2016 Mass Envirothon Current Issue

Managing Invasive Species

Background and Strategies for Community Research 2.0*

The Mass Envirothon Current Issue challenges your team to investigate an important environmental issue as it occurs in your community, to develop recommendations, and to present your findings to a panel of judges at the Envirothon competition. Use the background and links on these pages as a starting point for your research into invasive species and your community.

** Updated 3/17/16. Look for further updates at http://massenvirothon.org/2016-current-issue/. For previous versions contact Will Snyder at wsnyder@umext.umass.edu*

The spread of species to new regions has been an essential feature of biological evolution and the development of ecological communities. Since life first evolved on Earth, this kind of change has been a constant in ecosystems. Most change has been very gradual. And for thousands of years, humans have played a role in the process.

But in the past century, the speed of species spread – as well as the number of species involved and the geographic extent of the change – has increased dramatically. Human activity is responsible, and the ecological disruption has been significant.

At the same time that we have learned to appreciate the value of stable ecosystems for our own well-being, our activities have increasingly enabled biological invasions that undermine that stability.

Species invasions that cause economic, damage ecological processes, and harm human health have been identified as a widespread and urgent environmental issue by scientists and resource managers. No place, particularly in an urbanized state like Massachusetts, is unaffected. Governments at all levels have mobilized to address the issues.

But species invasions and rapidly changing ecosystems are only one aspect of the accelerating change we are experiencing. They are not a problem to be solved alone.

The 2016 Current Issue Problem will ask your team to report on the status of invasive species in your community, and to answer the question: What is the most noteworthy change in species and ecological community relationships affecting or potentially affecting your community? What – if anything – should be done that will promote the health of ecosystems that are important to us?

To participate fully, and to make sure your presentation is the best possible, your team should

- Get outdoors and explore!

- Connect the concepts in your biology textbooks with real conditions in the ecosystem around you. **The science of biological invasions offers a great opportunity to explore the ways that the really big natural processes** that we study in biology – like evolution, adaptation, competition, succession, ecological community, biodiversity, resilience – play out around you in your own community.

- Aim to learn to identify at least 15 species – invasives and others – that you didn't know before. Be able to spot them in the field, explain their important ecological characteristics, and tell their story.

- Get to know the people in your community who are knowledgeable about the natural world and are taking action for stewardship.

- Consider the challenges to conventional thinking about invasive species management. For example: Are you living in a "novel ecosystem"? Is it worth protecting?

A Note on Resources

This Massachusetts guide you hold in your hand should be your primary source of guidance and resource links for your investigations in Massachusetts. These pages also point out some of the interesting and important questions and controversies that have emerged in the field in recent years, and suggest some ways to get started on your community research.

The National Conservation Foundation's 2016 Envirothon Current Issue is "Invasive Species: A Challenge to the Environment, Economy, and Society". Ontario Envirothon has prepared a study guide to the topic that covers the basic tenets of this field of science and natural resource management. Their guide should also be an important background resource for you and may be found here: http://www.forestsontario.ca/files/FinalStudyGuide.pdf

Presentations from 2015-16 Mass Envirothon workshops are posted at http://massenvirothon.org/2016-current-issue/ . The presentations offer a rich array of knowledge and experience from the science and management of invasive species in Massachusetts.

Questions? Contact Will Snyder, UMass Extension, wsnyder@umext.umass.edu .

Invasive Species Management in the 21st century

▲ **While there are questions and controversies in the field of invasive species management, there is much agreement among natural resource managers and scientists about practical priorities:**

- There is strong agreement that invasions that threaten human health should trigger intensive management.
- Controlling invaders to prevent species extinction elicits a similar near-unanimous agreement.
- There is also general support for management when an invasion is demonstrated to cause direct damage to ecosystem services that we depend upon, incurring economic costs.
- There is lively debate about the value of native over non-native species and the potential for ecosystem restoration.

