ARTICLES INSIDE • Fracking and Biodiversity • Ancient Floodplain Forest • Hudsonia Projects 2011

Northern saw-whet owl.
Photo © Esther Kiviat

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Cover Photo: Northern saw-whet owl, photographed at Hudson Valley Raptor Center by Esther Kiviat. This is the smallest northeastern owl, only seven inches long. It rests in conifers, thickets, and other dense vegetation. Esther Kiviat (1915-2009) left her photographs to benefit Hudsonia, and we are looking for a volunteer to curate and catalog this collection.

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Telephone: (845) 758-7053
Facsimile: (845) 758-7033
Website: www.hudsonia.org

PO Box 5000
Annandale, NY 12504-5000

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FRACKING AND BIODIVERSITY:
Unaddressed Issues in the New York Debate

By Erik Kiviat* and Karen Schneller-McDonald**
condensed and adapted for *News from Hudsonia* by Kristen Bell Travis

Eastern states from New York to West Virginia are undergoing large-scale development of natural gas resources from the Marcellus shale. Recently it became economically feasible to exploit this source of gas via technology called high volume horizontal hydraulic fracturing (HVHHF, also called "fracking"). While New York has not yet permitted gas extraction by HVHHF, gas development using this technology has proceeded rapidly in Pennsylvania and West Virginia during the past few years. The New York State government will soon make decisions about whether and where to permit HVHHF in New York. If New York decides to permit HVHHF, areas of southern New York west of the Hudson River and the Shawangunk Mountains would potentially be available for gas extraction from the Marcellus shale. As of 2009, New York had 6,628 active "shallow" gas wells in 18 counties that used technologies other than HVHHF.[19] Shallow wells in the Marcellus region would potentially be available for conversion to HVHHF if that technology is permitted in New York.

The impacts of HVHHF on water supplies, human health, and safety have received much justifiable attention during the past two years, but scientific study of impacts on biological resources is just beginning. Because of the magnitude of potential physical and chemical environmental impacts of HVHHF across the Marcellus region, and the potential threats to many uncommon and rare species and habitats, we perceived a critical need for analysis of impacts to biodiversity. Here we discuss potential individual and cumulative effects on habitats and species resulting from different aspects of HVHHF, and then draw attention to species that may be the most vulnerable to these effects.

HVHHF AND ITS IMPACTS

The gas-bearing Marcellus shale of New York, Pennsylvania, Ohio, West Virginia, Maryland, and Virginia occurs beneath the Allegheny Plateau. In New York the Marcellus shale extends approximately from the Hudson River and the Shawangunk Mountains westward, south of the Mohawk River, to the western end of New York. The Marcellus shale is a blackish, organic-rich, Devonian shale about 400 million years old, and it contains large amounts of methane (natural gas) derived from anaerobic decay of the organic matter. The gas is tightly bound in pores within the rock.

Recently the HVHHF technology was developed to economically mine natural gas from gas shales. This technology constitutes drilling vertically to a depth of a mile or more to reach the Marcellus, then drilling horizontally for a mile or more, and forcing a mixture of water, sand, and chemicals into the shale to fracture the rock and release the gas. Gas and some of the water are then pumped from the well and the gas is cleaned and compressed for pipeline transmission. The "frack water" that returns to the surface is polluted with the chemicals forced into the well and other toxic substances from the shale itself. Drilling companies use diverse mixtures of fracking chemicals that include many very toxic substances.[23] An individual fracking installation, with its drilling pad, access road, and other facilities, may occupy 5 acres or more (average of 8.8 acres in a Pennsylvania sample).[7] Pipelines and compressor stations that move the gas from the drilling areas create additional disturbance in the surrounding landscape.

Continued on page 2

CONTENTS

* Executive Director, Hudsonia Ltd. **Hickory Creek Consulting LLC, Red Hook, Dutchess County, NY (hickorycreekllc.com)

Fracking continued from page 1

Wastewater. Among the most troubling impacts of HVHHF are those caused by wastewater. Ten to forty percent of the water forced into the well to fracture the shale returns to the surface with the gas. This frack water contains portions of the fracking chemicals as well as salt, naturally occurring radioactive materials, and heavy metals from the shale. Salt levels of frack water are sometimes, perhaps often, high compared to local fresh water. In theory, the wastewater is treated to remove pollutants before being discharged to the environment. In Pennsylvania, however, fracking wastewater is commonly stored in pits or ponds at the fracking installations, or disposed of in sewage treatment plants, most or all not designed to handle large volumes of industrial wastewater that contains non-traditional chemicals, salt, and radioactive materials. "Production brine" (i.e., salty return water from gas wells) might be allowed to be spread on roads in New York depending on levels of radioactivity in the brine, and storage of "flowback water" might be allowed in surface impoundments at some sites.[18] Wastewater ponds are likely to attract semi-aquatic animals, such as waterfowl and other water birds, muskrat, turtles, frogs, and aquatic insects. Some of these animals will be poisoned by toxic substances concentrating in the wastewater ponds as water evaporates. A mass mortality of ducks occurred at tar sands wastewater ponds in Alberta,[4] which illustrates the potential for trouble where toxic substances accumulate in open ponds or pits.

