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## 2002 Massachusetts Envirothon Current Issue

# Introduced Species and Biodiversity

## Questions and Resources for Team Preparation

This year's Envirothon current issue question aims to introduce teams to concepts of biodiversity through local investigations of the natural communities, developed landscapes, and introduced species. Each team will choose an introduced species to focus on in depth. The goal is for teams to gain knowledge and weigh values related to biodiversity and human activity, particularly species introduction and biodiversity conservation in their communities.

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Contact Will Snyder ( [wsnyder@umext.umass.edu](mailto:wsnyder@umext.umass.edu) or 413/545-3876) with questions about these questions and resources. Web sites included in the text were tested in October 2001. They by no means comprise an exhaustive list. More information on the topic of introduced species and biodiversity can also be found at the Canon Envirothon web site at:

[http://www.envirothon.org/2002\\_competition.htm](http://www.envirothon.org/2002_competition.htm) .

## What is Biodiversity?

Conservationist and pioneering ecologist Aldo Leopold articulated the basic understanding that underpins biodiversity to Americans in his 1953 essay "The Round River" (Oxford University Press, republished with *A Sand County Almanac* by Ballantine Books, 1966):

The land is one organism. Its parts, like our own parts, compete with each other and cooperate with each other. The competitions are as much a part of the inner workings as the cooperations. You can regulate them - cautiously - but not abolish them. (p. 190)

Biologist Edward O. Wilson is probably most responsible for giving the concept of biodiversity its wide public currency in the past decade through his Pulitzer prize-winning book *The Diversity of Life*

Biological diversity -- 'biodiversity' in the new parlance -- is the key to the maintenance of the world as we know it. Life in a local site struck down by a passing storm springs back quickly because enough diversity still exists. Opportunistic species evolved for just such an occasion rush in to fill the spaces. They entrain the succession that circles back to something resembling the original state of the environment. This is the assembly of life that took a billion years to evolve. . . . It holds the world steady. (p.15)

The Biodiversity page of the Massachusetts EOE web site offers a broad but useful definition of the term ( <http://www.state.ma.us/envir/biodiversity.htm> ):

Biodiversity is the variety of life and its processes. It includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting.

In good conservation practice today, biodiversity is as much about maintaining the integrity of complex processes as it is about maintaining the mix of species. The biodiversity of a place cannot be simply represented as the number of species present. Introducing a species to a community does not necessarily increase its biodiversity, and may in fact degrade it. Nevertheless, focusing on individual species is a valuable means of monitoring and protecting biodiversity.

**Terms and Concepts.** Many key biodiversity terms and concepts are drawn from the fields of ecology and evolutionary biology. See the 2002 Competition background information on the Canon Envirothon web site ( <http://www.envirothon.org> ) for some useful definitions of common terms like *community*, *niche*, *adaptation*, and relevant qualifiers for the term *species*: *native*, *introduced*, *naturalized*, *re-introduced*, *exotic*, *alien*, *invasive*.

## Why Protect Biodiversity?

More than half a century ago, Aldo Leopold made a common sense statement that conservation biologists still refer to today:

If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.

Our growing understanding through ecological science has made us even more aware of the utilitarian value of biodiversity. In *The Diversity of Life* Edward O. Wilson writes:

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

Ecological economists point out that Earth's natural systems provide an array of "ecosystem services" such as water supply, soil formation, atmospheric gas balance, crop pollination, and waste management. One study estimated the global value of these services at \$33 trillion, or nearly twice the GNP value of all the world's economies put together. (see <http://www.wri.org/wr-98-99/ecoserv.htm> ).

Recent years have also seen an evolving environmental ethic, whose development Aldo Leopold hoped to foster, that places a high value on nature for its own sake. For example, the Earth Charter, developed in the 1990s under United Nations auspices, declares as its first principle "Respect and Care for the Community of Life." It urges that we "recognize that all beings are interdependent and every form of life has value regardless of its worth to human beings." (see <http://www.earthcharterusa.org> )

## Human Impact on Biodiversity

Ecosystems are dynamic and evolving, and species population growth, decline, movements, and extinctions are natural processes. Humans are part of this web of life, but humans have become a major threat to biodiversity in the nature, pace, and extent of our activities.

**Tinkering.** Humans have always played experimentally with pieces of ecological systems, and modified our surroundings to suit our desires. This is the "tinkering" that Aldo Leopold wrote about.