For a good statement of the controversies and common ground in the field of invasive species management, see this 2014 opinion piece from the New York Times, "How to mend the conservation divide": http://www.nytimes.com/2014/11/01/opinion/how-to-mend-the-conservation-divide.html?_r=1

▲ **Invasive species management is a well-developed conservation field, including a long-standing interest in maintaining public support and involvement.** As a result, there are many useful resources available on the web.

For example, several **federal agencies** host large sites with plenty of introduction and background material for the public:

- The Center for Invasive Species and Ecosystem Health http://www.invasive.org/ (see their **Invasive Species 101 - An Introduction to Invasive Species** at http://www.invasive.org/101/index.cfm)
- U.S. Department of Agriculture http://www.invasivespeciesinfo.gov/unitedstates/ma.shtml
- U.S. Department of Agriculture Animal & Plant Health Inspection Service (APHIS) http://www.hungrypests.com/
- U.S. Fish & Wildlife Service http://www.fws.gov/invasives/what-you-can-do.html
- U.S. Department of the Interior National Invasive Species Council https://www.doi.gov/invasivespecies/
- U.S.D.A. Natural Resources Conservation Service http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/invasive/
- U.S. Forest Service http://www.fs.fed.us/invasivespecies/restoration.shtml
- U.S. Environmental Protection Agency http://water.epa.gov/type/oceb/habitat/invasive_species_index.cfm

Massachusetts Environmental agencies host rich sites as well:

- Executive Office of Energy & Environmental Affairs http://www.mass.gov/eea/land-use-habitats/ecological-restoration/invasive-species/
- Massachusetts fact sheets on invasive species: http://massnrc.org/pests/index.htm
- Department of Conservation & Recreation, Division of Water Resource Protection: http://www.mass.gov/eea/agencies/dcr/water-res-protection/lakes-and-ponds/aquatic-invasive-species.html
- The Natural Heritage Program within Mass Wildlife: http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/land-protection-and-management/invasive-species/invasive-plants.html
- The Massachusetts Office of Coastal Zone Management: http://www.mass.gov/eea/agencies/czm/program-areas/aquatic-invasive-species/
- Massachusetts Natural Resources Collaborations (Mass Department of Agricultural Resources and UMass Extension) http://massnrc.org/pests/index.htm

Several **environmental education/advocacy organizations** in Massachusetts are concerned with invasive species:

- Massachusetts Association of Conservation Commissions https://maccweb.org/resources_inv_intro.html
- Massachusetts Audubon Society http://www.massaudubon.org/our-conservation-work/ecological-management/invasive-species
- The Trustees of Reservations http://www.thetrustees.org/what-we-care-about/the-natural-world/least-wanted.html
- Ecological Landscape Alliance http://www.ecolandscaping.org/category/invasive-plants/

▲ **Stretching available resources to meet the challenge is a recurring theme today in management efforts.** Some best management practices that save time and money and target the most important problems include:

Setting strategic priorities

- The Nature Conservancy: *To Control or Not to Control? An Invasive Plant Management Decision Analysis Tool* https://www.conservationgateway.org/News/Pages/control-or-not-control-in.aspx
- *Is Fighting Non-Natives Worth the Costs? A forum with three different perspectives*: https://www.conservationgateway.org/News/Pages/fighting-non-natives-wort.aspx

Developing and following management plans

- *MIPAG Guidance for the Effective Management of Invasive Plants* http://www.massnrc.org/mipag/docs/GuidanceInvPlantMgmtMIPAG.pdf
- The Nature Conservancy *Quick introduction to Invasive Species Prevention and Management* https://www.conservationgateway.org/Documents/InvasiveSpeciesMgmt101.pdf
- *Strategy for the Management of Invasive Species on Massachusetts Audubon Society Wildlife Sanctuaries* http://www.massaudubon.org/content/download/7236/131988/file/MAS_InvasiveSpeciesStrategy.pdf
- *A Landowner's Guide to Invasive Plant Management* from the Westfield River Watershed Invasive Species Partnership http://www.thetrustees.org/assets/documents/what-we-care-about/WISP_Invasives_Management.pdf

