foresight to undertake a project like *Unfinished Business*.

Unfinished Business presents useful, preliminary information for comparing environmental problems, although in some cases its rankings are a matter of judgment and cannot be supported fully by existing data. The Ecology and Welfare Subcommittee questioned the welfare rankings, because it disagreed with some of the economic assumptions underlying those rankings and because of a general lack of relevant economic data. The Human Health Subcommittee questioned the accuracy of any ranking of human health risks at this time, given the limited human exposure and chronic toxicity data currently available. Both Subcommittees observed that the 31 problems assessed were not derived from a systematic classification of all environmental problems, and both suggested alternative and more comprehensive approaches to classification that would facilitate a more coherent ranking.

Most of the 31 environmental problems assessed in *Unfinished Business* are so broad, and include so many toxic and non-toxic agents, that its ranking of problems cannot be evaluated with rigor or confidence. Additionally, the authors of *Unfinished Business* intentionally defined environmental problems to correspond to legislation and programmatic organization. As a result, they attempted to compare heterogenous mixtures of pollutants (like air pollutants and drinking water pollutants) to pollutant sources (like oil spills and mining waste) to receptors (like consumers and workers). Yet without a consistent basis for comparison, such comparisons are tenuous at best.

Moreover, because the authors chose to limit the environmental problems they compared, *Unfinished Business* does not address problems like the loss of habitat and the decline in genetic diversity, even though such problems pose very serious risks, and EPA and other agencies may be able to take actions to mitigate them. A meaningful ranking of relative environmental risks must include all such risks, whether or not laws have been passed or programs set up to control them.

A final shortcoming for the authors of *Unfinished Business* was the availability of data. Good data to evaluate risks simply did not — and in many cases still do not — exist. The EPA staff understandably used their professional judgment to fill the data gaps. The Subcommittee reports appended to this overview report document in more detail the members' judgments as to the relative strength and weakness of the data used to support the risk rankings in *Unfinished Business*.

The findings and recommendations described in this overview report have been derived mainly from the reports prepared by the three Subcommittees of the Relative Risk Reduction Strategies Committee. Those reports, which are included as appendices to this report, contain detailed information that support and more fully explain the findings and recommendations. Such information can be found by referring to the sections of the different appendices that are listed at the beginning of each finding and recommendation. In the listed crossreferences:

- "E" refers to the Report of the Ecology and Welfare Subcommittee;
- "H" refers to the Report of the Human Health Subcommittee; and
- "S" refers to the Report of the Strategic Options Subcommittee.

2. Problems in Ranking Risks

E-3.0; E-5.2
H-3.0; H-6.0

As long as there are large gaps in key data sets, efforts to evaluate risk on a consistent, rigorous basis or to define optimum risk reduction strategies necessarily will be incomplete, and the results will be uncertain. For example, data on human exposure and on the toxicity of many pollutants are seriously deficient. In particular, the lack of pertinent exposure data makes it extremely difficult to assess human health risks.

Moreover, great uncertainty often is associated with the data that do exist. Exposure and toxic response models, the numbers used to quantify risks, and variations in individual susceptibility to risks are often highly uncertain. Without more and better data, conclusions about relative risk will be tenuous and will depend in large measure on professional judgment.

In addition to the lack of data, methodological inadequacies also impede the assessment and comparison of risk. At this time EPA does not have an effective, consistent way of identifying environmental problems in a manner that neither fragments nor aggregates sources of risk to an extent that renders comparisons untenable. EPA's current framework of statutory mandates and program structure helps to maintain artificial distinctions among environmental problems, and those distinctions are conducive neither to sound evaluation of relative risk nor to selection of the most effective actions to reduce risk.

In particular, the methodologies currently used to estimate the benefits of risk reduction activities are inadequate and inappropriate. For example, a methodology that presumes the future value of an ecological resource necessarily must be less than its present value will not be a useful analytical t sustaining economic development over the lc term. The standard practice of discounting fu resource values is inappropriate, and it resul policies that lead to the depletion of irreplace natural resources.

Reliance on "willingness to pay" and simil techniques commonly used in economic anal distorted current understanding of the value natural resources. While some people may n about wetlands and assign no value to their existence, such areas still provide valuable ec services to this and future generations. Whil people are likely to care about and be willing for plankton and fungi, such organisms play role in sustaining economically valuable ecos

An additional difficulty entailed in any att compare and rank environmental risks is the inevitable value judgments that must be mac example, are health risks posed to the aged r less serious than health risks posed to infant risks of cancer more or less serious than thre reproductive processes? Comparing the risks to human populations with the risks posed t ecosystems may be even more difficult. It se that subjective values always will — and sho influence the ranking of relative environmen no matter how sophisticated the technical an analytical tools become.

3. The Extraordinary Value of Natural Ecosystems

E-5.2

Natural ecosystems like forests, wetlands, and oceans are extraordinarily valuable. Those ecosystems contain economically valuable natural resources that feed, clothe, and house the human race. They act as sinks that, to a certain extent, absorb and neutralize the pollutants generated by human activity. Although natural ecosystems — and the linkages among them — are not completely understood, there is no doubt that over time the quality of human life declines as the quality of natural ecosystems declines.

The value of natural ecosystems is not limited to their immediate utility to humans. They have an intrinsic, moral value that must be measured in its own terms and protected for its own sake.

However, over the past 20 years and especially over the past decade, EPA has paid too little attention to natural ecosystems. The Agency has considered the protection of public health to be its primary mission, and it has been less concerned about risks posed to ecosystems. The Agency's relative lack of concern reflects society's views as expressed in environmental legislation; ecological degradation probably is seen as a less serious problem because it is often subtle, long-term, and cumulative. But for whatever reason, this imbalance is a manifest, if inadvertent, part of current national environmental policy.

EPA's response to human health risks as compa to ecological risks is inappropriate, because, in the real world, there is little distinction between the two Over the long term, ecological degradation either directly or indirectly degrades human health and the economy. For example, as the extent and quality of saltwater estuaries decline, both human health and local economies can suffer. As soils erode, forests, farmlands, and waterways can become less productive. And while the loss of species may not be noticed immediately, over time the decline in genetic diversity has implications for the future health of the human race.

In short, human health and welfare ultimately rely upon the life support systems and natural resources provided by healthy ecosystems. Moreover, human beings are part of an interconnected and interdependent global ecosystem, and past experience has shown that change in one part of the system often affects other parts in unexpected ways National efforts to evaluate relative environmental risks should recognize the vital links between human life and natural ecosystems. Up to this point, they have not.

4. Time, Space, and Risk

E-4.3; E-7.0
S-2.2

While the data needed to support firm rankings of risk were found to be limited, the RRRSC identified a number of important factors that must be considered in any assessment or ranking of the risk associated with a particular environmental problem. Those factors include the number of people and other organisms exposed to the risk, the likelihood of the environmental problem actually occurring among those exposed, and the severity of the effects, including the economic losses and other damages involved, if it does occur.

In addition, two other aspects of potential environmental problems — i.e., their temporal and spatial dimensions — also must be given considerable weight in any analysis of relative environmental risk. Consideration of time and space can help guide judgments about relative risks in the absence of complete data.

The temporal dimension of an environmental problem is the length of time over which the problem is caused, recognized, and mitigated. For some environmental problems the temporal dimension can be very long. For example, the chronic human health effects of air or water pollution may become apparent only after many years of exposure. It may take decades of human activity to begin to change the global climate, and more decades may pass before the effects of human activity on the global climate are clearly understood. Some pollutants can persist in the environment — and thus pose environmental risks — indefinitely. And it may take decades or even centuries before depleted species of wildlife recover from the loss of habitat, if recovery is possible at all.

The spatial dimension of an environmental problem is the extent of the geographical area that is affected by it. Some environmental problems, like elevated levels of radon, may be limited to the basements of some homes, while problems like stratospheric ozone depletion can affect the entire globe. And some global problems, like the loss of genetic diversity, can be caused by human activities in relatively limited geographical areas.

The time and space dimensions of environm problems should weigh heavily in any compari relative environmental risks. For example, if long-lived pollutants like DDT and PCBs can b concentrated in the food chain and pose a thre future as well as present human and ecological health, those future risks should be taken into account when relative risks are compared. Simi if global climate change or stratospheric ozone depletion has the potential to affect the health economic well-being of virtually everyone on e now and in the future, the extent and duration risk should suggest a relatively high-risk rankir

Ecosystems are generally resilient to short-te insults. For example, oil spills and water pollut usually cause only temporary ecological chang nature has a substantial capacity for healing its However, some changes are either permanent semipermanent. Destroying wetlands, altering natural water flows (as in the Everglades), glob warming, and stratospheric ozone depletion ca cause irreversible and, in some cases, widespre problems.

In fact, some long-term and widespread environmental problems should be considered relatively high-risk even if the data on which t assessment is based are somewhat incomplete uncertain. Some risks are potentially so serious the time for recovery so long, that risk reductic actions should be viewed as a kind of insuranc premium and initiated in the face of incomplet uncertain data. The risks entailed in postponin action can be greater than the risks entailed in inefficient or unnecessary action. Moreover, preemptive actions are especially justifiable if - the energy conservation efforts that would slo accumulation of greenhouse gases — they leac unrelated but immediate and substantial benef such as improved ambient air quality and redu U.S. dependence on imported oil.

5. The Links Between Risk and Choice

S-2.2 It is sometimes tempting to think simplistically about the sources of environmental risk as being a particular industry, a particular product, or a particular pollutant. Conceptually, smokestacks can be controlled, products modified, and pollutants banned with relative ease.

But the sources of environmental risk are much more diverse and complicated than that. In fact, the sources of risk often are to be found in the day-to-day choices made by individuals, communities, and businesses. And many kinds of environmental risk will not be reduced substantially, especially over the long term, if past patterns of individual, community, and business choices do not change in light of the relative risks posed by those choices.

In a sense, the very existence of the human race inevitably poses some level of environmental risk. People necessarily generate wastes, both as individuals and through aggregate economic activities. People necessarily destroy or infringe upon some natural habitats when they construct their own. Individuals either increase or lessen environmental risk depending on which consumer products they buy, how they design their homes, and whether they walk or drive to work. Society affects environmental risk at the local level through building codes and zoning laws and at the national level through tax, energy, and agricultural policies.

But all these activities involve choice, and the environmental risks posed by many human activities can be reduced sharply if different choices are made. So one of the most important questions facing society is how to influence and shape individual, community, and business choices so that environmental risks are reduced.

Choice is influenced by a number of factors, including education and ethics. Some people may choose to purchase certain consumer products because of a genuine concern about the environmental effects of their personal buying patterns. Similarly, some businesses may redesign production processes to eliminate pollution because of a desire to be perceived as corporate "good citizens."

Economic incentives are also important tools for inducing particular kinds of choices. When the price of energy rises, consumers are likely to buy more fuel-efficient vehicles and weatherize their homes, while plant managers have an added incentive to purchase more energy-efficient equipment. Full pricing of municipal services can give people an incentive to recycle their household wastes and conserve water.

Laws and regulations, of course, are very effective at shaping individual and social choices. Local zoning laws can change the pattern of economic development in a community and limit where homes can be built. Local, State, and Federal procurement regulations can have a substantial effect on the development of markets for recycled products.

Projected future growth in population and economic activity could add enormously to the environmental risks faced in this country and around the world. But growth and reductions in environmental risk are not necessarily incompatible, if past patterns of individual, community, and business choice can change. In national efforts to assess, compare, and control relative risks, the importance of those choices — and the policy options available to influence those choices — should not be overlooked.

6. Public Perceptions of Risk

S-B.4

Public opinion polls taken over the past several years confirm that people are more worried about environmental problems now than they were 20 years ago when the first wave of environmental concern led to major changes in national policy. But the areas of greatest concern to the public today are not necessarily those problems identified in *Unfinished Business*. In other words, the remaining and emerging environmental risks considered most serious by the general public today are different from those considered most serious by the technical professionals charged with reducing environmental risk.