Wastewater can be injected into deep underground disposal areas or re-used for fracking, but it is not known how practical, cost-effective, or safe these practices will be. Even though some substances can be removed by treating wastewater, one of the most important pollutants, salt, is very expensive and impractical to remove. Brackish (salty) wastewater is expected to pollute streams and wetlands, rendering them unsuitable for many salt-sensitive freshwater organisms including salamanders, frogs, many fishes, and many freshwater plants. Brackish wastewater spilled or leaked onto soil would render the habitat unsuitable for many common and rare woodland plants including some trees, as well as many soil invertebrates.

Little information is available on the potential impacts of other fracking chemicals on streams, wetlands, or upland soils. Because some of these chemicals are known to be endocrine disruptors or carcinogens, we expect that these substances would cause harm to many stream, wetland, and forest wildlife species. In the Monongahela National Forest in West Virginia, HVHHF operations were allowed to dispose of frack water by spraying on the ground, resulting in mortality of forest vegetation.[1] Riverkeeper[13] documented a large number of accidents at existing gas drilling installations that resulted in contamination of drinking water supplies or other impacts to human health and safety (also see Helman[6]). Many accidents of these kinds would harm wildlife and plants as well as people.

Air emissions. HVHHF can be a significant source of air pollution. Air emissions are produced by drilling rigs, diesel-powered pumps that create pressure in the wells, venting of some natural gas, and vehicular traffic. Pollutant emissions from natural gas drilling activities in the Dallas–Fort Worth region approximately equaled emissions from all car and truck traffic in that region.[3]

Between 2005 and 2009, hydraulic fracturing companies used 595 substances including 24 different hazardous air pollutants, among them hydrogen fluoride, hydrogen chloride, methanol, formaldehyde, ethylene glycol, and lead.[23] Volatile organic compounds (VOCs) including benzene, toluene, ethylbenzene, and xylene are emitted from wastewater during concentration and storage, engine exhaust, and compressor operation. Benzene and toluene are known human carcinogens; toluene affects the reproductive and central nervous systems; and ethylbenzene and xylene may have respiratory and neurological effects. Other air pollutants emitted by drilling operations include heavy metals, particulate matter, sulfur dioxide, and two precursors to the formation of ozone: VOCs and nitrogen oxides. Polycyclic aromatic hydrocarbons from diesel exhaust and wastewater pits are probable carcinogens that have been shown to have reproductive effects in animals. HVHHF also brings low levels of naturally occurring radioactive materials to the surface, a portion of which may become airborne. Some of these air pollutants would be toxic to trees and other plants where concentrated near drilling pads, as well as toxic to wildlife.

Habitat fragmentation. Large portions of the Marcellus region support extensive forests, and many animals (and some plants) require large areas of continuous forest habitat in order to support viable populations. A dirt road through a forest may not significantly degrade habitat for a white-tailed deer that can readily cross such a road and is not harmed by changes associated with the road. The same road, however, may fragment habitat for a wood thrush if the road attracts nest predators, or for a ground beetle that has difficulty crossing even a dirt road or may be exposed to predators while doing so.

Areas of intensive gas drilling show forests fragmented by roads built for exploration, drilling pads, access roads, pipelines, and other facilities. Johnson[7] presented data for 242 drilling pads on the Marcellus shale of Pennsylvania, about half of which were in forested areas. An average of 8.8 acres of forest was cleared for each drilling pad with its roads and other infrastructure. Assuming an ecological edge effect of 330 feet extending into intact forest from cleared areas, each drilling installation affected 30 acres of forest.[7] In some areas of Pennsylvania, HVHHF installations occurred at a density of 1 per 40 acres, representing a very high degree of fragmentation. Johnson[7] predicted that area-sensitive forest birds such as the black-throated blue warbler and scarlet tanager would be adversely affected.

A study in western Canada found that territories of the ovenbird, a ground-nesting warbler, did not straddle 25 foot wide cleared seismic exploration lines but did straddle 10 foot wide seismic lines.[4] The wider lines fragmented ovenbird habitat, sometimes leading to local population declines. There is accumulating evidence that many forest songbirds avoid roads, trails, pipelines, and human activities.[4] Other organisms that can be negatively affected by forest fragmentation include woodland pool-breeding amphibians, forest floor wildflowers with ant-dispersed seeds, and plants whose pollinators or herbivores are affected. American ginseng, an economically valuable medicinal plant, may be affected by forest fragmentation because the seeds have difficulty dispersing from one fragment to another.[5]

The New York State Department of Environmental Conservation (NYSDEC)[18] stated, "Significant adverse impacts to habitats, wildlife, and biodiversity from site disturbance associated with high-volume hydraulic fracturing in the area underlain by the Marcellus shale in New York will

Fortuna Energy site (tract 587) in Tioga State Forest, PA, illustrating degree of forest fragmentation of a single HVHHF installation. Photo: Dick Martin of www.PAForestCoalition.org.

be unavoidable. In particular, the most significant potential wildlife impact associated with high-volume hydraulic fracturing is fragmentation of rare interior forest and grassland habitats… " and "Human induced openings can influence breeding bird productivity several hundred feet from the edge of the forest through increased predation and increased nest parasitism."