Collaboration among agencies and the public

- **The Massachusetts Invasive Plant Advisory Group** (MIPAG, http://www.massnrc.org/mipag/index.htm) is a voluntary collaborative representing research institutions, non-profit organizations, the green industry, and state and federal agencies concerned with the conservation of the Massachusetts landscape. MIPAG is charged with providing recommendations to the Commonwealth regarding which plants are invasive and what steps should be taken to manage these species. The diversity of membership means that the findings and recommendations of the group encourage cooperation among conservation agencies and organizations, businesses, and citizens concerned with the threat to the Commonwealth of invasive plants.
- **Cooperative Invasive Species Management Areas** (CISMAs) are partnership of federal, state, and local government agencies, tribes, individuals, and various interested groups that manage invasive species in a defined area. In Massachusetts, there have been CISMAs in two river watersheds: the Sudbury/Assabet/Concord Rivers (see http://cisma-suasco.org/) and the Westfield River.

Sharing data online via maps and databases

- EDDMapS: Early Detection & Distribution Mapping System – http://www.eddmaps.org/
- iMapInvasives: Sharing information for Strategic Management http://www.imapinvasives.org/

Volunteer involvement

- **The Outsmart Invasive Species Project** – http://masswoods.net/outsmart is one example of a way to involve the public in early detection and monitoring of invasive species in Massachusetts, using smartphones or digital cameras. Volunteer involvement can translate into public support.

Critical Perspectives on Invasive Species Issues

"Calling a plant invasive allows us to blame it for ruining the environment when really it is humans who are actually to blame" (Peter Del Tredici, *Wild Urban Plants of the Northeast*, p. 2)

▲ **Invasive species issues are embedded in a much larger picture of global change.** We have entered the Anthropocene, a new era of Earth's history in which human activity is the major driving force in environmental systems. Three forms of human activity contribute to the invasive species problem:

- **Economic globalization.** Increased travel and trade have eliminated many barriers to the introduction – intentionally and unintentionally – of plants, insects, animals, and pathogens to every region of the planet. Some say that we have, in effect, created a "New Pangea".
- **Resource Use and Urbanization.** Not only is the human population growing, but the ecological footprint of each of us is growing, as well. Our increasing exploitation of land and water resources, make us the dominant factor in every ecosystem. Successful species are those who have adapted to our presence.
- **Fossil fuel use.** Climate change, caused by our burning of fossil fuels, is accelerating, taking the form of warmer climate but also more unpredictable and extreme weather. The changes are altering the basic conditions in the ecosystems familiar to us.

▲ **Coming to terms with accelerating global change is raising questions about several basic assumptions in this field of conservation.**

- **We now recognize that there are no "pristine" ecosystems**. Nearly every ecosystem on Earth has experienced some form of deliberate management by humans. For example, when the pilgrims arrived at Plymouth they thought they were looking at a vast wilderness, but in fact, Native Americans had been employing a variety of land use strategies across the landscape for thousands of years.
- **"Ecological restoration" may or may not be possible, depending on the definition of "restoration".** Re-establishing earlier ecological conditions requires more than replanting an assemblage of species. It also requires reproducing soil chemistry and ecology, and perhaps a hydrological regime as well. In an era of climate change, this is likely to be impossible. However, the term "restoration" is sometimes used more generally to refer to efforts that promote ecological health, integrity, and sustainability.
- **"Native" and "alien" are relative terms.** Species introductions and migrations have been a constant in the history of Earth ecosystems. The point in time before which a species is labeled native is essentially arbitrary. *Don't judge species on their origins:* http://www.macalester.edu/~davis/Nature%20Essay.pdf
- **Native species can act like non-native invaders** when basic environmental conditions – land use, hydrologic regimes, and climate – change. See http://kateprengaman.com/native-invasive-species/
- **Similarly, an invading species may become less aggressive in time and changing conditions**, and take a modest niche in the new community rather than overwhelming it.