This dichotomy between public perceptions and professional understanding of environmental risk presents an enormous challenge to a pluralistic, democratic country. A Federal agency like EPA must be sensitive to public concerns about environmental problems. In fact, since public concerns tend to drive national legislation, Federal environmental laws are more reflective of public perceptions of risk than of scientific understanding of risk. Consequently, EPA's budget and staff resources tend to be directed at those environmental problems perceived to be most serious by the general public.

Yet if national resources are to be used most effectively to promote environmental quality, then such resources must be aimed at those environmental problems that pose the greatest risks. The ability to match resources to risks will m the success of national policies to protect the environment.

One obvious way to bridge this dichotomy be to improve the public's understanding of t scientific and technical aspects of environmer while improving scientists' understanding of basis of public concern. Public perceptions of environmental risk tend to incorporate deeply subjective values, like justice and equity, that although difficult to quantify, reflect importa elements of the quality of life that governmer bound to protect. Moreover, since the scienti understanding of any environmental problem likely to evolve as the science improves, and environmental policy necessarily embodies su values, scientific understanding should not b sole determinant of environmental policy.

Therefore, EPA must be prepared to listen carefully to the public's perceptions of risk. Moreover, EPA should balance those percept with current scientific understanding as the A develops long-term risk reduction strategies.

7. Relatively High-Risk Environmental Problems

E-4.0; E-6.0; H-5.0; H-7.0

The RRRSC not only reviewed the risk rankings contained in *Unfinished Business*, but it also identified several environmental problems as relatively high-risk, based on available scientific data and technical understanding. This effort was challenging for a number of reasons. Ecological, health, and welfare risks can be manifested in a number of different endpoints; it is difficult to compare risks with widely different time scales and spatial dimensions; because of data gaps and methodological inadequacies, it is rarely feasible to quantify total risk. In other words, the RRRSC faced many of the same hurdles that faced the authors of *Unfinished Business* when they developed their risk rankings.

Consequently, the RRRSC did not rank risks in the same manner as *Unfinished Business* did. The Ecology and Welfare Subcommittee grouped environmental problems into high-, medium-, and low-risk areas; the Human Health Subcommittee identified environmental problem areas where existing data indicated that risks could be relatively high. Additional data might identify additional high-risk problems. Both Subcommittees developed their assessments in light of the latest scientific and technical knowledge and using their best professional judgment, and both caution that their assessments are based on incomplete and often inadequate knowledge about 1) the extent of human and ecological exposures to pollutants and 2) exposure-response relationships.

Risks To The Natural Ecology And Human Welfare

The Ecology and Welfare Subcommittee identified areas of relatively high, medium, and low risk, despite gaps in the relevant data. The four environmental problems that it considered to be relatively high-risk are likely to be considered high-risk even after data and analytical methodologies are improved, because the geographic scale of all four is very large (regional to global), and because the time that could be required to mitigate all four is very long, and some effects are irreversible.

The Ecology and Welfare Subcommittee did not limit their assessment to the environmental problems listed in *Unfinished Business*. The order of problems listed within each of the three different risk groups shown below is not meant to imply a ranking.

Relatively High-Risk Problems

- Habitat Alteration and Destruction

  Humans are altering and destroying natural habitats in many places worldwide, e.g., by the draining and degradation of wetlands, soil erosion, and the deforestation of tropical and temperate rain forests.

- Species Extinction and Overall Loss of Biological Diversity

  Many human activities are causing species extinction and depletion and the overall loss of biological diversity, including the genetic diversity of surviving species.

- Stratospheric Ozone Depletion

  Because releases of chlorofluorocarbons and other ozone-depleting gases are thinning the earth's stratospheric ozone layer, more ultraviolet radiation is reaching the earth's surface, thus stressing many kinds of organisms.

- Global Climate Change

  Emissions of carbon dioxide, methane, and other greenhouse gases are altering the chemistry of the atmosphere, threatening to change the global climate.

Relatively Medium-Risk Problems

- Herbicides/Pesticides
- Toxics, Nutrients, Biochemical Oxygen Demand, and Turbidity in Surface Waters
- Acid Deposition
- Airborne Toxics

Relatively Low-Risk Problems

- Oil Spills
- Groundwater Pollution
- Radionuclides
- Acid Runoff to Surface Waters
- Thermal Pollution

Chapter Three—Recommendations

1. EPA Should Target Its Environmental Protection Efforts On The Basis Of Opportunities For The Greatest Risk Reduction

S-4.2 Seen in its historical context, the *ad hoc* development of U.S. national environmental policy is understandable. Yet 20 years of experience in developing and implementing environmental policy has demonstrated that not all environmental problems are equally serious, and not all remediation efforts are equally urgent. The nation cannot do everything at once. In national efforts to protect the environment, the most obvious steps have been taken to reduce the most obvious risks. *Now environmental priorities must be set.*

In order to set priorities for reducing environmental risks, EPA must weigh the relative risks posed by different environmental problems, determine if there are cost-effective opportunities for reducing those risks, and then identify the most cost-effective risk reduction options. This effort should build on the analytical process begun in *Unfinished Business* and in this report and its appendices.

However, the SAB recognizes that risk analyses always will be imperfect tools. No matter how much the data and methodologies are improved, EPA's decisions to direct specific actions at specific risks will entail a large measure of subjective judgment. Yet the SAB believes that relative risk data and risk assessment techniques should inform that judgment as much as possible. In short, EPA programs should be shaped and guided by the principle of relative risk reduction, and all available risk data and the most advanced risk assessment and comparison methodologies should be incorporated explici the Agency's decisionmaking process.

In order to implement a risk-based action a EPA must take several essential steps. It mus articulate to its own employees and to the ge public the fact that it intends to set priorities action based on opportunities for relative risk reduction. Next the Agency must establish an process for incorporating those consideration long-term planning and budget processes. Fir the Agency must act on those priorities.

In practice, of course, EPA's activities are d by the laws that it is required to administer. I also has a responsibility to respond to public concerns about an environmental problem, nc how limited the risk may seem to be. Howev should not limit its risk comparison efforts to environmental problems it is required by law mitigate. The risks posed by other problems a potential problems — like the loss of biologic diversity — must be compared and ranked as

Simply stated, EPA is responsible for prote the environment, not just for implementing environmental law. Thus the Agency should and compare the universe of environmental r then take the initiative to address the most s risks, whether or not Agency action is requir specifically by law.

2. EPA Should Attach As Much Importance To Reducing Ecological Risk As It Does To Reducing Human Health Risk

E-4.0 Largely because of the requirements of the laws it administers, EPA has tended to pay far more attention to protecting human health and welfare than to protecting the ecology. Indeed, during the 1980s EPA's agenda was dominated by concerns about the effects of toxic chemicals on human health.

Yet from the perspective of risk there are strong linkages between human health and the health of wetlands, forests, oceans, and estuaries. Most human activities that pose significant ecological risks — for example, the effects of agricultural activities on wetlands — pose direct or indirect human health risks as well. Likewise, actions taken to reduce pollution and thus improve human health usually improve various aspects of ecological quality.

These very close linkages between human health and ecological health should be reflected in national environmental policy. When EPA compares the risks posed by different environmental problems in order to set priorities for Agency action, the risks posed to ecological systems must be an important part of the equation.

This recommendation is not meant to imply the relative value of human life *vis a vis* plant or animal life. Rather, it is meant to reflect in national environmental policy the very strong ties between all forms of life on this planet. Ecological systems like the atmosphere, oceans, and wetlands have a limited capacity for absorbing the environmental degradation caused by human activities. After that capacity is exceeded, it is only a matter of time before those ecosystems begin to deteriorate and human health and welfare begin to suffer.

In short, beyond their importance for protecting plant and animal life and preserving biodiversity, healthy ecosystems are a prerequisite to healthy humans and prosperous economies. Although ecological damage may not become apparent for years, society should not be blind to the fact that damage is occurring and the losses will be felt, sooner or later, by humans. Moreover, when species and habitat are depleted, ecological health may recover only with great difficulty, if recovery is possible at all.

Thus EPA's risk-based priorities for action should reflect an appropriate balance between ecological, human health, and welfare concerns. Furthermore, the Agency should communicate to the general public a clear message that it considers ecological risks to be just as serious as human health and welfare risks, because of the inherent value of ecological systems and their strong links to human health.

10. EPA Should Develop Improved Methods To Value Natural Resources And To Account For Long-Term Environmental Effects In Its Economic Analyses

E-5.2

Traditional forms of economic analysis, as applied to the costs and benefits of economic development and environmental protection, have systematically undervalued natural resources. This practice threatens the world's natural resources — like estuaries and rainforests — without which the lives of future generations will be impoverished. The failure of current analytic techniques to estimate properly either the full benefits of natural ecosystems or the full costs of activities that degrade them too often has allowed the justification of long-term ecological degradation for the sake of present gain.

A private company invests its profits to maintain and increase its capital value. When a company invests to maintain facilities, expand production, buy new equipment, and improve the quality of services provided, it protects its long-term health.

In a similar manner, this planet requires certain investments in order to maintain itself as a healthy ecosystem and to ensure sustainable, long-term economic growth. Future generations depend on those investments, and if they are not made, then civilization will put itself out of business.

It is necessary and appropriate to conduct economic analyses of human activities that affect the environment. But it is essential that such analyses properly value the long-term, sustained productivity of natural ecosystems. For that reason, EPA should undertake a broad national effort to develop analytical techniques that more adequately assess the real long-term value of ecosystems, and that support the identification of the most cost-effective ways to reduce risks that threaten long-term, sustained productivity.

There are a variety of problems with pr methods. Many of the problems stem from that public goods, such as clean air, are ur markets and thus are easily — and often — undervalued in economic analyses. Nation accounting schemes typically characterize n generated by activities that deplete or degr environmental resources as "income" while consider the resulting depletion of society's environmental capital assets.

When economists do try to value ecosyst are hobbled by the limitations of the availat For instance, the "willingness to pay" meth significantly undervalue aspects of ecosyste which people are not familiar. Some of the assumptions underlying discounting proced not hold when environmental effects occur time periods; thus they assign little value to very important long-term effects. Multipliers applied differently to environmental values t are to more traditionally measured economic (e.g., employment) may further distort the r economic analyses.

As a first step EPA should commission a s that surveys the ideas of ecologists, economi social scientists, and other experts from insid outside the Agency. The study should attem develop a way of incorporating ecological investments into a concept of sustainable gro

Environmental economics is a controversial complex, and rapidly-evolving field. EPA sho the lead in developing methods of analysis th give fair consideration to investments that wil protect the natural resource base for future generations.

This overview report has been derived mainly from three detailed reports prepared by the three Subcommittees of the Relative Risk Reduction Strategies Committee. Those reports are:

- Appendix A: *Report of the Ecology and Welfare Subcommittee*(EPA-SAB-EC-90-021A).

  Includes a critique of the ecological and welfare rankings in *Unfinished Business*. Suggests an alternative approach to defining environmental problems, ranking them from an ecological perspective. Identifies a need to more accurately reflect ecological concerns in economic/welfare considerations.

- Appendix B: *Report of the Human Health Subcommittee*(EPA-SAB-EC-90-021B).

  Includes a critique of the cancer and non-cancer rankings in *Unfinished Business*. Provides specific suggestions for methodological improvements for analyzing and evaluating relative risks of environmental problems, including a possible approach for merging cancer and non-cancer concerns.

- Appendix C: *Report of the Strategic Options Subcommittee*(EPA-SAB-EC-90-021C).

  Describes the wide range of "tools" available for addressing environmental problems. Includes 60 examples of such strategic options applied to 13 different environmental problems. Provides a set of criteria for selecting from among the options in any given case.