Other impacts. A single fracking episode may take several months, and a well may need to be fracked repeatedly at intervals of a few years in order to continue yielding gas. Each fracking episode requires about one to several million gallons of water, usually taken from lakes and river. The large volumes of ***surface water extraction*** required for HVHHF could affect plants and animals that depend on certain minimum water levels and flows during particular stages of their life cycles. Minimum instream flows are especially important to trout, freshwater mussels, and many other economically important or rare aquatic animals. ***Soil erosion and siltation*** caused by clearing and grading for the construction of drilling pads, access roads, and pipelines would very likely have a significant negative impact on water quality and the species that depend upon clean water in streams and wetlands.[1] Little or no precipitation water can infiltrate into the soil through the ***impervious surfaces*** of drilling pads and access roads, potentially leading to less groundwater recharge, altered stream flows, and increased stream siltation. Heavy ***truck traffic*** (for establishment and maintenance of HVHHF installations, in some cases transportation of water for fracking, and removal of wastes) will result in animals killed on the roads, which for some species can cause population declines.[4] Wildlife that is especially vulnerable to road mortality includes most turtles, snakes, salamanders, and frogs; ruffed grouse, eastern screech-owl, and many kinds of songbirds; small and medium-sized mammals; and a variety of insects. Gas drilling access roads and pipeline maintenance roads are likely to give ***all-terrain vehicles*** (ATVs) access into areas of forests and other habitats not easily reached otherwise. ATVs cause air pollution, soil compaction, erosion, and siltation of waterways; create water-filled ruts conducive to mosquito breeding; and make noise that disturbs animals. HVHHF installations are likely to be brightly lit at night. ***Artificial night lighting*** has many deleterious impacts on wildlife,[20] including the attraction and killing of night-flying aquatic and terrestrial insects, which could deplete the prey of stream fishes and bats. Gas compressors produce ***loud noise*** 24 hours per day. Noise can disrupt the behavior of wildlife that communicates acoustically, including birds, bats, frogs, and singing insects such as katydids and crickets.

Cumulative impacts. Impacts that occur at multiple sites separated in space or time may have additive or synergistic effects on biological resources. Cumulative impacts may also involve interactions of different impacts, such as the interaction of HVHHF impacts with those of coal mining, residential development, or climate change. Cumulative effects from many separated drilling installations on branches of a stream system may result in large impacts downstream. Salinity or toxic substances from wastewater,

Continued on page 8

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ANCIENT FLOODPLAIN FOREST:
A Rare and Diverse Habitat in the Hudson Valley

By Claudia Knab-Vispo and Conrad Vispo*

Floodplain forests are strangely attractive. They are among the few places in our cultural landscape where nature's raw forces can be experienced regularly, usually during an early spring flood. After the streams have returned to their beds, the debris piles left in the floodplain attest to the physical power of the water. These piles are composed not only of driftwood and leaf litter, but also a striking array of man-made detritus, reminding us that, all too often, rivers are still used as a convenient garbage "disposal" system. Despite a certain degree of neglect or even misuse, however, floodplain forests are well worth a visit.

Autumn is a good time of year for exploring an old floodplain forest. The mosquitoes, which can be so prevalent during the summer, are gone. Yet there are still enough remains of the luxurious summer vegetation to remind us of the botanical richness of the place. The sometimes enormous tree trunks and the open understory give it a cathedral-like feel. A mosaic of soil conditions bears witness to the water's opposing powers of erosion and deposition, which largely depend on the speed and the sediment load of the water. Pebbles and rocks are deposited in places where fast-flowing water had carried away the finer particles and dropped only the coarse and heavy materials. Sandy deposits are in areas where the water was not quite as fast. And fine-textured silt is deposited in places where the flood flow was slow or where water had been trapped in pools and percolated into the ground, leaving on the soil surface the small and light particles it had carried in suspension.

Plants and animals living in this environment have to deal with occasional submersion and the physically destructive power of floods. We are amazed each year to find, in spite of this harsh environment, another rich display of spring flowers, such as spring beauty, Dutchman's breeches, blue cohosh, and wild ginger, followed in many floodplain forests by the tall and lush mid-summer growth of ostrich fern, woodnettle, and jewelweed.

The Hawthorne Valley Farmscape Ecology Program received support from the Biodiversity Research Institute and the Hudson River Estuary Program (of the New York State Department of Environmental Conservation) to find and map, in collaboration with Hudsonia, the extent of remaining floodplain forests in Dutchess and Columbia counties, to document the plants and animals that live in these forests, and to begin an exploration of the patterns of species composition and diversity.[2]

Our study focused on forests along streams on soils mapped as "alluvial" in the county soil surveys and that were subject to occasional (on average once, at the most two or three times per year) flooding by stream water. We excluded floodplain swamps because our initial field exploration into such forests revealed their great similarity with non-alluvial swamp forests. We also excluded freshwater tidal swamps and the occasionally flooded forests along the Hudson River.

We found that floodplain forest is a rare habitat in Dutchess and Columbia counties, and currently covers only 1/3 of the suitable soils along bottomlands of larger streams and some of their (2nd and 3rd order) tributaries in both counties. "Ancient" floodplain forests, which can be defined as those which have likely never been completely cleared for agriculture[5] (although they may have seen a variety of human activities, including selective logging and garbage dumping), are even rarer. Less than half of the currently forested floodplain areas in Columbia County and less than a third of those in Dutchess County are "ancient" by this definition. Furthermore, most floodplain forests, and especially the remnants of ancient ones, occur only in small, isolated patches.