▲ **Permaculture advocates have critiqued invasive species management** from a more holistic, systems perspective for decades. For a sample see this interview of Tao Orion, author of *Beyond the War on Invasive Species*:

> *"Many of the people involved in restoration care deeply about preserving diverse and functional ecosystems, but when restoration focuses on removing invasive species without looking at why they are there in the first place, it is never going to achieve meaningful results, especially over time. . . . If we desire landscapes rich with diverse native species, then we have to design our lives in ways that meet this goal."*
> https://www.organicconsumers.org/news/interview-tao-orion-author-beyond-war-invasive-species

▲ **The concept of "novel ecosystems" is emerging as an additional basis for scientific research and management in a rapidly changing world**. The term was coined to describe a new way of looking at invasive species and ecological management questions in general. **A novel ecosystem is one that has been heavily influenced by humans but is not under human management.** The reality, these scientists and resource managers say, is that the scruffy, heterogeneous systems all around us can provide important ecosystem services and even protection for biodiversity. Here is a sampling of the discussion:

- *Landscapes are increasingly composed of ecosystems that are altered to different degrees; decisions on when and how to intervene in varying situations need to be made on the basis of the degree of alteration, likelihood of success, and landscape context*
- *Intervention in systems that are now radically altered from historical configurations needs to take into account their current values (particularly for ecosystem functions, services, and conservation outcomes) and the full range of options available, rather than being limited to traditional conservation or restoration measures*
- *Instead of posing a threat to existing practice, expanding the options available provides a more robust and comprehensive toolkit for intervening in rapidly changing landscapes*

From: *"Managing the whole landscape: historical, hybrid, and novel ecosystems"*
http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/54972/KennedyPatriciaFisheriesWildlifeManagingWholeLandscape.pdf?sequence=1

The arguments that attempting to restore an ecosystem is futile . . . and that novel ecosystems can serve our purposes better can only lead policy-makers to be more willing to allow environmentally damaging projects and the public to exert less pressure to prevent habitat destruction.
http://ensia.com/voices/novel-ecosystems-are-a-trojan-horse-for-conservation/

In the end, the question of novel ecosystems, like so many questions in ecology and conservation, boils down to what should be valued most in nature. For people who value processes . . . novel ecosystems are great hubs of active evolution. For those who value ecosystem services, any novel ecosystem could be better or worse than what came before depending on how it operates. For those who care about global extinctions or about preserving historical ecosystems, they are bad news.
http://www.nature.com/news/2009/090722/pdf/460450a.pdf

Are humans an invasive species?

The question is bound to come up. And it's worth asking, even if only as a thought experiment to see the issue from a different side.

Here's one opinion that says NO, because we are a native species:
http://www.smithsonianmag.com/science-nature/are-humans-an-invasive-species-42999965/?no-ist

And here's another opinion that says YES, because of our record of destructiveness:
http://indiancountrytodaymedianetwork.com/2011/08/14/humans-earths-most-invasive-species

This question has also been the subject of scientific study. What specific traits and environmental conditions permitted the rapid spread of a species that destabilized ecosystems worldwide?
http://www.scientificamerican.com/article/how-homo-sapiens-became-the-ultimate-invasive-species/

Take care with the words you use!

From the ecosystem's point of view (and hopefully the scientists' as well), a successful species is simply taking advantage of environmental conditions for which it is suited.

But the language of invasive species management often includes terms that can color our perception and scientific judgment. It may be impossible to find terms that do not have any value connotations. However, the common terms we use in the field reflect some of our most fearful human attitudes about each other. Plants that are successfully reproducing in a new ecosystem may be labeled ***alien, noxious, aggressive, threatening native communities***. Management can take on an unwarranted militaristic tone when we use words like ***invasion, attack,*** and ***escape***. References to ***pristine*** or ***degraded*** ecosystems imply that introduced species are a form of pollution.