Introducing non-native species has been a major feature of our tinkering. It has almost always been done with the best intention to improve our quality of life, but have been done largely in ignorance of ecological consequences. In her recent book *Tinkering with Eden: A Natural History of Exotics in America* (W. W. Norton & Co., 2001), Kim Todd tells the stories, including the varied human motivations behind, seventeen introduced species, many of which (for example, pigeons and honeybees), are now a part of our everyday American landscape.

Many of our intentional species introductions in recent decades - for example, biological pest controls - have been more cautious and sophisticated as a consequence of better understanding of ecological systems. But questions still linger about whether we can calculate all possible consequences of such introductions ahead of time.

Development of genetically engineered organisms adds a new dimension to the question of introduced species. Debate rages as to whether GMOs pose a threat to biodiversity.

Is "intelligent tinkering" compatible with "progress"? Progress may need to be redefined. The **Precautionary Principle**, a recently articulated (and still somewhat controversial) response to concerns about the process of applying scientific knowledge, seeks to address this question. It advises erring on the side of caution: "When an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." (see <http://www.sehn.org/precaution.html> for some background from proponents)

**Our Growing Ecological Footprint.** Burgeoning human population and consumption are also taking their toll. Loss of habitat is acknowledged to be the leading threat to biodiversity. In one 1986 study, a group of economists estimated that organic material equivalent to about 40% of the present net primary production (photosynthesis) in terrestrial ecosystems is being co-opted by human beings each year, and concluded that

The co-option, diversion, and destruction of these terrestrial resources clearly contributes to human caused extinctions of species and genetically distinct populations extinctions that could cause a greater reduction in organic diversity than occurred at the Cretaceous-Tertiary boundary 65 million years ago. (from "Human Appropriation of the Products of Photosynthesis" by Peter Vitousek, Paul R. Ehrlich, Anne H. Ehrlich and Pamela Matson, originally published in *BioScience* in 1986 and reprinted at <http://dieoff.org/page83.htm> )

**A new Pangaea?** The isolation afforded by islands and continental drift allowed the development of a rich variety of species and communities in different parts of the world. Today, however, the increasing globalization of the economy, with extensive travel and shipment of goods between continents, brings increasing numbers of unintended new invasions. This problem, and opportunities to stem it, are outlined by Chris Bright in his 1998 book *Life Out of Bounds: Bioinvasion in a Borderless World* (WorldWatch Institute, Washington DC <http://www.worldwatch.org> ).

**Climate Change.** The rate of global climate change in the coming century is projected to be more rapid than any change in climate that has occurred in the last 10,000 years. According to the World Conservation Union (IUCN), "Species will be more vulnerable because of climate change, and even where they are able to tolerate changes, they will have to deal with a variety of new competitors, predators, diseases, and alien species for

which they have no natural defense." (see <http://www.iucn.org/themes/climate/climatechangeandiucn.html> )

## Managing Introduced Species Problems

A wide array of international, national, state, and local government agencies and non-governmental organizations have responsibility and interests for managing introduced species and protecting biodiversity. As might be expected, the focus of most government efforts is on invasive exotics that have proven their ability to cause economic disruption.

Three components -- **prevention, control, and restoration** -- are necessary for successful management, according to the National Strategy for Invasive Plant Management (see <http://refuges.fws.gov/FICMNEWFiles/NatlWeedStrategyTOC.html> ) The strategy also stresses that **cooperation** among state and federal agencies, private organizations, and individuals is important, and that **education** and **research** must be top priorities.

The first step in effective management for the long term is a thorough understanding of the species and its interactions with other species. **Cost** is always a major consideration - how pressing a priority is the damage this species causes?

The World Conservation Union (IUCN) ( <http://www.iucn.org> ) is an example of an international nongovernmental organization addressing the problem.

In the United States, responsible federal agencies with information on their web sites include U.S. Department of Agriculture's Animal and Plant Health Inspection Service ( <http://www.aphis.usda.gov/> ), Forest Service ( <http://www.fs.fed.us/> ), and Natural Resource Conservation Service ( <http://www.nrcs.usda.gov/> ); the U.S. Department of Interior's Fish & Wildlife Service ( <http://invasives.fws.gov/> ) and National Park Service ( <http://www.nps.gov/plants/alien> ). The U.S. Environmental Protection Agency is particularly concerned with invasive species in waters of the United States. (see [http://www.epa.gov/owow/invasive\\_species/](http://www.epa.gov/owow/invasive_species/) ).