Green dragon (*Arisaema dracontium*) is one of the plants especially associated with floodplain forest in our region. Photo © Conrad Vispo

Nevertheless, during our two-year study of 31 floodplain forest sites in both counties we documented a large diversity of plants and animals. We recorded:

- 442 species of vascular plants, including 47 rare or uncommon species, such as Davis' sedge (NYS Threatened), winged monkeyflower (NYS Rare), green dragon, false mermaid-weed, and hackberry (all regionally rare or scarce[1]);
- 25 species of mammals, including river otter (regionally scarce), muskrat (regionally declining), eastern small-footed bat (NYS Special Concern), and a landowner's report of Indiana bat (US and NYS Endangered);
- 46 species of birds, including Louisiana waterthrush, scarlet tanager, and wood thrush (all NYS Species of Greatest Conservation Need);
- 4 species of reptiles, including eastern box and wood turtles (both NYS Special Concern);
- 8 species of amphibians;
- more than 20 species of butterflies (including the rare hackberry emperor and American snout, and the uncommon question mark and spicebush swallowtail);
- 45 species of dragonflies and damselflies—more than 10 of these were new county records, including brook snaketail, spine-crowned clubtail, arrow clubtail, and blue-tipped dancer (all NYS Species of Greatest Conservation Need);
- 85 species of ground beetles, 35 of which are considered rare or uncom-

* Coordinators of Ecological Research and Outreach at the Hawthorne Valley Farmscape Ecology Program, Ghent, Columbia County, NY (farmscapeecology.org).

The larvae of the hackberry emperor butterfly feed on the leaves of hackberry (*Celtis occidentalis*), a native tree of riparian habitats. Photo © Conrad Vispo

mon in our region; and

- 59 species of native bees, a group not yet studied enough in our region to even begin assessing their rarity.

Many of these species occur in other habitats in addition to floodplain forests, but we found more than 50 plant species which, in our experience, occur almost exclusively or mostly along streams, at least in Dutchess and Columbia counties. More than half of the documented dragonfly and damselfly species were classified as stream or river species, whose aquatic larvae develop in running water, and more than half of the ground beetle species were classified as associated with water. Half of the native bees recorded in the floodplains were not found in adjacent farm fields, but we cannot say whether they are especially associated with riparian forests.

For other species, forested stream corridors provide migration routes and resource-rich areas where they come to feed on aquatic organisms. The fish-eating river otter and birds, such as belted kingfisher, common merganser, and great blue heron are examples. The stream also supports terrestrial life through the abundant insects emerging from aquatic larvae.[1] Bats and birds hunt on the wing for these insects, while spiders and tiger beetles stalk their prey along the shores. Floodplain forests, in turn, supply high quality organic detritus to the stream, creating shelter and serving as the base of the food web for stream organisms.[4] Forested river banks help to minimize soil erosion and filter surface runoff before it reaches the stream, thereby maintaining stream water quality.[3] In some areas, floodplain forests also play a role in diffusing the downstream intensity of flooding.

The floodplain forests in our study grouped into five forest types according to their dominant tree species: 'Sugar Maple-dominated', 'Elm – Sugar Maple – Bitternut', 'Elm – Ash – Black Cherry', 'Black Locust – Sycamore – Cottonwood' and 'Green Ash – Silver Maple' floodplain forests. Each of these forest types had particular physical characteristics and a set of herbaceous (non-woody) indicator species which, while not necessarily unique to that type, occurred in significantly higher densities.

In our study, ancient floodplain forests had significantly lower densities of invasive shrubs and higher diversity of native herbaceous plants than recently reforested floodplains. While floodplain forests can provide many important ecological services independent of their species composition, our study indicated that ancient floodplain forests might be hotspots for biological diversity. Nobody knows if natural succession or restoration efforts in recently reforested floodplains will eventually lead to the same level of biodiversity. For the time being, we believe that ancient floodplain forest remnants should be considered ecologically unique and potentially irreplaceable. They deserve high priority for conservation, especially in the few areas where large ancient floodplain forests remain. ■

The full report on *"Floodplain forests of Columbia and Dutchess counties, NY"* is available at: http://www.hawthornevalleyfarm.org/fep/FEP%20Floodplain%20Forest%20Report%20Nov%202010.pdf).

REFERENCES CITED

1. Kiviat, E. and G. Stevens. 2001. Biodiversity assessment manual for the Hudson River estuary corridor. New York State Department of Environmental Conservation, Albany. 508 p.
2. Knab-Vispo, C. and C. Vispo. 2010. Floodplain forests of Columbia and Dutchess counties, NY: Distribution, biodiversity, classification, and conservation. Hawthorne Valley Farmscape Ecology Program, Ghent, NY. 67 p + Appendix. Available at: http://www.hawthornevalleyfarm.org/fep/FEP%20Floodplain%20Forest%20Report%20Nov%202010.pdf (viewed October 2011).
3. Naiman, R.J., Décamps, H., and M.E. McClain. 2005. Riparia: Ecology, conservation, and management of streamside communities. Elsevier Academic Press, Amsterdam. 430 p.
4. Nakano, S. and M. Murakami. 2001. Reciprocal subsidies: Dynamic interdependence between terrestrial and aquatic food webs. Proceedings of the National Academy of Sciences 98:166-170.
5. Rackham, O. 2006. Woodlands. Collins, London. 609 p.