Copies of the three appendices to this report can be obtained by writing:

The Science Advisory Board (A-101)
U. S. Environmental Protection Agency
401 M Street, S. W.
Washington, D. C. 20460

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SEGMENT D
PROBLEMS AND PARTNERSHIP
IN BIODIVERSITY

Class #19
How Can People Live With the Land to Help Our Own Long-Term Survival?

****

OBJECTIVE: For students to understand that the concept and subject of "land use" is an important area that bears upon the interrelationship between biodiversity and human enterprise.

THEME: Our land use decisions are important factors in the ability of migratory birds to survive, upon biodiversity, and in the ability of humans to survive in the long-run.

CLASS ACTIVITIES:

I. Review the concept of "forest fragmentation" discussed in Class #17. Explain that it centers on the concept of "land use".

II. Discuss the article assigned as Homework reading from Class #18, "Carving Up Tomorrow's Planet". Encourage students to discuss whether they agree or not that the planet should be "carved up" as set forth in the article. Encourage students to suggest alternatives. Note the suggested alternatives on the blackboard, flip chart or overhead projector. Discuss the students suggestions.

Possibly, organize students into debate teams to advocate different positions on these issues, ie. taking the side of the Robinson interview, and taking

the position of different alternatives offered by the students.

III. If there is enough time, discuss articles from the local newspaper centering on land use issues. Discuss the how they may relate to protection of migratory birds, local ecosystems and biodiversity.

PREPARATION:

Read and become familiar with the articles assigned as Homework reading from Class #18.

Select local newspaper articles on land use, from the articles you have been collecting this spring.

RESOURCES NEEDED:

Blackboard, flip-chart pad or overhead projector.

HOMEWORK TO ASSIGN:

Read:

Weissman, Arthur, "Why Save Neotropical Migratory Birds?", Partners in Flight newsletter, Vol. 3, No. 2, pp. 10-11; and

Babbitt, Bruce, "Protecting Biodiversity", Nature Conservancy, Vol. 44, No. 1 (Jan./Feb. 1994); pp. 16-21.

FOLLOW-UP:

Make note of discussion themes that may need to be picked up in the remaining classes.

HANDOUTS:

Articles from local newspaper on land use issues.

LINKS: Sociology and geography.

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SEGMENT D
PROBLEMS AND PARTNERSHIP
IN BIODIVERSITY

Class #20
Key Tools We Have to Protect Migratory Birds and Biodiversity

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OBJECTIVE: Introduce students to key tools we have to protect Neotropical migratory birds and biodiversity: the Endangered Species Act and the 1993 Biodiversity Convention.

THEME: We have important legal tools that can be used to help protect migratory birds, biodiversity, and ensure our own long-term survival.

CLASS ACTIVITY:

I. Introduce the Endangered Species Act, pointing out the specified purpose, and the framework of the law. This law involves some complicated provisions. It is not necessary to delve into the details of the law. It may be one of the first times, however, that students have examined the actual text of a law, and so it is a useful activity to even see what is there, and how it is organized. Similarly, the 1993 Biodiversity Convention can be examined and considered by the class.

II. Discuss the article assigned as Homework reading from Class #19, "Protecting Biodiversity", which can be used as an illustration of current issues under the Endangered Species Act.

III. Hand out copies of the "Pan American Day and Pan American Week, 1993", proclamation by the President (copy in "Handouts", below). Discuss this type of

document, as contrasted with the laws examined earlier. Discuss how the recognition of the linkage of the Americas affects the issue of migratory birds.

PREPARATION:

Read and become familiar with the article assigned as Homework for Class #19.

Review the excerpts provided in "Handouts" on the Endangered Species Act and the Biodiversity Convention, and select points you wish to bring up during the class discussion.

Copy the "Proclamation" identified in "Handouts", below.

RESOURCES NEEDED:

Copies of: the Endangered Species Act (excerpts)

the "Pan American Day Proclamation"

the Biodiversity Convention

identified in "Handouts", below.

HOMEWORK TO ASSIGN:

Articles to be discussed during the next class can be handed out to the students as homework reading. Alternatively, the teacher may decide to hand them out during the next class, for reading during the class.

FOLLOW-UP:

Identify any discussion items that need to be covered in the next class.

HANDOUTS:

Proclamation, "Pan American Day and Pan American Week"

Endangered Species Act (excerpts)

Biodiversity Convention

LINKS: Law, political science, civics and geography.

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Class #20

HANDOUT

excerpts from the federal ENDANGERED SPECIES ACT

excerpts from
the federal
ENDANGERED SPECIES ACT
16 U.S.C. § 1531

CHAPTER 35—ENDANGERED SPECIES

§ 1531. Congressional findings and declaration of purposes and policy

(a) Findings

The Congress finds and declares that—

(1) various species of fish, wildlife, and plants in the United States have been rendered extinct as a consequence of economic growth and development untempered by adequate concern and conservation;

(2) other species of fish, wildlife, and plants have been so depleted in numbers that they are in danger of or threatened with extinction;

(3) these species of fish, wildlife, and plants are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people;

(4) the United States has pledged itself as a sovereign state in the international community to conserve to the extent practicable the various species of fish or wildlife and plants facing extinction, pursuant to—

(A) migratory bird treaties with Canada and Mexico;

(B) the Migratory and Endangered Bird Treaty with Japan;

(C) the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere;

(D) the International Convention for the Northwest Atlantic Fisheries;

(E) the International Convention for the High Seas Fisheries of the North Pacific Ocean;

(F) the Convention on International Trade in Endangered Species of Wild Fauna and Flora; and

(G) other international agreements.

(5) encouraging the States and other interested parties, through Federal financial assistance and a system of incentives, to develop and maintain conservation programs which meet national and international standards is a key to meeting the Nation's international commitments and to better safeguarding, for the benefit of all citizens, the Nation's heritage in fish, wildlife, and plants.

(b) Purposes

The purposes of this chapter are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section.

(c) Policy

(1) It is further declared to be the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this chapter.

(2) It is further declared to be the policy of Congress that Federal agencies shall cooperate with State and local agencies to resolve water resource issues in concert with conservation of endangered species.

(Pub. L. 93-205, § 2, Dec. 28, 1973, 87 Stat. 884; Pub. L. 96-159, § 1, Dec. 28, 1979, 93 Stat. 1225; Pub. L. 97-304, § 9(a), Oct. 13, 1982, 96 Stat. 1426.)

For the purpose of this chapter—

(1) The term "alternative courses of action" means all alternatives and thus is not limited to original project objectives and agency jurisdiction.

(2) The term "commercial activity" means all activities of industry and trade, including, but not limited to, the buying or selling of commodities and activities conducted for the purpose of facilitating such buying and selling: *Provided, however,* That it does not include exhibition of commodities by museums or similar cultural or historical organizations.

(3) The terms "conserve", "conserving", and "conservation" mean to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this chapter are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking.

(4) The term "Convention" means the Convention on International Trade in Endangered Species of Wild Fauna and Flora, signed on March 3, 1973, and the appendices thereto.

(5)(A) The term "critical habitat" for a threatened or endangered species means—

(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and

(ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species.

(B) Critical habitat may be established for those species now listed as threatened or endangered species for which no critical habitat has heretofore been established as set forth in subparagraph (A) of this paragraph.

(C) Except in those circumstances determined by the Secretary, critical habitat shall not include the entire geographical area which can be occupied by the threatened or endangered species.

(6) The term "endangered species" means any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this chapter would present an overwhelming and overriding risk to man.

(7) The term "Federal agency" means any department, agency, or instrumentality of the United States.

(8) The term "fish or wildlife" means any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, nonmigratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof.

(9) The term "foreign commerce" includes, among other things, any transaction—

(A) between persons within one foreign country;

(B) between persons in two or more foreign countries;

(C) between a person within the United States and a person in a foreign country; or

(D) between persons within the United States, where the fish and wildlife in question are moving in any country or countries outside the United States.

(10) The term "import" means to land on, bring into, or introduce into, or attempt to land on, bring into, or introduce into, any place subject to the jurisdiction of the United States, whether or not such landing, bringing, or introduction constitutes an importation within the meaning of the customs laws of the United States.

(11) Repealed. Pub. L. 97-304, § 4(b), Oct. 13, 1982, 96 Stat. 1420.

(12) The term "permit or license applicant" means, when used with respect to an action of a Federal agency for which exemption is sought under section 1536 of this title, any person whose application to such agency for a permit or license has been denied primarily because of the application of section 1536(a) of this title to such agency action.

(13) The term "person" means an individual, corporation, partnership, trust, association, or any other private entity, or any officer, employee, agent, department, or instrumentality of the Federal Government, of any State or political subdivision thereof, or of any foreign government.

(14) The term "plant" means any member of the plant kingdom, including seeds, roots and other parts thereof.

(15) The term "Secretary" means, except as otherwise herein provided, the Secretary of the Interior or the Secretary of Commerce as program responsibilities are vested pursuant to the provisions of Reorganization Plan Numbered 4 of 1970; except that with respect to the enforcement of the provisions of this chapter and the Convention which pertain to the importation or exportation of terrestrial plants, the term means the Secretary of Agriculture.

(16) The term "species" includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.

(17) The term "State" means any of the several States, the District of Columbia, the Commonwealth of Puerto Rico, American Samoa, the Virgin Islands, Guam, and the Trust Territory of the Pacific Islands.

(18) The term "State agency" means any State agency, department, board, commission, or other governmental entity which is responsible for the management and conservation of fish, plant, or wildlife resources within a State.

(19) The term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

(20) The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

(21) The term "United States", when used in a geographical context, includes all States.

§ 1537. International cooperation

(a) Financial assistance

As a demonstration of the commitment of the United States to the worldwide protection of endangered species and threatened species, the President may, subject to the provisions of section 1306 of title 31, use foreign currencies accruing to the United States Government under the Agricultural Trade Development and Assistance Act of 1954 [7 U.S.C. 1691 et seq.] or any other law to provide to any foreign country (with its consent) assistance in the development and management of programs in that country which the Secretary determines to be necessary or useful for the conservation of any endangered species or threatened species listed by the Secretary pursuant to section 1533 of this title. The President shall provide assistance (which includes, but is not limited to, the acquisition, by lease or otherwise, of lands, waters, or interests therein) to foreign countries under this section under such terms and conditions as he deems appropriate. Whenever foreign currencies are available for the provision of assistance under this section, such currencies shall be used in preference to funds appropriated under the authority of section 1542 of this title.

(b) *Encouragement of foreign programs*

In order to carry out further the provisions of this chapter, the Secretary, through the Secretary of State, shall encourage—

(1) foreign countries to provide for the conservation of fish or wildlife and plants including endangered species and threatened species listed pursuant to section 1533 of this title;

(2) the entering into of bilateral or multilateral agreements with foreign countries to provide for such conservation; and

(3) foreign persons who directly or indirectly take fish or wildlife or plants in foreign countries or on the high seas for importation into the United States for commercial or other purposes to develop and carry out with such assistance as he may provide, conservation practices designed to enhance such fish or wildlife or plants and their habitat.

(c) Personnel

After consultation with the Secretary of State, the Secretary may—

(1) assign or otherwise make available any officer or employee of his department for the purpose of cooperating with foreign countries and international organizations in developing personnel resources and programs which promote the conservation of fish or wildlife or plants; and

(2) conduct or provide financial assistance for the educational training of foreign personnel, in this country or abroad, in fish, wildlife, or plant management, research and law enforcement and to render professional assistance abroad in such matters.

(d) Investigations

After consultation with the Secretary of State and the Secretary of the Treasury, as appropriate, the Secretary may conduct or cause to be conducted such law enforcement investigations and research abroad as he deems necessary to carry out the purposes of this chapter.

(Pub. L. 93-205, § 8, Dec. 28, 1973, 87 Stat. 892; Pub. L. 96-159, § 5, Dec. 28, 1979, 93 Stat. 1228.)