The U.S. Geological Survey has a Biological Resources Division (see <http://biology.usgs.gov/> ) with extensive web resources on U.S. biological topics including invasive and nonindigenous species, and maintains the **National Biological Information Infrastructure** ( <http://www.nbii.gov/> ) with a search engine for biological topics, and a state-by-state guide to resources (Massachusetts is at <http://www.nbii.gov/geographic/us/ma-nbii.html> )

Massachusetts state government has taken several initiatives to go beyond fighting battles against individual invaders to look at the larger picture of how best to conserve biodiversity (see <http://data.massgis.state.ma.us/Biodiversity/BrowsingBiodiv.htm> )

The Natural Heritage and Endangered Species Program, a part of the Division of Fisheries & Wildlife (see <http://www.state.ma.us/dfwele/dfw/nhesp/heritage.htm> ) researches and inventories biological resources, and has responsibilities for protecting nongame, especially endangered species habitat.

Biodiversity Days and the Visible Species of Massachusetts Database are educational initiatives designed to challenge citizens to familiarize themselves with the wealth of animal and plant species present in Massachusetts communities. There is also an *Exploring Biodiversity* workbook in PDF format. (see <http://www.state.ma.us/envir/biodiversity.htm> )

The **BioMap Project** (see <http://www.state.ma.us/dfwele/dfw/nhesp/nhbiomap.htm> ) is a new initiative designed to identify land areas crucial to the survival of Massachusetts' species and exemplary natural communities, and to help conservationists prioritize land protection efforts. The BioMap is a spatial representation of the areas deemed most critical to the long-term conservation of the known biodiversity

of Massachusetts.

Many universities do research on invasive species and biodiversity for federal and state agencies and others, and publish findings and tools on the world wide web. For example, researchers in UMass Amherst's Department of Natural Resources Conservation are developing a computer software program designed to help land use planners assess biodiversity value of a piece of land anywhere in the state, and prioritize lands for conservation. For more information, see <http://www.umass.edu/landeco/> and follow links to **BIOPLAN** and slide presentations.

## Investigating Introduced Species in Your Community

The following questions are designed to help teams in their investigations. They are meant only as a guide; every investigation will be different.

**1. First, define your area of investigation -- watershed, region, town, large land parcel -- and gain an appreciation for its biodiversity.** Use maps supplied by MassGIS and other sources, your own investigations, and interviews with naturalists, conservationists, and local officials to develop answers to these questions:

Where is the undeveloped land? What areas are protected open space? Are there areas of critical environmental concern? Are there areas shown on the BioMap as "core habitat" or "supporting natural landscape"?

What natural communities are represented? What are the constituent native species? How and why are these communities different from each other?

What is the history of land use in your area? This investigation can be an opportunity to interview long-time residents - particularly farmers, foresters, and naturalists. How has the biodiversity changed over time, and what is the evidence? Any major population fluctuations? Have the "dominant" species changed? How might human activity have contributed to these changes, directly and indirectly?

Are there threatened or endangered species present? Are invasive species a problem? What would you say are the top three introduced species in your community in terms of impact on biodiversity?

What evidence do you see of ecosystem robustness/resilience? of ecosystem weakening?

**2. Report on activities that are protecting biodiversity in your area.** Don't limit yourselves to projects that use the term "biodiversity." Some important protection activities may not be going by that name.

Who is working in ways that conserve biodiversity? Federal agencies? State agencies? Statewide NGOs? Land trusts? local conservation commissions? Citizen groups? Individuals? Are there local, state, or federal laws that work to protect biodiversity?

What is being done to protect biodiversity? Activities might include inventories and mapping, open space protection, awareness and education efforts, research, or invasive species control projects.

Are there prevention or control efforts aimed at particular species? Even if this is not the species you choose to focus on in #3 below, you should do enough research to answer these questions: Why is this species considered a problem? What is the management strategy? Who is involved? Why is this site a priority?

If you were to give a biodiversity protection medal to some organization, group, or individual in your area, who would that be and why?

**3. Focus on one introduced species in your community. Get to know it well, so that you can tell its story in a compelling way.** You may choose an exotic invasive, or a species that offers benefits to people and seems to fit in with minimal ecosystem disruption, or something in between. You are welcome to choose any species (although we STRONGLY discourage choosing *Homo sapiens*). We recommend the following (with some starter web sites) as interesting, perhaps somewhat controversial, and relevant to Massachusetts communities:

Free range cat

<http://www.dfg.ca.gov/hcpb/species/threats/threats.shtml>

Japanese knotweed

<http://fisher.bio.umb.edu/knotweed/>

Hemlock woolly adelgid

<http://www.invasivespecies.gov/profiles/hemlockwa.shtml>

Gypsy moth

<http://fhpr8.srs.fs.fed.us/wv/gmdigest/gmdigest.html>

Purple loosestrife

<http://www.dnr.state.wi.us/org/land/er/invasive/factsheets/loose.htm>

Norway maple

<http://www.hort.uconn.edu/plants/a/acepla/acepla1.html>

Buckthorn

<http://www.dnr.state.wi.us/org/land/er/invasive/factsheets/buckthorns.htm>

<http://tncweeds.ucdavis.edu/esadocs/franalnu.html>

Water chestnut

<http://www.invasivespecies.gov/profiles/waterchestnut.shtml>

Tree of heaven (Ailanthus)

<http://tncweeds.ucdavis.edu/esadocs/ailaalti.html>

[http://newcrop.hort.purdue.edu/newcrop/duke\\_energy/Ailanthus\\_altissima.html](http://newcrop.hort.purdue.edu/newcrop/duke_energy/Ailanthus_altissima.html)

Pigeon

<http://dep.state.ct.us/burnatr/wildlife/problem/pignprob.htm>

Honey bee

<http://www.angus.co.uk/bibba/index.html>

<http://www.nhb.org/bee-r/index.html>

Mute swan

<http://www.dnr.state.md.us/wildlife/mstfpc.html#msrecommend>

<http://www.hsus.org/whatnew/mdmuteswanalert022601.html>

Green crab

<http://www.invasivespecies.gov/profiles/greencrab.shtml>

Phragmites (common reed)

<http://omega.cc.umb.edu/~conne/leslie/lesliepage.htm>

Learn the species' Latin name and other common names, and what these tell about the species.

Describe the species' most important characteristics and the ecological niche it fills. Why is it successful, or what holds it in check? Where is it native to? How is that ecosystem similar and different from this one? What do we know about its life cycle? What are its habitat requirements? Its effects on other species? Is it limited to managed landscapes, or does it spread to natural landscapes, as well? What don't we know? What research has been or is being done?

Was the introduction intentional? If so, what was the reasoning behind the introduction? Has it been seen to have positive value or usefulness? When were problems first noticed?

When and how was this species introduced? How did it spread? Where and how large are the populations in your area now? How are they growing or changing?

What research questions have been asked about this species? Who is doing the research? What is being learned?

What strategies, if any, have been developed for managing this species? What agencies have an interest in management? What are the costs involved? How successful and permanent are the results?

In your judgment, is this species a significant threat to biodiversity in your area? in nearby areas? What are the environmental costs (e.g. competition with local species, destruction of habitat)? Are there questions or controversies about its impact?

What are the economic effects of this species, positive and/or negative?

Does its presence affect our quality of life in other ways?

Describe and analyze any action that is planned or already underway regarding this species in your area: Who is in the lead? Who else is involved? Why is this area a priority? What management strategies exist, what are their economic costs and benefits, and why were the strategies used here chosen over others? Is there enough funding to ensure success? Who is paying? Is the public knowledgeable, concerned, and/or taking action? Is anyone not in agreement with control efforts? What else is needed for the effort to be successful? What changes in policy beyond the scope of your community are necessary?

If no action is planned or underway, describe any actions you believe should be taken to ensure that biodiversity in your area is not degraded because of this species. If a cost is involved, how would you justify it, and who should pay? (Remember: according to Barry Commoner's Fourth Law of Ecology "There is no such thing as a free lunch.")

What, if anything, will happen if no action is taken?

## How will Envirothon team presentations be judged?

As in past years, teams will have 15 minutes to present their recommendation to a panel of judges at the Envirothon. This will be followed by a 10 minute period for formal questions from the panel. Judging criteria will include:

- Evidence of first-hand knowledge of the biodiversity in your area, from **field exploration** and substantial **contacts and interviews** with people
- Evidence of background knowledge gained from document and web research
- In-depth familiarity with one species
- Quality of presentation, including organization, public speaking skills, teamwork, effective use of maps and other visual aids, time management, and response to questions
- Overall quality, including curiosity, critical thinking, effort, depth, honesty, and creativity.

➡ This year, the Massachusetts Envirothon is proposing two new Envirothon awards that would recognize all teams that reached a certain standard in their Current Issue investigation, not just those with the highest scores. Two levels of award are proposed:

A SILVER AWARD "for community investigation" will be awarded to all teams who can demonstrate that they have conducted certain field investigations and interviewed relevant experts and local officials.

A GOLD AWARD "for community service and action" will be awarded to any team that uses the knowledge they gain to serve their community through education, conservation practice, or advocacy.

This proposal will not change the competition. Teams would not have to participate. While the standard will be high, in theory every team could qualify for both a silver and gold award. When a decision is made about this proposal, necessary information will be forwarded to teams.