A typical floodplain forest in mid-summer with ostrich fern dominating the herbaceous layer. Photo © Conrad Vispo

SOME HUDSONIA PROJECTS IN 2011

ARE DISTURBED SITES USEFUL "SENTINELS" FOR NONNATIVE PLANTS?

This summer we surveyed the flora on 30 disturbed areas (mines, clearcuts, and transportation sites) in the Catskill Mountain region. We discovered several nonnative plants that are beginning to spread in the region, including cut-leaved teasel, wall lettuce, and hairy willow-herb. We learned that many native plants, as well as nonnative plants, colonize disturbed areas. Mines and transportation sites (such as railroad verges, soil storage areas, and abandoned parking lots) have good "sentinel" potential for early detection of nonnative plants that can allow management actions for species that might become troublesome weeds. (Funded by the Catskill Regional Invasive Species Partnership.)

BIODIVERSITY ASSESSMENT HANDBOOK FOR NEW YORK CITY

Many parks and other greenspaces in New York City support a wide variety of common and rare native species as well as serving to treat stormwater, cool the air, and provide respite to people. The *Biodiversity Assessment Handbook for New York City*, loosely modeled on Hudsonia's *Biodiversity Assessment Manual for the Hudson River Estuary Corridor*, will help planners and conservationists assess the importance of greenspaces for biodiversity and factor biological resources into management decisions. (Funded by New York City Environmental Fund. A collaboration with the American Museum of Natural History Center for Biodiversity and Conservation.)

AN OLD GROWTH FOREST 35 YEARS LATER

In 1976, Erik Kiviat studied the South Woods at Montgomery Place, the lowland forest with the largest trees of any in the Hudson Valley. In 2011, Eric Keeling and his Forest Ecology class at Bard College are working with Hudsonia to re-sample this forest and detect changes associated with hemlock mortality due to nonnative insects. As the co-dominant hemlocks die in South Woods, seedlings of other trees and forest floor herbs are taking advantage of the new openings in the forest. So far, most of the regeneration is of native plants. There are several escaped horticultural trees and shrubs, however, including the striking umbrella magnolia. We hope to see in the next several years how native and nonnative trees, shrubs, herbs, and vines create a new forest community.

BIODIVERSITY ASSESSMENT OF A SUBDIVISION SITE

During this past spring and summer, Hudsonia conducted a habitat assessment, vernal pool survey, breeding bird survey, and rare plant survey on a site proposed for residential development in the Hudson Highlands in Putnam County, New York. On the 240 acre site we found few nonnative plants, numerous bird species considered sensitive to land use change (including worm-eating warbler, northern waterthrush, and Louisiana waterthrush), intermittent woodland pools with wood frogs, spotted salamanders, and marbled salamanders, and substantial areas of ledge and talus (slide rock) habitats. We anticipate working with the developer, engineer, and municipal officials as environmental review proceeds. Biodiversity assessment is most useful at this early stage of planning when it is possible to design a development project around the natural features of the site.

HABITAT MAPPING

In Hudsonia's Habitat Mapping program our biologists identify ecologically significant habitats throughout large areas—typically whole towns or watersheds. In 2011 we are working on townwide projects in **Clinton** (Dutchess County) and **Woodstock** (Ulster County), and another project along the **Catskill Creek corridor** (Schoharie, Albany, and Greene counties); we temporarily suspended our habitat mapping work in the Town of **Dover** (Dutchess County) while we seek additional funding. These projects are developing original habitat information to assist with local education and conservation of habitats and water resources. Since 2001 we have mapped significant habitats on over 400 square miles in the Hudson Valley, and prepared reports describing our findings and their relevance to regional biodiversity and conservation.

BIODIVERSITY EDUCATION

We believe that those with the greatest influence on the natural landscapes in the region are members of municipal planning boards, town boards, conservation commissions, and the staffs of land trusts. These are the people establishing regulatory policy and procedures, conducting environmental reviews, issuing land use approvals, designing and monitoring conservation easements and, in some cases, acquiring conservation lands. But most such work is accomplished without good information about the biological resources that might be affected by those decisions. Hudsonia's Biodiversity Education program is especially designed to equip local decision-makers with information and skills that will help them regularly incorporate biodiversity conservation into their important work.

In 2011 Hudsonia conducted two sessions of the three-day **Biodiversity Assessment Short Course** that we offer to municipal agencies, land trusts, and others who are regularly engaged in land use planning and decision-making. The courses were attended by participants representing 13 municipalities and four land trusts, as well as state and county agencies. Funding from the Hudson River Estuary Program (of NYSDEC) has enabled us to provide the courses at negligible cost to attendees, and to provide additional **technical assistance** to municipal agencies and conservation NGOs who have participated in Hudsonia's Biodiversity Education or Habitat Mapping programs. This year we have provided such assistance to

Learning field techniques in the Biodiversity Assessment Short Course.
Photo © Lan Tran

eight towns in Columbia, Dutchess, and Westchester counties, and will be expanding the program to other towns and NGOs over the next several months. This year we also published (online) a series of ***Plant Indicator Guides*** with simple descriptions and photographs of plant species that will help users identify certain habitats worthy of conservation. These *Guides* and our ***Habitat Fact Sheets*** are available on Hudsonia's website (hudsonia.org/programs/biodiversity-resources-center).