§ 1537a. Convention implementation

(a) Management Authority and Scientific Authority

The Secretary of the Interior (hereinafter in this section referred to as the "Secretary") is designated as the Management Authority and the Scientific Authority for purposes of the Convention and the respective functions of each such Authority shall be carried out through the United States Fish and Wildlife Service.

(b) Management Authority functions

The Secretary shall do all things necessary and appropriate to carry out the functions of the Management Authority under the Convention.

(c) Scientific Authority functions; determinations

(1) The Secretary shall do all things necessary and appropriate to carry out the functions of the Scientific Authority under the Convention.

(2) The Secretary shall base the determinations and advice given by him under Article IV of the Convention with respect to wildlife upon the best available biological information derived from professionally accepted wildlife management practices; but is not required to make, or require any State to make, estimates of population size in making such determinations or giving such advice.

(d) Reservations by the United States under Convention

If the United States votes against including any species in Appendix I or II of the Convention and does not enter a reservation pursuant to paragraph (3) of Article XV of the Convention with respect to that species, the Secretary of State, before the 90th day after the last day on which such a reservation could be entered, shall submit to the Committee on Merchant Marine and Fisheries of the House of Representatives, and to the Committee on the Environment and Public Works of the Senate, a written report setting forth the reasons why such a reservation was not entered.

(e) Wildlife preservation in Western Hemisphere

(1) The Secretary of the Interior (hereinafter in this subsection referred to as the "Secretary"), in cooperation with the Secretary of State, shall act on behalf of, and represent, the United States in all regards as required by the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (56 Stat. 1354, T.S. 982, hereinafter in this subsection referred to as the "Western Convention"). In the discharge of these responsibilities, the Secretary and the Secretary of State shall consult with the Secretary of Agriculture, the Secretary of Commerce, and the heads of other agencies with respect to matters relating to or affecting their areas of responsibility.

(2) The Secretary and the Secretary of State shall, in cooperation with the contracting parties to the Western Convention and, to the extent feasible and appropriate, with the participation of State agencies, take such steps as are necessary to implement the Western Convention. Such steps shall include, but not be limited to—

(A) cooperation with contracting parties and international organizations for the purpose of developing personnel resources and programs that will facilitate implementation of the Western Convention;

(B) identification of those species of birds that migrate between the United States and other contracting parties, and the habitats upon which those species depend, and the implementation of cooperative measures to ensure that such species will not become endangered or threatened; and

(C) identification of measures that are necessary and appropriate to implement those provisions of the Western Convention which address the protection of wild plants.

(3) No later than September 30, 1985, the Secretary and the Secretary of State shall submit a report to Congress describing those steps taken in accordance with the requirements of this subsection and identifying the principal remaining actions yet necessary for comprehensive and effective implementation of the Western Convention.

Class #20

HANDOUT

Article:

"Why Save Neotropical Migratory Birds?"

by Arthur Weissman

WHY SAVE NEOTROPICAL MIGRATORY BIRDS?

Part 2

by: Arthur Weissman

(This column explores some of the reasons behind all the activities described in the rest of the Partners in Flight *newsletter. The reasons for saving neotropical migratory birds are, of course, multifarious--biological, ecological, aesthetic, economic, philosophical, and even spiritual. As the* Partners in Flight *Program broadens its base and begins to have real effects, the question will inevitably be asked: why save the birds? You don't have to be an avid birder or ornithologist to appreciate the answers.)*

With all the irony and surprise found in the natural world, we can truly say that we need to save nature to save ourselves, and to care for other animals to become better human beings.

That we depend physically and biologically on the world around us is at once obvious to the point of tautology and also frustratingly elusive. Nature provides the basic materials and energy necessary for all life to survive and reproduce. Birds play an important role in the so-called life-support systems by keeping in balance the growth of insects and other prey, by spreading seeds and in some cases causing them to germinate, and by providing food to their predators.

But would removal of the avian class--much less the subset of neotropical migratory birds--in itself undermine these systems? The very question makes us shift uncomfortably, both because it evokes a horrible thought and because it is so difficult to answer affirmatively. We can tally up the tons of insects removed by feeding birds, the number of seeds ingested and dispersed, the larvae that might otherwise smother a forest. It becomes a speculative matter, hypothetical but not proved, that certain ecosystems may become impaired or destroyed without birds. With a few exceptions, such as the oilbirds of Venezuela, we lack the definitive connection demonstrating not only that birds are part of the web of life, which is self-evident, but that their absence would tear the web asunder. (As a result, we often fall back on the equally compelling notion that birds are indicators of ecosystem health: if they go, the rest is going too.)

As human beings we strive to save birds... because we have learned to care

And so it is throughout nature. It is difficult enough to obtain an accurate baseline along one ecosystem dimension (witness the continuing controversy about the real population trends of neotropical migrants; see Hagan and Johnston, eds., Ecology and Conservation of Neotropical Migrant Landbirds). Trying to correlate two or more variables in an ecosystem becomes a formidable task that often eludes us in all but the most egregious (or elegant) cases. A still further connection then needs to be made between ecosystem structure and function and the presence of any particular species, and then between ecosystem health and the health of our species; a connection which, in view of society's indifference to the loss of species and to global warming, does not appear to be transparent or automatically compelling.

Birds play an important role in life-support systems by controlling the growth of insects and by spreading seeds

So we can't with certainty assert that loss of birds or any subset of bird species necessarily undermines ecosystems and endangers our existence. Many of us remain convinced, however, that major ecological processes cannot be destroyed or grievously altered without threatening our very survival. In the spirit of Leopold, we are also inclined to believe that major components of an ecosystem are vital to its survival, and that removal of a number of bird species, for example, could damage the ecosystem irreparably.

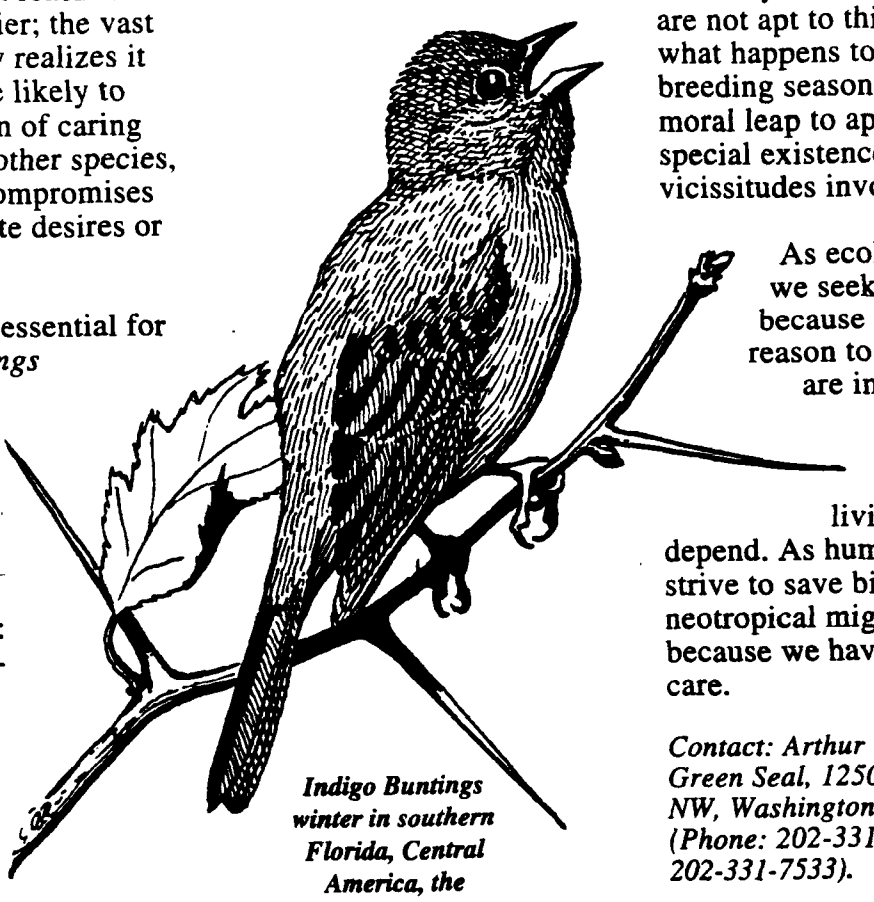
As human beings we are also concerned about our moral state. If we were truly

children of nature, we would not consciously consider the welfare of other species, except perhaps as it might affect our own survival. But we are endowed with the potential of a moral conscience--both a curse and a blessing, but most of all an underused faculty. The development of a moral conscience is directly correlated with the extent to which one is truly concerned for the welfare of "others"--outside the self (the first step), outside the family, outside the nation... and ultimately outside our own species. The vanguard of humanity has just reached this final moral frontier; the vast majority scarcely realizes it exists, or is more likely to belittle the notion of caring intrinsically for other species, especially if it compromises its own immediate desires or needs.

This is why it is essential for us *as human beings* to care about the welfare of the rest of nature. Yes, there are many unmet needs in our own species: people are starving, living in substandard conditions, or not getting opportunities to produce or be fulfilled. While these social needs must be addressed even more than they are today, we must reserve an important portion of our efforts to benefit other species as well. The other species we help tend at first to be the glamor species or those with whom we can best identify or empathize: large mammals of land or sea, birds, big trees, and fish. This is equivalent to expanding our love to relatives or friends; there's nothing wrong with it, but it is a limited and somewhat self-serving love. Caring about the small and unglamorous (even ugly) species reflects not only a fuller appreciation of the web of life but also a greater love for the whole of life.

Caring about the small and unglamorous species reflects a greater love for the whole of life

Neotropical migratory landbirds probably fit in both categories. Many are colorful and aesthetically appealing, stars of the nature-appreciation sweepstakes. But as a group they suffer from being out of sight for over half the year, as well as from having an uncatchy name. Even birders are not apt to think about what happens to them outside breeding season. It takes a moral leap to appreciate their special existence and the vicissitudes involved.



Indigo Buntings winter in southern Florida, Central America, the Bahamas, and the Greater Antilles.

As ecologists, then, we seek to save birds because we have reason to believe they are important to the ecosystems upon which we and all living things depend. As human beings, we strive to save birds, including neotropical migratory birds, because we have learned to care.

Contact: Arthur Weissman, Green Seal, 1250 23rd Street NW, Washington, DC 20037 (Phone: 202-331-7337; FAX: 202-331-7533).

Class #20

HANDOUT

copy of a Presidential Proclamation:

Pan American Day and Pan American Week, 1993

Federal Register
Vol. 58, No. 73
Monday, April 19, 1993

Presidential Documents

Title 3—

The President

Proclamation 6545 of April 14, 1993

Pan American Day and Pan American Week, 1993

By the President of the United States of America

A Proclamation

Five hundred years after the first Europeans began exploring the Americas, it is appropriate to reflect on our hemisphere's unique role in this rapidly changing world and to rediscover the peoples of the Americas. On Pan American Day, the people of the Americas pledge to renew the ties that make our relationship unique. We cherish our hemisphere's proud history as we look forward to a new era of cooperation between our countries and cultures.

We have seen remarkable changes around the globe. The defeat of totalitarianism and the sweep of democratic and free market reforms have brought new opportunities and new challenges to the world. Progress toward political, economic, and social change has been dramatic in our own hemisphere.

From North to South, more and more citizens of the Americas are enjoying the benefits of liberty. Fundamental principles of democracy, including respect for human rights, continue to be embraced. It is our hope that all nations of the Americas will join in this democratic revolution and at last realize the dream of a hemisphere of democratic nations.

The need for international cooperation is greater than ever, because we face many difficult issues in this era: drug trafficking, weapons proliferation, and environmental degradation. Through a renewed partnership between nations of this hemisphere, we can develop innovative means to combat such problems, thus ensuring lasting security for future generations.