Contrast these terms with descriptions Peter del Tredici uses in his *Wild Urban Plants of the Northeast,* which recall human traits in a different way: *"The plants that grow in our cities are a cosmopolitan array of species that reflect the natural and cultural histories of the area. . . . The plants that can survive and reproduce in the urban environment are* ***among the toughest on the planet****. . . . In general, the successful urban plant needs to be* ***flexible . . . opportunistic . . . and tolerant*** *. . . ."* (emphasis added) (9-11) To popularize this alternative view of invasives, he has coined the term ***cosmopolitan urban meadow***.

Invasive species and the urban environment

It may make more sense to view our urban (and many suburban) environments as novel ecosystems rather than as degraded, invaded native ecosystems. For a sampling of international opinion, see: http://www.thenatureofcities.com/2014/07/07/how-much-should-we-worry-about-exotic-species-in-urban-zones-how-do-we-reduce-damage-from-exotic-invasives-when-management-resources-are-limited-are-there-conflicts-between-management-or-eradicatio/

Video of an excellent panel presentation at the New York Botanical Garden is available online:
NYBG Symposium: The Changing Nature of Nature in Cities (November 7, 2014)
https://www.youtube.com/watch?v=a7vrdD3eVS0

Urban ecosystems can provide substantial ecological services, including stormwater management, pollution remediation, carbon sequestration, and aesthetic value. And according urban ecologist Peter Del Tredici, urban areas are a good place to study how climate change will affect the environment because ". . . they have already arrived at the future." (*Wild Urban Plants of the Northeast*, p.15) Some qualities of the urban environment relevant to invasive species:

- A wide variety of landscapes are present: remnant, highly invaded native landscapes (often associated with wetlands and water bodies), intensively planted and managed areas with good soils, and ruderal landscapes – abandoned and neglected land with disturbed, polluted, and compacted soils.
- Frequent disturbances and edge habitats provide opportunities for new species to take hold and become established.
- There is a high rate of introductions of new species via human travel and trade.
- Harsher climatic conditions prevail, including warmer temperatures overall, and more extreme hydrologic patterns of flood and drought (due to impervious surfaces).

Science + Values = Conservation.

Some thoughts from two important conservation thinkers relating to management of ecosystems:

In short, a land ethic changes the role of Homo sapiens from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such." (Aldo Leopold, The Land Ethic, 1949)

"A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity." (Aldo Leopold, The Land Ethic, 1949)

"The last word in ignorance is the man who says of an animal or plant, "What good is it?" If the land mechanism as a whole is good, then every part is good, whether we understand it or not. . . . who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering." (Aldo Leopold, Round River, 1953)

"I say to the young people, don't get into this with the idea that you're going to save it and solve all the problems even in your lifetime. The important thing to do is to learn all you can about where you are and if you're going to work there it becomes even more important to learn everything you can about that place, to make common cause with that place, and then resigning yourself, becoming patient enough to work with it over a long time." (Wendell Berry, PBS interview, 2013) http://billmoyers.com/segment/wendell-berry-on-his-hopes-for-humanity/

Getting Started on Your Community Research

The following pages introduce several starting points for your Current Issue research. To do a good job, your team will eventually need to be acquainted with all these areas. But you can start with any one of them. The resources and directions for research here barely scratch the surface of what is out there to be explored in your community. Don't feel limited by the suggestions here!

For your team's presentation at the 2016 Envirothon, you will need to address this problem:

Species invasions and rapidly changing ecosystems are one aspect of accelerating change in the Anthropocene Era of Earth's history.

What is the most noteworthy change in species and ecological community relationships affecting or potentially affecting your community? What – if anything – should be done?

Starting Points:

▲ **Gather several different biology textbooks**. (Re)familiarize yourself with the following concepts and ask: where is an example of this right in our neighborhood?

- Evolution
- Adaptation
- Competition
- Succession
- Ecological community
- Biodiversity
- Resilience

▲ **Find someone with a naturalist's eye** and knowledge in your community who can help you see these concepts in action around you. Can they show you an invasion? What do they think of the idea of novel ecosystems?