To promote better recognition, management, and protection of important natural resources, we collaborated with the Columbia Land Conservancy and the Hudson River Estuary Program in a meeting to encourage the establishment of **Conservation Advisory Councils** in towns of Greene and Columbia counties. Over 40 participants representing 17 municipalities met to discuss local conservation issues, to learn about the experiences and accomplishments of existing CACs, and discuss obstacles and approaches to establishing CACs in their own communities.

(Major funding for the Habitat Mapping and Biodiversity Education programs, and other programs of the Biodiversity Resources Center in 2011 has been provided by the Educational Foundation of America, the Hudson River Estuary Program [of NYSDEC], the Town of Clinton, the Millbrook Tribute Garden [through the Dutchess Land Conservancy], the Ashokan Watershed Stream Management Program, the Catskill Watershed Corporation, and the NYSDEC Division of Water [all three through the Town of Woodstock].)

HABITAT CONNECTIONS: EMERGING ISSUES AND IDEAS

After 30 years of biodiversity assessments at development sites and parks, habitat mapping of towns, detailed studies of rare species and their landscapes, and lots of other natural history and applied ecology research, we are integrating Hudsonia's data and ideas to address the big picture of land use, climate change, and other impacts on biodiversity. We call this new initiative **HABITAT CONNECTIONS**. Some of the projects discussed in this issue of *News from Hudsonia* operate under the HABITAT CONNECTIONS aegis, among them the analysis of gas drilling impacts on wildlife and plants, the study of change in the old-growth forest, and the surveys of nonnative flora at disturbed habitats.

HABITAT CONNECTIONS gives us the opportunity to get even more out of the results of past and ongoing studies. For example, we have completed habitat maps town-by-town for half of Dutchess County and portions of Ulster and Orange counties. Town planners and citizens are using these maps and the associated reports to factor the conservation of habitats and species into local planning and land use decision-making. Now we are learning how to use the more than 400 square miles of habitat mapping to answer larger questions about how wildlife and plants move around the landscape as human activities and natural disturbances change habitats. This will allow us to work with municipal agencies, NGOs, and landowners to protect, create, or restore habitats, and the links between habitats that will help native biological communities survive rapid environmental change.

Important to protecting biodiversity is understanding how it got to be what it is today. This includes the decline or loss of species and habitats, as well as the arrival of new species (native or nonnative) and the creation of new habitats. No one has a "crystal ball" for understanding the past, but we can analyze existing data for insight into past conditions and ongoing changes of species or habitats. The study of the effects of hemlock decline in an old-growth forest (see page 6) is one such use of old data. Our studies 10 to 40 years ago of goldenclub (a rare plant along 60 miles of the Hudson River), an unusual population of painted turtles in a freshwater tidal marsh, the flora of an old farm and of a bog lake, and vegetation in 25 fen wetlands, for example, will enable us to compare current with past conditions. Furthermore, our 15-year data sets on the Threatened Blanding's turtle and its environment in central Dutchess County continue to yield insights into turtle responses to habitat restoration, weather, and land use change. The Blanding's turtle study has taught us that this species (and certain other turtles) needs diverse wetland and upland habitats to satisfy its needs in wet years and dry years; as climate change alters temperature and precipitation, turtles may need even larger landscapes in which to find appropriate foraging and nesting sites.

We're excited to embark on this new initiative, and to see our completed projects reincarnated to address new questions.

RECENT PUBLICATIONS

Dowling, Z., T. Hartwig, E. Kiviat and F. Keesing. 2010. Experimental management of nesting habitat for the Blanding's turtle (*Emys blandingii*). Ecological Restoration. 28(2):154-159.

Kiviat, E. 2009. Human uses of tidal freshwater wetlands on the USA East Coast. P. 21-30 in A. Barendregt, D. Whigham and A. Baldwin, eds. Tidal Freshwater Wetlands. Backhuys Publishers, Leiden, The Netherlands.

Kiviat, E. 2009. Invasive plants in tidal freshwater wetlands - North American East Coast. P. 106-114 in A. Barendregt, D. Whigham and A. Baldwin, eds. Tidal Freshwater Wetlands. Backhuys Publishers, Leiden, The Netherlands.

Kiviat, E. 2011. Frog call surveys in an urban wetland complex, the Hackensack Meadowlands, New Jersey, 2006. Urban Habitats 6 (unpaginated). Available at: urbanhabitats.org.

Kiviat, E., G. Mihocko, G. Stevens, P.M. Groffman & D. Van Hoewyk. 2011. Vegetation, soils, and land use in fens of eastern New York and adjacent Connecticut. Rhodora 112(952): 335-354.