A century ago, representatives of the nations of this hemisphere met in Washington to establish the International Union of the American Republics. Accepting the principles of democracy, peace, security, and prosperity, these member nations made a firm commitment to mutual cooperation throughout the hemisphere. Its successor, the Organization of American States, has furthered this commitment. In the words of the Charter of the Organization of American States, "[the] historic mission of America is to offer to man a land of liberty." I applaud and encourage the activity of the Organization of American States in this pursuit to ensure that worldwide changes create a hemisphere of peace and prosperity.

We can take great pride in what the Americas have already achieved. But there is much work to be done. All Americans from North to South should renew their commitment to fulfilling our forefathers' vision of an inter-America system. The hemisphere of George Washington and Thomas Jefferson, of Simón Bolívar and José de San Martín, establishes an example of freedom for the rest of the world. With democracy as the cornerstone of a new working partnership, we can achieve a revolutionary level of cooperation among the countries of America.

NOW, THEREFORE, I, WILLIAM J. CLINTON, President of the United States of America, by the authority vested in me by the Constitution and the laws of the United States, do hereby proclaim Wednesday, April 14, 1993, as "Pan American Day" and the week of April 11 through April 17, 1993, as "Pan American Week." I urge the Governors of the 50 States, the Governor of the Commonwealth of Puerto Rico, and officials of other areas under

the flag of the United States of America to honor these observances with appropriate ceremonies and activities.

IN WITNESS WHEREOF, I have hereunto set my hand this fourteenth day of April, in the year of our Lord nineteen hundred and ninety-three, and of the Independence of the United States of America the two hundred and seventeenth.

William J. Clinton

[FR Doc. 93-9255
Filed 4-15-93; 4:20 pm]
Billing code 3195-01-P

EARTH SUMMIT

CONVENTION ON BIOLOGICAL DIVERSITY

United Nations
Conference on
Environment and
Development

Rio de Janeiro
Brazil
3-14 June 1992

UNITED NATIONS

FINAL TEXT

INTRODUCTION

The United Nations Convention on Biological Diversity is intended to ensure effe international action to curb the destruction of biological species, habitats and ecosystems. It opened for signature at the UN Conference on Environment and Development — the E Summit — in Rio de Janeiro, Brazil on 5 June 1992. At the Conference, 157 countries signe Convention, including the European Community. In order for the Convention to become la must be ratified by at least 30 countries, usually by the national legislature.

The most important provisions of the Convention include:

- The requirement that countries adopt regulations to conserve their biological resource
- The legal responsibility of Governments for the environmental impact in other coun of activities by their private corporations;
- Funding to assist developing countries in implementing the Convention, to be adminis through the Global Environment Facility, pending the establishment of a new institutic structure;
- The transfer of technology to developing countries on preferential and concessional ter where such transfer does not prejudice intellectual property rights or patents;
- Regulation of biotechnology firms;
- Access to and ownership of genetic material;
- Compensation to developing countries for extraction of their genetic materials.

BACKGROUND

The United Nations Environment Programme (UNEP) first called on Governments to consider international legal instrument for the conservation and rational use of biological diversity in 19 The following year UNEP established an Ad Hoc Working Group of Experts on Biologi Diversity, which held three sessions between November 1988 and July 1990. On the basis of group's final report, UNEP established a Working Group of Legal and Technical Experts negotiate a convention. This group held two sessions and was then renamed the Intergovernmer Negotiating Committee for a Convention on Biological Diversity (INC). The INC comple negotiations for the Convention in five sessions between June 1991 and May 1992.

ISSUES

During the negotiations, contentious issues included: financial aid to enable developing countri to implement the terms of the Convention; the terms under which industrialized countries wou have access to genetic materials found mostly in tropical forests in developing countries; the ter under which developing countries would have access to environmentally sound technology to new biotechnologies developed from materials found in their tropical forests; and the questi of ownership and use of patent rights of the biotechnology produced from such materials.

After negotiations were complete, a number of countries expressed reservations on vario aspects of the Convention but later agreed to sign. The United States did not sign on the groun that provisions in the Convention would unduly restrict the biotechnology industry in that countr

UNITED NATIONS CONVENTION ON BIOLOGICAL DIVERSITY

Preamble

The Contracting Parties,

Conscious of the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components,

Conscious also of the importance of biological diversity for evolution and for maintaining life sustaining systems of the biosphere,

Affirming that the conservation of biological diversity is a common concern of humankind,

Reaffirming that States have sovereign rights over their own biological resources,

Reaffirming also that States are responsible for conserving their biological diversity and for using their biological resources in a sustainable manner,

Concerned that biological diversity is being significantly reduced by certain human activities,

Aware of the general lack of information and knowledge regarding biological diversity and of the urgent need to develop scientific, technical and institutional capacities to provide the basic understanding upon which to plan and implement appropriate measures,

Noting that it is vital to anticipate, prevent and attack the causes of significant reduction or loss of biological diversity at source,

Noting also that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat,

Noting further that the fundamental requirement for the conservation of biological diversity is the *in-situ* conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings,

Noting further that *ex-situ* measures, preferably in the country of origin, also have an important role to play,

Recognizing the close and traditional dependence of many indigenous and local communities embodying traditional lifestyles on biological resources, and the desirability of sharing equitably benefits arising from the use of traditional knowledge, innovations and practices relevant to the conservation of biological diversity and the sustainable use of its components,

Recognizing also the vital role that women play in the conservation and sustain biological diversity and affirming the need for the full participation of women at all level making and implementation for biological diversity conservation,

Stressing the importance of, and the need to promote, international, regional and global among States and intergovernmental organizations and the non-governmental sector for the c of biological diversity and the sustainable use of its components,

Acknowledging that the provision of new and additional financial resources and approp to relevant technologies can be expected to make a substantial difference in the world's ability the loss of biological diversity,

Acknowledging further that special provision is required to meet the needs of developin including the provision of new and additional financial resources and appropriate access technologies,

Noting in this regard the special conditions of the least developed countries and small isl

Acknowledging that substantial investments are required to conserve biological diversit there is the expectation of a broad range of environmental, economic and social benefits f investments,

Recognizing that economic and social development and poverty eradication are the overriding priorities of developing countries,

Aware that conservation and sustainable use of biological diversity is of critical impor meeting the food, health and other needs of the growing world population, for which purpose and sharing of both genetic resources and technologies are essential,

Noting that, ultimately, the conservation and sustainable use of biological diversity will st friendly relations among States and contribute to peace for humankind,

Desiring to enhance and complement existing international arrangements for the conserv biological diversity and sustainable use of its components, and

Determined to conserve and sustainably use biological diversity for the benefit of present ar generations,

Have agreed as follows:

Article 1. Objectives

The objectives of this Convention, to be pursued in accordance with its relevant provisions, conservation of biological diversity, the sustainable use of its components and the fair and e sharing of the benefits arising out of the utilization of genetic resources, including by appropriate to genetic resources and by appropriate transfer of relevant technologies, taking into account all rig those resources and to technologies, and by appropriate funding.

Article 2. Use of Terms

For the purposes of this Convention:

"*Biological diversity*" means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

"*Biological resources*" includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

"*Biotechnology*" means any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

"*Country of origin of genetic resources*" means the country which possesses those genetic resources in *in-situ* conditions.

"*Country providing genetic resources*" means the country supplying genetic resources collected from *in-situ* sources, including populations of both wild and domesticated species, or taken from *ex-situ* sources, which may or may not have originated in that country.

"*Domesticated or cultivated species*" means species in which the evolutionary process has been influenced by humans to meet their needs.

"*Ecosystem*" means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

"*Ex-situ conservation*" means the conservation of components of biological diversity outside their natural habitats.

"*Genetic material*" means any material of plant, animal, microbial or other origin containing functional units of heredity.

"*Genetic resources*" means genetic material of actual or potential value.

"*Habitat*" means the place or type of site where an organism or population naturally occurs.

"*In-situ conditions*" means conditions where genetic resources exist within ecosystems and natural habitats, and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

"*In-situ conservation*" means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

"*Protected area*" means a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

"*Regional economic integration organization*" means an organization constituted by sovereign St a given region, to which its member States have transferred competence in respect of matters go by this Convention and which has been duly authorized, in accordance with its internal procedures, t ratify, accept, approve or accede to it.

"*Sustainable use*" means the use of components of biological diversity in a way and at a rate tha not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the and aspirations of present and future generations.

"*Technology*" includes biotechnology.

Article 3. Principle

States have, in accordance with the Charter of the United Nations and the principles of interna law, the sovereign right to exploit their own resources pursuant to their own environmental policie the responsibility to ensure that activities within their jurisdiction or control do not cause damage t environment of other States or of areas beyond the limits of national jurisdiction.

Article 4. Jurisdictional Scope

Subject to the rights of other States, and except as otherwise expressly provided in this Conver the provisions of this Convention apply, in relation to each Contracting Party:

(a) In the case of components of biological diversity, in areas within the limits of its nat jurisdiction; and

(b) In the case of processes and activities, regardless of where their effects occur, carrie under its jurisdiction or control, within the area of its national jurisdiction or beyond the limits of nat jurisdiction.

Article 5. Cooperation

Each Contracting Party shall, as far as possible and as appropriate, cooperate with other Contrac Parties, directly or, where appropriate, through competent international organizations, in respect of beyond national jurisdiction and on other matters of mutual interest, for the conservation and sustain use of biological diversity.

Article 6. General Measures for Conservation and Sustainable Use

Each Contracting Party shall, in accordance with its particular conditions and capabilities:

(a) Develop national strategies, plans or programmes for the conservation and sustainable of biological diversity or adapt for this purpose existing strategies, plans or programmes which s reflect, *inter alia*, the measures set out in this Convention relevant to the Contracting Party concerned;

(b) Integrate, as far as possible and as appropriate, the conservation and sustainable use biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.

Article 7. Identification and Monitoring

Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10:

(a) Identify components of biological diversity important for its conservation and sustainable use having regard to the indicative list of categories set down in Annex I;

(b) Monitor, through sampling and other techniques, the components of biological diversity identified pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use;

(c) Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques; and

(d) Maintain and organize, by any mechanism data, derived from identification and monitoring activities pursuant to subparagraphs (a), (b) and (c) above.

Article 8. *In-situ* Conservation

Each Contracting Party shall, as far as possible and as appropriate:

(a) Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity;

(b) Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measures need to be taken to conserve biological diversity;

(c) Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use;

(d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;

(e) Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas;

(f) Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, *inter alia*, through the development and implementation of plans or other management strategies;

(g) Establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to human health;

(h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;

(i) Endeavour to provide the conditions needed for compatibility between present uses an conservation of biological diversity and the sustainable use of its components;

(j) Subject to its national legislation, respect, preserve and maintain knowledge, innovation practices of indigenous and local communities embodying traditional lifestyles relevant for conservation and sustainable use of biological diversity and promote their wider application with approval and involvement of the holders of such knowledge, innovations and practices and encourag equitable sharing of the benefits arising from the utilization of such knowledge, innovations and pract

(k) Develop or maintain necessary legislation and/or other regulatory provisions for protection of threatened species and populations;

(l) Where a significant adverse effect on biological diversity has been determined pursua Article 7, regulate or manage the relevant processes and categories of activities; and

(m) Cooperate in providing financial and other support for *in-situ* conservation outline subparagraphs (a) to (l) above, particularly to developing countries.

Article 9. *Ex-situ* Conservation

Each Contracting Party shall, as far as possible and as appropriate, and predominantly for purpose of complementing *in-situ* measures:

(a) Adopt measures for the *ex-situ* conservation of components of biological diversity, prefer in the country of origin of such components;

(b) Establish and maintain facilities for *ex-situ* conservation of and research on plants, anir and micro-organisms, preferably in the country of origin of genetic resources;

(c) Adopt measures for the recovery and rehabilitation of threatened species and for t reintroduction into their natural habitats under appropriate conditions;

(d) Regulate and manage collection of biological resources from natural habitats for *ex-* conservation purposes so as not to threaten ecosystems and *in-situ* populations of species, except wl special temporary *ex-situ* measures are required under subparagraph (c) above; and

(e) Cooperate in providing financial and other support for *ex-situ* conservation outlinec subparagraphs (a) to (d) above and in the establishment and maintenance of *ex-situ* conservation facili in developing countries.