- The Mass Natural Heritage and Endangered Species Program has prepared fact sheets describing assemblages of species that occur together in space and time. These **natural communities** are groups of plants and animals found in recurring patterns that can be classified and described by their dominant physical and biological features. Do any occur in your neighborhood? Start here for an introduction and links to fact sheets: http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/natural-communities/
- Massachusetts Audubon invasive plants information: http://www.massaudubon.org/learn/nature-wildlife/invasive-plants

▲ **Explore with Maps**

Bird's Eye View. A fun way to explore your community is by flying over it using http://www.bing.com/maps.

Oliver. Oliver, the MassGIS online mapping tool at http://maps.massgis.state.ma.us/map_ol/oliver.php can be used to map a variety of themes related to ecosystems and invasive species themes under *Conservation/Recreation*.

BioMap2 is a MassGIS resource specifically designed to guide strategic biodiversity conservation in Massachusetts in this decade by focusing land protection and stewardship on the areas that are most critical for ensuring the long-term persistence of rare and other native species and their habitats, exemplary natural communities, and a diversity of ecosystems.

- See the links to specific BioMap2 resources, including **town by town reports with maps** at http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/land-protection-and-management/biomap2/
- An interactive map is online at https://maps.massgis.state.ma.us/dfg/biomap2.htm

EDDMapS (Early Detection & Distribution Mapping System) resources include maps showing locations where invasive species have been identified. Find the species at http://www.eddmaps.org/distribution/ and click on <points>.

Team maps. The Massachusetts Executive Office of Energy & Environmental Affairs provides registered Envirothon teams with large scale color printed maps of their communities showing information for use in research and presentations. This year's issue is somewhat challenging, as invasive species are usually mapped and managed at a very local scale. We have chosen the following map elements:

- "Disturbed land" as identified by Oliver (see above). These areas, which have been heavily affected by human activity and then neglected, may be more likely to be home to invasive species populations and novel species associations. Keep in mind that these disturbed areas were identified more than ten years ago and may have seen development or other radical change.

- Areas with a higher "index of ecological integrity" as determined by the Conservation Assessment and Prioritization System (CAPS, see http://www.umasscaps.org/). These areas have experienced less human impact and might be expected to have fewer invasive species populations and exhibit more classic ecosystem community types. Some managers advocate prioritizing such areas for monitoring and control of invasive species.

It is important to keep in mind that invasive species populations, examples of "novel ecosystems", and identified priority areas for invasive species management may be anywhere in your community.

▲ **GO OUTDOORS!** This Current Issue involves getting to know particular species and the ecosystems of which they are a part. Appreciate the biological vitality of your neighborhood without passing judgment on it.

Find and map at least five local places that demonstrate different combinations of

- Terrestrial, aquatic, coastal habitat
- Remnant, managed, ruderal landscapes
- Forest, agriculture, urban land use

- What ecosystem services would you expect are being provided by each? Are there any protections in place for these services?
- Are any invasive species present?
- Which area has the highest biodiversity right now? Why do you think so?
- What evidence do you see of ecosystem robustness/resilience? Of ecosystem stress?

Identify and map evidence of a variety of plants, insects, animals, and pathogens, including

- at least five species that are generally considered invasive
- at least five species that are naturalized but not invasive
- at least five species that are generally considered native

Chart this information about each species

- Approximate year of arrival in your region
- Where it came from
- Habitat preferences
- Life cycle, especially reproduction strategies
- Ecological functions
- Cultural significance

Answer this question about each species:

- What are the negative and positive effects these species have on the ecosystem services your community relies upon?

▲ **Contact your Conservation Commission**. What invasive species issues have they encountered recently? What biodiversity and invasive species work – research, control, monitoring, education – is being conducted by other government agencies in your town this year?

▲ **Contact a local land trust or other public interest land-holder**. What invasive species issues have they encountered recently? Where? Do they have a management plan and does it address invasive species issues? What do they think of the idea of novel ecosystems?

▲ **Be on the lookout for good stories!** The history of invasive species is full of interesting anecdotes – some funny, some sad. Beyond questions of natural resource management, teams should keep an eye out for tales of human values and judgment and foibles, as well as accounts of amazing ecological relationships and adaptations.