Swarth, C. and E. Kiviat. 2009. Animal communities in North American tidal freshwater wetlands. P. 71-88 in A. Barendregt, D. Whigham and A. Baldwin, eds. Tidal Freshwater Wetlands. Backhuys Publishers, Leiden, The Netherlands.

Tabak, N.M. 2011. *Salvia glutinosa* (Lamiaceae) naturalized in southeastern New York. Rhodora 113(954):220-224.

Fracking continued from page 3

sediment from soil erosion, increased runoff from impervious surfaces, and spills and leaks of fracking chemicals would cause cumulative impacts on streams or wetlands.

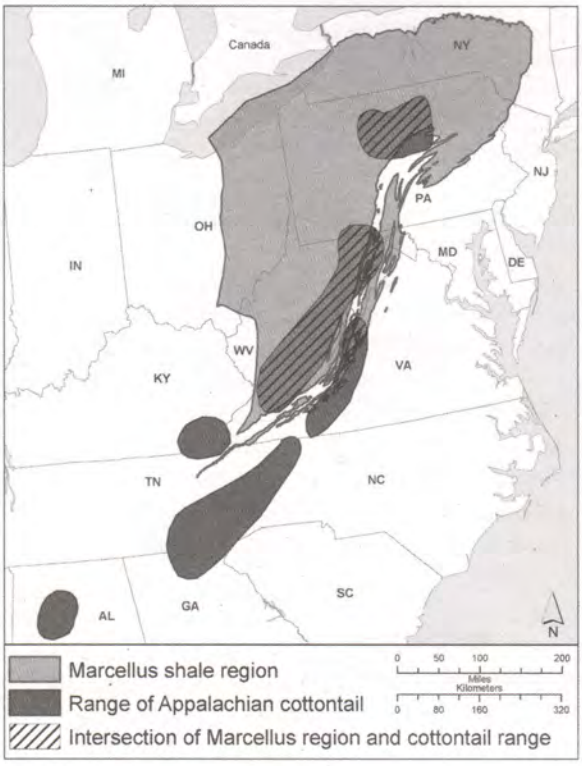
IMPLICATIONS FOR THE BIOTA

Streams would be among the habitats most vulnerable to the impacts of HVHHF, putting many rare, endangered, and "resource species" that depend on streams with good water quality at risk. Resource species include those organisms that people use directly for food or other purposes. Trout fishing, for example, is a widespread and economically important form of recreation on the Allegheny Plateau. Trout, and the native **brook trout** in particular, require high quality streams with cool water, high dissolved oxygen levels, adequate flow even in droughts, areas of suitable gravelly substrate for spawning, and otherwise good water quality. Removal of forest cover for drilling installations and their infrastructure would raise stream water temperatures. Higher temperatures and any additions of sediment from disturbed soils would reduce dissolved oxygen and degrade spawning habitats. Salt from frack water would kill many of the **freshwater aquatic insects** of the trout diet.

Other rare species would also be threatened by the degradation of stream quality associated with HVHHF development. The **eastern hellbender** (*Cryptobranchus allegheniensis*) is North America's largest aquatic salamander. In New York, it occurs only in the Marcellus region, in the Susquehanna and Allegheny river systems.[17] This species evidently requires high levels of dissolved oxygen and is believed to be vulnerable to habitat degradation from siltation. In New York, four species of darters (small fishes in the family Percidae) are apparently confined to the Marcellus region: the **bluebreast darter** (*Etheostoma camurum*), **spotted darter** (*E. maculatum*), **banded darter** (*E. zonale*), and **variegate darter** (*E. variatum*).[21] These are all species of flowing streams where they are likely to be sensitive to pollution by salt and sediment. **Freshwater mussels** (many species) are among the most endangered of American wildlife.[22] Many of these animals are also among the most sensitive to water quality and hydrological conditions, and they can be affected by salinization, sediment inputs, and reduction of flows during dry periods. Portions of several major river systems in the Marcellus region support important populations of rare freshwater mussels. **Riverweed** (*Podostemum ceratophyllum*), a Threatened species in New York, is a small plant that grows on rocks in running water of good quality.[15] Four of the seven New York counties in which it occurs[24] are partly or entirely in the Marcellus region. A preliminary study of stream chemistry and wildlife in Pennsylvania revealed elevated water conductivity and fewer species of salamanders and sensitive aquatic insects in small watersheds with HVHHF installations compared to watersheds without HVHHF installations.[2] As yet, because information on fracking chemicals is essentially limited to a list, it is hard to predict toxicological impacts of HVHHF on wildlife. A few species that are particularly sensitive to toxic contaminants may be assumed to be in danger, including **American mink**, **river otter**, **common muskrat**, **great blue heron**, **osprey**, and **bald eagle**.

Organisms that are restricted to the Marcellus region, or substantially so, will be under a higher level of threat from HVHHF. **Wehrle's salamander** (*Plethodon wehrlei*) has most of its global range in the Marcellus region. The endangered **Chittenango ambersnail** (*Novisuccinea chittenangoensis*) is apparently limited to a single locality in New York.[14] This locality may be over the Marcellus shale or subject to downstream impacts from gas drilling in the Marcellus. The **West Virginia white** (*Pieris virginiensis*) in New York occurs only in the Marcellus region. This butterfly lives in forests in and near wet areas, and is not readily able to cross nonforested areas.[16] The federally listed plant **monk's-hood** (*Aconitum noveboracense*) in New York occurs primarily in the Marcellus region.