Article 10. Sustainable Use of Components of Biological Diversity

Each Contracting Party shall, as far as possible and as appropriate:

(a) Integrate consideration of the conservation and sustainable use of biological resources i national decision-making;

(b) Adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity;

(c) Protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements;

(d) Support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced; and

(e) Encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources.

Article 11. Incentive Measures

Each Contracting Party shall, as far as possible and as appropriate, adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity.

Article 12. Research and Training

The Contracting Parties, taking into account the special needs of developing countries, shall:

(a) Establish and maintain programmes for scientific and technical education and training in measures for the identification, conservation and sustainable use of biological diversity and its components and provide support for such education and training for the specific needs of developing countries;

(b) Promote and encourage research which contributes to the conservation and sustainable use of biological diversity, particularly in developing countries, *inter alia*, in accordance with decisions of the Conference of the Parties taken in consequence of recommendations of the Subsidiary Body on Scientific, Technical and Technological Advice; and

(c) In keeping with the provisions of Articles 16, 18 and 20, promote and cooperate in the use of scientific advances in biological diversity research in developing methods for conservation and sustainable use of biological resources.

Article 13. Public Education and Awareness

The Contracting Parties shall:

(a) Promote and encourage understanding of the importance of, and the measures required for, the conservation of biological diversity, as well as its propagation through media, and the inclusion of these topics in educational programmes; and

(b) Cooperate, as appropriate, with other States and international organizations in developing educational and public awareness programmes, with respect to conservation and sustainable use of biological diversity.

Article 14. Impact Assessment and Minimizing Adverse Impacts

1. Each Contracting Party, as far as possible and as appropriate, shall:

(a) Introduce appropriate procedures requiring environmental impact assessment of it projects that are likely to have significant adverse effects on biological diversity with a view tc or minimizing such effects and, where appropriate, allow for public participation in such proc

(b) Introduce appropriate arrangements to ensure that the environmental consequen programmes and policies that are likely to have significant adverse impacts on biological diversit taken into account;

(c) Promote, on the basis of reciprocity, notification, exchange of information and co on activities under their jurisdiction or control which are likely to significantly affect adve biological diversity of other States or areas beyond the limits of national jurisdiction, by encour conclusion of bilateral, regional or multilateral arrangements, as appropriate;

(d) In the case of imminent or grave danger or damage, originating under its jurisc control, to biological diversity within the area under jurisdiction of other States or in areas be limits of national jurisdiction, notify immediately the potentially affected States of such danger or as well as initiate action to prevent or minimize such danger or damage; and

(e) Promote national arrangements for emergency responses to activities or events, caused naturally or otherwise, which present a grave and imminent danger to biological dive encourage international cooperation to supplement such national efforts and, where appropriate ar by the States or regional economic integration organizations concerned, to establish joint con plans.

2. The Conference of the Parties shall examine, on the basis of studies to be carried out, the liability and redress, including restoration and compensation, for damage to biological diversity where such liability is a purely internal matter.

Article 15. Access to Genetic Resources

1. Recognizing the sovereign rights of States over their natural resources, the authority to de access to genetic resources rests with the national governments and is subject to national legisl

2. Each Contracting Party shall endeavour to create conditions to facilitate access to genetic re for environmentally sound uses by other Contracting Parties and not to impose restrictions that run to the objectives of this Convention.

3. For the purpose of this Convention, the genetic resources being provided by a Contractin as referred to in this Article and Articles 16 and 19, are only those that are provided by Cor Parties that are countries of origin of such resources or by the Parties that have acquired the resources in accordance with this Convention.

4. Access, where granted, shall be on mutually agreed terms and subject to the provisions Article.

5. Access to genetic resources shall be subject to prior informed consent of the Contracting Party providing such resources, unless otherwise determined by that Party.

6. Each Contracting Party shall endeavour to develop and carry out scientific research based on genetic resources provided by other Contracting Parties with the full participation of, and where possible in, such Contracting Parties.

7. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, and in accordance with Articles 16 and 19 and, where necessary, through the financial mechanism established by Articles 20 and 21 with the aim of sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources. Such sharing shall be upon mutually agreed terms.

Article 16. Access to and Transfer of Technology

1. Each Contracting Party, recognizing that technology includes biotechnology, and that both access to and transfer of technology among Contracting Parties are essential elements for the attainment of the objectives of this Convention, undertakes subject to the provisions of this Article to provide and/or facilitate access for and transfer to other Contracting Parties of technologies that are relevant to the conservation and sustainable use of biological diversity or make use of genetic resources and do not cause significant damage to the environment.

2. Access to and transfer of technology referred to in paragraph 1 above to developing countries shall be provided and/or facilitated under fair and most favourable terms, including on concessional and preferential terms where mutually agreed, and, where necessary, in accordance with the financial mechanism established by Articles 20 and 21. In the case of technology subject to patents and other intellectual property rights, such access and transfer shall be provided on terms which recognize and are consistent with the adequate and effective protection of intellectual property rights. The application of this paragraph shall be consistent with paragraphs 3, 4 and 5 below.

3. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, with the aim that Contracting Parties, in particular those that are developing countries, which provide genetic resources are provided access to and transfer of technology which makes use of those resources, on mutually agreed terms, including technology protected by patents and other intellectual property rights, where necessary, through the provisions of Articles 20 and 21 and in accordance with international law and consistent with paragraphs 4 and 5 below.

4. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, with the aim that the private sector facilitates access to, joint development and transfer of technology referred to in paragraph 1 above for the benefit of both governmental institutions and the private sector of developing countries and in this regard shall abide by the obligations included in paragraphs 1, 2 and 3 above.

5. The Contracting Parties, recognizing that patents and other intellectual property rights may have an influence on the implementation of this Convention, shall cooperate in this regard subject to national legislation and international law in order to ensure that such rights are supportive of and do not run counter to its objectives.

Article 17. Exchange of Information

1. The Contracting Parties shall facilitate the exchange of information, from all publicly sources, relevant to the conservation and sustainable use of biological diversity, taking into acc special needs of developing countries.

2. Such exchange of information shall include exchange of results of technical, scientific an economic research, as well as information on training and surveying programmes, specialized kno indigenous and traditional knowledge as such and in combination with the technologies refer Article 16, paragraph 1. It shall also, where feasible, include repatriation of information.

Article 18. Technical and Scientific Cooperation

1. The Contracting Parties shall promote international technical and scientific cooperation in t of conservation and sustainable use of biological diversity, where necessary, through the app international and national institutions.

2. Each Contracting Party shall promote technical and scientific cooperation with other Cont Parties, in particular developing countries, in implementing this Convention, *inter alia*, throu development and implementation of national policies. In promoting such cooperation, special at should be given to the development and strengthening of national capabilities, by means of resources development and institution building.

3. The Conference of the Parties, at its first meeting, shall determine how to establish a clearing mechanism to promote and facilitate technical and scientific cooperation.

4. The Contracting Parties shall, in accordance with national legislation and policies, encoura develop methods of cooperation for the development and use of technologies, including indigenou traditional technologies, in pursuance of the objectives of this Convention. For this purpos Contracting Parties shall also promote cooperation in the training of personnel and exchange of ex

5. The Contracting Parties shall, subject to mutual agreement, promote the establishment of research programmes and joint ventures for the development of technologies relevant to the objecti this Convention.

Article 19. Handling of Biotechnology and Distribution of Its Benefits

1. Each Contracting Party shall take legislative, administrative or policy measures, as appropri provide for the effective participation in biotechnological research activities by those Contracting Pa especially developing countries, which provide the genetic resources for such research, and where fea in such Contracting Parties.

2. Each Contracting Party shall take all practicable measures to promote and advance priority ac on a fair and equitable basis by Contracting Parties, especially developing countries, to the results benefits arising from biotechnologies based upon genetic resources provided by those Contracting Par Such access shall be on mutually agreed terms.

3. The Parties shall consider the need for and modalities of a protocol setting out appropriate procedures, including, in particular, advance informed agreement, in the field of the safe transfer, handling and use of any living modified organism resulting from biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity.

4. Each Contracting Party shall, directly or by requiring any natural or legal person under its jurisdiction providing the organisms referred to in paragraph 3 above, provide any available information about the use and safety regulations required by that Contracting Party in handling such organisms, as well as any available information on the potential adverse impact of the specific organisms concerned to the Contracting Party into which those organisms are to be introduced.

Article 20. Financial Resources

1. Each Contracting Party undertakes to provide, in accordance with its capabilities, financial support and incentives in respect of those national activities which are intended to achieve the objectives of this Convention, in accordance with its national plans, priorities and programmes.

2. The developed country Parties shall provide new and additional financial resources to enable developing country Parties to meet the agreed full incremental costs to them of implementing measures which fulfil the obligations of this Convention and to benefit from its provisions and which costs are agreed between a developing country Party and the institutional structure referred to in Article 21, in accordance with policy, strategy, programme priorities and eligibility criteria and an indicative list of incremental costs established by the Conference of the Parties. Other Parties, including countries undergoing the process of transition to a market economy, may voluntarily assume the obligations of the developed country Parties. For the purpose of this Article, the Conference of the Parties, shall at its first meeting establish a list of developed country Parties and other Parties which voluntarily assume the obligations of the developed country Parties. The Conference of the Parties shall periodically review and if necessary amend the list. Contributions from other countries and sources on a voluntary basis would also be encouraged. The implementation of these commitments shall take into account the need for adequacy, predictability and timely flow of funds and the importance of burden-sharing among the contributing Parties included in the list.

3. The developed country Parties may also provide, and developing country Parties avail themselves of, financial resources related to the implementation of this Convention through bilateral, regional and other multilateral channels.

4. The extent to which developing country Parties will effectively implement their commitments under this Convention will depend on the effective implementation by developed country Parties of their commitments under this Convention related to financial resources and transfer of technology and will take fully into account the fact that economic and social development and eradication of poverty are the first and overriding priorities of the developing country Parties.

5. The Parties shall take full account of the specific needs and special situation of least developed countries in their actions with regard to funding and transfer of technology.

6. The Contracting Parties shall also take into consideration the special conditions resulting from the dependence on, distribution and location of, biological diversity within developing country Parties, in particular small island States.

7. Consideration shall also be given to the special situation of developing countries, including that are most environmentally vulnerable, such as those with arid and semi-arid zones, coast mountainous areas.

Article 21. Financial Mechanism

1. There shall be a mechanism for the provision of financial resources to developing country P for purposes of this Convention on a grant or concessional basis the essential elements of whic described in this Article. The mechanism shall function under the authority and guidance of, ar accountable to, the Conference of the Parties for purposes of this Convention. The operations c mechanism shall be carried out by such institutional structure as may be decided upon by the Confe of the Parties at its first meeting. For purposes of this Convention, the Conference of the Parties determine the policy, strategy, programme priorities and eligibility criteria relating to the access tc utilization of such resources. The contributions shall be such as to take into account the nee predictability, adequacy and timely flow of funds referred to in Article 20 in accordance with the an of resources needed to be decided periodically by the Conference of the Parties and the importan burden-sharing among the contributing Parties included in the list referred to in Article 20, paragr Voluntary contributions may also be made by the developed country Parties and by other countrie sources. The mechanism shall operate within a democratic and transparent system of governance.

2. Pursuant to the objectives of this Convention, the Conference of the Parties shall at its first mee determine the policy, strategy and programme priorities, as well as detailed criteria and guideline eligibility for access to and utilization of the financial resources including monitoring and evaluatio a regular basis of such utilization. The Conference of the Parties shall decide on the arrangements to effect to paragraph 1 above after consultation with the institutional structure entrusted with the oper of the financial mechanism.

3. The Conference of the Parties shall review the effectiveness of the mechanism established ur this Article, including the criteria and guidelines referred to in paragraph 2 above, not less than two y after the entry into force of this Convention and thereafter on a regular basis. Based on such reviev shall take appropriate action to improve the effectiveness of the mechanism if necessary.

4. The Contracting Parties shall consider strengthening existing financial institutions to prov financial resources for the conservation and sustainable use of biological diversity.

Article 22. Relationship with Other International Conventions

1. The provisions of this Convention shall not affect the rights and obligations of any Contract Party deriving from any existing international agreement, except where the exercise of those rights obligations would cause a serious damage or threat to biological diversity.

2. Contracting Parties shall implement this Convention with respect to the marine environm consistently with the rights and obligations of States under the law of the sea.

Article 23. Conference of the Parties

1. A Conference of the Parties is hereby established. The first meeting of the Conference of t Parties shall be convened by the Executive Director of the United Nations Environment Programme r

later than one year after the entry into force of this Convention. Thereafter, ordinary meetings of the Conference of the Parties shall be held at regular intervals to be determined by the Conference at its first meeting.

2. Extraordinary meetings of the Conference of the Parties shall be held at such other times as may be deemed necessary by the Conference, or at the written request of any Party, provided that, within six months of the request being communicated to them by the Secretariat, it is supported by at least one third of the Parties.

3. The Conference of the Parties shall by consensus agree upon and adopt rules of procedure for itself and for any subsidiary body it may establish, as well as financial rules governing the funding of the Secretariat. At each ordinary meeting, it shall adopt a budget for the financial period until the next ordinary meeting.

4. The Conference of the Parties shall keep under review the implementation of this Convention, and, for this purpose, shall:

(a) Establish the form and the intervals for transmitting the information to be submitted in accordance with Article 26 and consider such information as well as reports submitted by any subsidiary body;

(b) Review scientific, technical and technological advice on biological diversity provided in accordance with Article 25;

(c) Consider and adopt, as required, protocols in accordance with Article 28;

(d) Consider and adopt, as required, in accordance with Articles 29 and 30, amendments to this Convention and its annexes;

(e) Consider amendments to any protocol, as well as to any annexes thereto, and, if so decided, recommend their adoption to the parties to the protocol concerned;

(f) Consider and adopt, as required, in accordance with Article 30, additional annexes to this Convention;

(g) Establish such subsidiary bodies, particularly to provide scientific and technical advice, as are deemed necessary for the implementation of this Convention;

(h) Contact, through the Secretariat, the executive bodies of conventions dealing with matters covered by this Convention with a view to establishing appropriate forms of cooperation with them; and

(i) Consider and undertake any additional action that may be required for the achievement of the purposes of this Convention in the light of experience gained in its operation.

5. The United Nations, its specialized agencies and the International Atomic Energy Agency, as well as any State not Party to this Convention, may be represented as observers at meetings of the Conference of the Parties. Any other body or agency, whether governmental or non-governmental, qualified in fields relating to conservation and sustainable use of biological diversity, which has informed the Secretariat of

its wish to be represented as an observer at a meeting of the Conference of the Parties, may be adm unless at least one third of the Parties present object. The admission and participation of observers be subject to the rules of procedure adopted by the Conference of the Parties.

Article 24. Secretariat

1. A secretariat is hereby established. Its functions shall be:

(a) To arrange for and service meetings of the Conference of the Parties provided fo Article 23;

(b) To perform the functions assigned to it by any protocol;

(c) To prepare reports on the execution of its functions under this Convention and present th to the Conference of the Parties;

(d) To coordinate with other relevant international bodies and, in particular to enter into s administrative and contractual arrangements as may be required for the effective discharge of its functic and

(e) To perform such other functions as may be determined by the Conference of the Partie

2. At its first ordinary meeting, the Conference of the Parties shall designate the secretariat fr amongst those existing competent international organizations which have signified their willingness carry out the secretariat functions under this Convention.

Article 25. Subsidiary Body on Scientific, Technical and Technological Advice

1. A subsidiary body for the provision of scientific, technical and technological advice is here established to provide the Conference of the Parties and, as appropriate, its other subsidiary bodies w timely advice relating to the implementation of this Convention. This body shall be open to participati by all Parties and shall be multidisciplinary. It shall comprise government representatives competent the relevant field of expertise. It shall report regularly to the Conference of the Parties on all aspects its work.

2. Under the authority of and in accordance with guidelines laid down by the Conference of t Parties, and upon its request, this body shall:

(a) Provide scientific and technical assessments of the status of biological diversity;

(b) Prepare scientific and technical assessments of the effects of types of measures taken accordance with the provisions of this Convention;

(c) Identify innovative, efficient and state-of-the-art technologies and know-how relating to th conservation and sustainable use of biological diversity and advise on the ways and means of promotin development and/or transferring such technologies;

(d) Provide advice on scientific programmes and international cooperation in research and development related to conservation and sustainable use of biological diversity; and

(e) Respond to scientific, technical, technological and methodological questions that the Conference of the Parties and its subsidiary bodies may put to the body.

3. The functions, terms of reference, organization and operation of this body may be further elaborated by the Conference of the Parties.

Article 26. Reports

Each Contracting Party shall, at intervals to be determined by the Conference of the Parties, present to the Conference of the Parties, reports on measures which it has taken for the implementation of the provisions of this Convention and their effectiveness in meeting the objectives of this Convention.

Article 27. Settlement of Disputes

1. In the event of a dispute between Contracting Parties concerning the interpretation or application of this Convention, the parties concerned shall seek solution by negotiation.

2. If the parties concerned cannot reach agreement by negotiation, they may jointly seek the good offices of, or request mediation by, a third party.

3. When ratifying, accepting, approving or acceding to this Convention, or at any time thereafter, a State or regional economic integration organization may declare in writing to the Depositary that for a dispute not resolved in accordance with paragraph 1 or paragraph 2 above, it accepts one or both of the following means of dispute settlement as compulsory:

(a) Arbitration in accordance with the procedure laid down in Part 1 of Annex II;

(b) Submission of the dispute to the International Court of Justice.

4. If the parties to the dispute have not, in accordance with paragraph 3 above, accepted the same or any procedure, the dispute shall be submitted to conciliation in accordance with Part 2 of Annex II unless the parties otherwise agree.

5. The provisions of this Article shall apply with respect to any protocol except as otherwise provided in the protocol concerned.

Article 28. Adoption of Protocols

1. The Contracting Parties shall cooperate in the formulation and adoption of protocols to this Convention.

2. Protocols shall be adopted at a meeting of the Conference of the Parties.

3. The text of any proposed protocol shall be communicated to the Contracting Parties by Secretariat at least six months before such a meeting.

Article 29. Amendment of the Convention or Protocols

1. Amendments to this Convention may be proposed by any Contracting Party. Amendments to protocol may be proposed by any Party to that protocol.

2. Amendments to this Convention shall be adopted at a meeting of the Conference of the Par Amendments to any protocol shall be adopted at a meeting of the Parties to the Protocol in question. text of any proposed amendment to this Convention or to any protocol, except as may otherwise provided in such protocol, shall be communicated to the Parties to the instrument in question by secretariat at least six months before the meeting at which it is proposed for adoption. The secret shall also communicate proposed amendments to the signatories to this Convention for information.

3. The Parties shall make every effort to reach agreement on any proposed amendment to Convention or to any protocol by consensus. If all efforts at consensus have been exhausted, anc agreement reached, the amendment shall as a last resort be adopted by a two-third majority vote of Parties to the instrument in question present and voting at the meeting, and shall be submitted by Depositary to all Parties for ratification, acceptance or approval.

4. Ratification, acceptance or approval of amendments shall be notified to the Depositary in writ Amendments adopted in accordance with paragraph 3 above shall enter into force among Parties hav accepted them on the ninetieth day after the deposit of instruments of ratification, acceptance or appr by at least two thirds of the Contracting Parties to this Convention or of the Parties to the prot concerned, except as may otherwise be provided in such protocol. Thereafter the amendments shall e into force for any other Party on the ninetieth day after that Party deposits its instrument of ratificat acceptance or approval of the amendments.

5. For the purposes of this Article, "Parties present and voting" means Parties present and castin affirmative or negative vote.

Article 30. Adoption and Amendment of Annexes

1. The annexes to this Convention or to any protocol shall form an integral part of the Conven or of such protocol, as the case may be, and, unless expressly provided otherwise, a reference to Convention or its protocols constitutes at the same time a reference to any annexes thereto. Such anne shall be restricted to procedural, scientific, technical and administrative matters.

2. Except as may be otherwise provided in any protocol with respect to its annexes, the follow procedure shall apply to the proposal, adoption and entry into force of additional annexes to Convention or of annexes to any protocol:

(a) Annexes to this Convention or to any protocol shall be proposed and adopted accordin the procedure laid down in Article 29;

(b) Any Party that is unable to approve an additional annex to this Convention or an annex to any protocol to which it is Party shall so notify the Depositary, in writing, within one year from the date of the communication of the adoption by the Depositary. The Depositary shall without delay notify all Parties of any such notification received. A Party may at any time withdraw a previous declaration of objection and the annexes shall thereupon enter into force for that Party subject to subparagraph (c) below;

(c) On the expiry of one year from the date of the communication of the adoption by the Depositary, the annex shall enter into force for all Parties to this Convention or to any protocol concerned which have not submitted a notification in accordance with the provisions of subparagraph (b) above.

3. The proposal, adoption and entry into force of amendments to annexes to this Convention or to any protocol shall be subject to the same procedure as for the proposal, adoption and entry into force of annexes to the Convention or annexes to any protocol.

4. If an additional annex or an amendment to an annex is related to an amendment to this Convention or to any protocol, the additional annex or amendment shall not enter into force until such time as the amendment to the Convention or to the protocol concerned enters into force.

Article 31. Right to Vote

1. Except as provided for in paragraph 2 below, each Contracting Party to this Convention or to any protocol shall have one vote.

2. Regional economic integration organizations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States which are Contracting Parties to this Convention or the relevant protocol. Such organizations shall not exercise their right to vote if their member States exercise theirs, and vice versa.

Article 32. Relationship between This Convention and its Protocols

1. A State or a regional economic integration organization may not become a Party to a protocol unless it is, or becomes at the same time, a Contracting Party to this Convention.

2. Decisions under any protocol shall be taken only by the Parties to the protocol concerned. Any Contracting Party that has not ratified, accepted or approved a protocol may participate as an observer in any meeting of the parties to that protocol.

Article 33. Signature

This Convention shall be open for signature at Rio de Janeiro by all States and any regional economic integration organization from 5 June 1992 until 14 June 1992, and at the United Nations Headquarters in New York from 15 June 1992 to 4 June 1993.

Article 34. Ratification, Acceptance or Approval

1. This Convention and any protocol shall be subject to ratification, acceptance or approval b and by regional economic integration organizations. Instruments of ratification, acceptance or a shall be deposited with the Depositary.

2. Any organization referred to in paragraph 1 above which becomes a Contracting Party Convention or any protocol without any of its member States being a Contracting Party shall be by all the obligations under the Convention or the protocol, as the case may be. In the case organizations, one or more of whose member States is a Contracting Party to this Convention or r protocol, the organization and its member States shall decide on their respective responsibilities performance of their obligations under the Convention or protocol, as the case may be. In such ca organization and the member States shall not be entitled to exercise rights under the Conven relevant protocol concurrently.

3. In their instruments of ratification, acceptance or approval, the organizations referred to in par 1 above shall declare the extent of their competence with respect to the matters governed Convention or the relevant protocol. These organizations shall also inform the Depositary of any n modification in the extent of their competence.

Article 35. Accession

1. This Convention and any protocol shall be open for accession by States and by regional ecc integration organizations from the date on which the Convention or the protocol concerned is clo signature. The instruments of accession shall be deposited with the Depositary.

2. In their instruments of accession, the organizations referred to in paragraph 1 above shall the extent of their competence with respect to the matters governed by the Convention or the re protocol. These organizations shall also inform the Depositary of any relevant modification in the of their competence.

3. The provisions of Article 34, paragraph 2, shall apply to regional economic integration organiz which accede to this Convention or any protocol.

Article 36. Entry into Force

1. This Convention shall enter into force on the ninetieth day after the date of deposit of the th instrument of ratification, acceptance, approval or accession.

2. Any protocol shall enter into force on the ninetieth day after the date of deposit of the numt instruments of ratification, acceptance, approval or accession, specified in that protocol, has deposited.

3. For each Contracting Party which ratifies, accepts or approves this Convention or accedes th after the deposit of the thirtieth instrument of ratification, acceptance, approval or accession, it shall into force on the ninetieth day after the date of deposit by such Contracting Party of its instrume ratification, acceptance, approval or accession.

4. Any protocol, except as otherwise provided in such protocol, shall enter into force for a Contracting Party that ratifies, accepts or approves that protocol or accedes thereto after its entry into force pursuant to paragraph 2 above, on the ninetieth day after the date on which that Contracting Party deposits its instrument of ratification, acceptance, approval or accession, or on the date on which this Convention enters into force for that Contracting Party, whichever shall be the later.

5. For the purposes of paragraphs 1 and 2 above, any instrument deposited by a regional economic integration organization shall not be counted as additional to those deposited by member States of such organization.

Article 37. Reservations

No reservations may be made to this Convention.

Article 38. Withdrawals

1. At any time after two years from the date on which this Convention has entered into force for a Contracting Party, that Contracting Party may withdraw from the Convention by giving written notification to the Depositary.

2. Any such withdrawal shall take place upon expiry of one year after the date of its receipt by the Depositary, or on such later date as may be specified in the notification of the withdrawal.

3. Any Contracting Party which withdraws from this Convention shall be considered as also having withdrawn from any protocol to which it is party.

Article 39. Financial Interim Arrangements

Provided that it has been fully restructured in accordance with the requirements of Article 21, the Global Environment Facility of the United Nations Development Programme, the United Nations Environment Programme and the International Bank for Reconstruction and Development shall be the institutional structure referred to in Article 21 on an interim basis, for the period between the entry into force of this Convention and the first meeting of the Conference of the Parties or until the Conference of the Parties decides which institutional structure will be designated in accordance with Article 21.

Article 40. Secretariat Interim Arrangements

The secretariat to be provided by the Executive Director of the United Nations Environment Programme shall be the secretariat referred to in Article 24, paragraph 2, on an interim basis for the period between the entry into force of this Convention and the first meeting of the Conference of the Parties.

Article 41. Depositary

The Secretary-General of the United Nations shall assume the functions of Depositary of this Convention and any protocols.

Article 42. Authentic Texts

The original of this Convention, of which the Arabic, Chinese, English, French, Rus Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United

IN WITNESS WHEREOF the undersigned, being duly authorized to that effect, have sig Convention.

Done at Rio de Janeiro on this fifth day of June, one thousand nine hundred and ninety-two.

Annex I

IDENTIFICATION AND MONITORING

1. Ecosystems and habitats: containing high diversity, large numbers of endemic or threatened species, or wilderness; required by migratory species; of social, economic, cultural or scientific importance; or, which are representative, unique or associated with key evolutionary or other biological processes;

2. Species and communities which are: threatened; wild relatives of domesticated or cultivated species; of medicinal, agricultural or other economic value; or social, scientific or cultural importance; or importance for research into the conservation and sustainable use of biological diversity, such as indicator species; and

3. Described genomes and genes of social, scientific or economic importance.

Annex II

Part 1

ARBITRATION

Article 1

The claimant party shall notify the secretariat that the parties are referring a dispute to a pursuant to Article 27. The notification shall state the subject-matter of arbitration and in particular, the articles of the Convention or the protocol, the interpretation or application of whi issue. If the parties do not agree on the subject matter of the dispute before the President of the is designated, the arbitral tribunal shall determine the subject matter. The secretariat shall for information thus received to all Contracting Parties to this Convention or to the protocol conce

Article 2

1. In disputes between two parties, the arbitral tribunal shall consist of three members. Eac parties to the dispute shall appoint an arbitrator and the two arbitrators so appointed shall desi common agreement the third arbitrator who shall be the President of the tribunal. The latter sha a national of one of the parties to the dispute, nor have his or her usual place of residence in the of one of these parties, nor be employed by any of them, nor have dealt with the case in a capacity.

2. In disputes between more than two parties, parties in the same interest shall appoint one a jointly by agreement.

3. Any vacancy shall be filled in the manner prescribed for the initial appointment.

Article 3

1. If the President of the arbitral tribunal has not been designated within two months appointment of the second arbitrator, the Secretary-General of the United Nations shall, at the rec a party, designate the President within a further two-month period.

2. If one of the parties to the dispute does not appoint an arbitrator within two months of rec the request, the other party may inform the Secretary-General who shall make the designation v further two-month period.

Article 4

The arbitral tribunal shall render its decisions in accordance with the provisions of this Conv any protocols concerned, and international law.

Article 5

Unless the parties to the dispute otherwise agree, the arbitral tribunal shall determine its ow of procedure.

Article 6

The arbitral tribunal may, at the request of one of the parties, recommend essential interim measures of protection.

Article 7

The parties to the dispute shall facilitate the work of the arbitral tribunal and, in particular, using all means at their disposal, shall:

(a) Provide it with all relevant documents, information and facilities; and

(b) Enable it, when necessary, to call witnesses or experts and receive their evidence.

Article 8

The parties and the arbitrators are under an obligation to protect the confidentiality of any information they receive in confidence during the proceedings of the arbitral tribunal.

Article 9

Unless the arbitral tribunal determines otherwise because of the particular circumstances of the case, the costs of the tribunal shall be borne by the parties to the dispute in equal shares. The tribunal shall keep a record of all its costs, and shall furnish a final statement thereof to the parties.

Article 10

Any Contracting Party that has an interest of a legal nature in the subject-matter of the dispute which may be affected by the decision in the case, may intervene in the proceedings with the consent of the tribunal.

Article 11

The tribunal may hear and determine counterclaims arising directly out of the subject-matter of the dispute.

Article 12

Decisions both on procedure and substance of the arbitral tribunal shall be taken by a majority vote of its members.

Article 13

If one of the parties to the dispute does not appear before the arbitral tribunal or fails to defend its case, the other party may request the tribunal to continue the proceedings and to make its award. Absence of a party or a failure of a party to defend its case shall not constitute a bar to the proceedings. Before rendering its final decision, the arbitral tribunal must satisfy itself that the claim is well founded in fact and law.

Article 14

The tribunal shall render its final decision within five months of the date on which it is fully constituted unless it finds it necessary to extend the time-limit for a period which should not exceed five more months.

Article 15

The final decision of the arbitral tribunal shall be confined to the subject-matter of the dispute and shall state the reasons on which it is based. It shall contain the names of the members who have participated and the date of the final decision. Any member of the tribunal may attach a separate or dissenting opinion to the final decision.

Article 16

The award shall be binding on the parties to the dispute. It shall be without appeal unless the parties to the dispute have agreed in advance to an appellate procedure.

Article 17

Any controversy which may arise between the parties to the dispute as regards the interpretation or manner of implementation of the final decision may be submitted by either party for decision to the arbitral tribunal which rendered it.

Part 2

CONCILIATION

Article 1

A conciliation commission shall be created upon the request of one of the parties to the dispute. The commission shall, unless the parties otherwise agree, be composed of five members, two appointed by each Party concerned and a President chosen jointly by those members.

Article 2

In disputes between more than two parties, parties in the same interest shall appoint their members of the commission jointly by agreement. Where two or more parties have separate interests or there is a disagreement as to whether they are of the same interest, they shall appoint their members separately.

Article 3

If any appointments by the parties are not made within two months of the date of the request to create a conciliation commission, the Secretary-General of the United Nations shall, if asked to do so by the party that made the request, make those appointments within a further two-month period.

Article 4

If a President of the conciliation commission has not been chosen within two months of the last of the members of the commission being appointed, the Secretary-General of the United Nations shall, if asked to do so by a party, designate a President within a further two-month period.

Article 5

The conciliation commission shall take its decisions by majority vote of its members. It shall, unless the parties to the dispute otherwise agree, determine its own procedure. It shall render a proposal for resolution of the dispute, which the parties shall consider in good faith.

Article 6

A disagreement as to whether the conciliation commission has competence shall be decided by the commission.

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SEGMENT D
PROBLEMS AND PARTNERSHIP
IN BIODIVERSITY

Class #21
Local Issues and Opportunities in Ecosystem Protection and Biodiversity

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OBJECTIVE: Encourage students to understand national concepts and themes by bringing them to a familiar and local level that they can see first-hand.

THEME: Biodiversity is an issue, it is currently threatened, and there are opportunities for ensuring national and international success by protecting ecosystems and biodiversity at the local and community level.

CLASS ACTIVITY:

I. Identify and discuss local issues relating to biodiversity and protection of migratory birds and of local ecosystems, by reviewing and discussing the newspaper articles collected on these topics throughout the spring.

Analyze the articles, and relate them back, to the key points concerning the importance of biodiversity preservation *discussed in Class #18.*

II. Identify and discuss any policies your state has for protecting biodiversity and encouraging ecosystem protection.

PREPARATION:

Collect local newspaper articles for each student. The articles can be handed out, one at a time, for reading during the class followed by discussion, or they can be assigned as homework from Class #20.

Find out any policies your state has concerning ecosystem protection and biodiversity.

RESOURCES NEEDED:

Articles for each student.

HOMEWORK TO ASSIGN:

Have the students write their own thoughts about:

1. What are the main threats to biodiversity, and natural ecosystems, including survival of migratory birds, in their local area?

2. What can they, individually and as a community, do to help preserve natural systems and biodiversity?

3. Ask students to bring their field trip journals to the next, and final, class.

FOLLOW-UP:

No specialized follow-up from this class.

HANDOUTS:

Newspaper articles.

LINKS: Science, sociology and political science.

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SEGMENT D
PROBLEMS AND PARTNERSHIP
IN BIODIVERSITY

Class #22
Measuring a Journey

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OBJECTIVE: Have students realize how much they have discovered, learned and thought about during the course, and that the course is only a beginning.

THEME: Repeat the Personal Survey first given in Class #2, and discuss students' other personal observations about the material covered in the course.

CLASS ACTIVITY:

I. Ask the students to share their thoughts from the Homework assigned from Class #21.

1II. Repeat the Personal Survey given in Class #2.

Then, give the students back their original copies of the first Personal Survey, so they each can contrast their answers, and realize some of the things they have learned about.

III. Have students take out the journals of their field trip observations, and encourage them to share and remember the interesting observations and experiences of the field trips.

IV. Be sure students have their individual life-

lists, and encourage them to look for hawks in the fall, and to look for birds and biodiversity throughout their lives.

V. Take out quarters, and flip them, as was done in Class #1, and encourage students to think about the amazing journeys and survival of migratory birds, whenever they use a quarter.

PREPARATION:

Collect and bring to class the original copies of the students' answers to the Personal Survey from Class #2.

Review the "Overview, Course Conclusion" (above).

RESOURCES NEEDED:

Quarters

HOMEWORK TO ASSIGN:

None

FOLLOW-UP:

Advise students as to possible continued reading on this topic area (See "General Preparation, Materials and Resources" above.)

HANDOUTS:

Original responses to the Personal Survey (from Class #2).

LINKS: Biology, sociology, and ecology.

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