Bats, snakes, frogs, salamanders, land snails (exclusive of slugs), freshwater mussels, crayfish, aquatic insects, xystodesmid millipedes, submergent aquatic plants, orchids, true sedges (*Carex*), fern allies, stoneworts, liverworts, and peat mosses (*Sphagnum*), as well as the fauna of freshwater streams, may be especially vulnerable to HVHHF. These are some of the taxonomic groups found to be absent or low in diversity at a heavily urbanized and industrialized site, the New Jersey Meadowlands.[8,9,10,11] Many of the impacts to the Meadowlands environment, including deforestation,



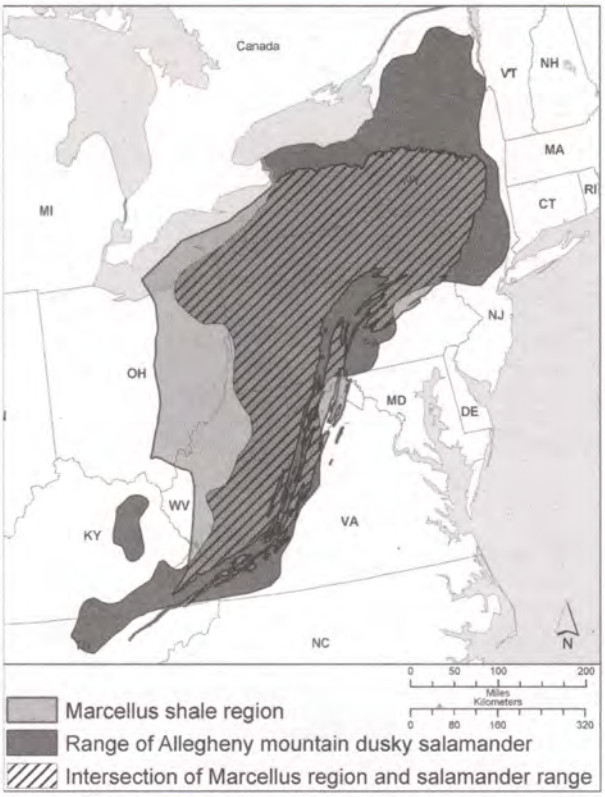
The Appalachian cottontail (*Sylvilagus obscurus*) is an atypical small rabbit that lives in high elevation forests and eats conifer needles. This animal was only recently recognized as a species distinct from the more northeasterly New England cottontail of shrublands east of the Hudson River.
Photo © Carly Lesser & Art Drauglis

industrialization, fragmentation of the landscape, hydrological alteration, salinization, and chemical contamination, are analogous to those predicted to occur around HVHHF installations.

Although there might be an occasional rare native plant or animal—e.g., **Schweinitz flatsedge** (*Cyperus schweinitzii*)—that is able to exploit the industrial environment around an HVHHF installation, we think the noise, night lighting, activity of people and machines, salt, and toxic contamination would inhibit most uncommon or rare native species. The result, as is often the case in intensely industrial habitats, would be an assemblage of mostly common nonnative and native species. The compacted or eroded soils around new roads, drilling pads, and pipelines would be good environments for the establishment of weedy native plants, and nonnative plants such as **common reed** (*Phragmites australis* ssp. *australis*), **Japanese knotweed** (*Fallopia japonica*), and **stiltgrass** (*Microstegium vimineum*). Salinized soils around HVHHF installations would inhibit the growth of many typical native plants, and allow more competitive salt-tolerant species such as common reed to thrive. Warming and pollution of streams and other waterbodies by sediment, frack water, and removal of forest cover may well create more favorable conditions for nonnative fishes such as **common carp**, **green sunfish**, **snakehead**, and **weatherfish**. The common propensity of nonnative plants and animals to spread from intensely disturbed habitats into more natural habitats is cause for serious concern.

The Environmental Impact Statement on hydrofracking[18] called for construction equipment and vehicles to be pressure-washed with hot water prior to delivery to sites where HVHHF wells are to be established, with the goal of preventing the arrival of nonnative species at the sites. However, HVHHF installations will host a steady stream of vehicles and equipment after well establishment and, in addition, nonnative plants can disperse along roads, pipelines, and electric rights-of-way without the help of trucks. In 2011, for example, we found many nonnative plants at sites of recent intensive disturbance, such as surface mines and logging areas, in the Catskill Mountain region.[12] Some of the less-common species that have not yet spread widely seem to be dispersing from disturbance to disturbance via roadways, heavy equipment, or vehicles, and we think that HVHHF installations would be effective "incubators" for incipient populations of some of these plants.

The Allegheny mountain salamander (mountain dusky salamander. *Desmognathus ochrophaeus*) inhabits stream margins and riparian seeps. It superficially resembles the northern dusky salamander and both are sensitive to hydrological and chemical changes in their streamside habitats.
Photo © John MacGregor



CONCLUSIONS

HVHHF as it is currently occurring in Pennsylvania is a very large scale and intensive industrial activity and land use with potentially severe impacts on wildlife and plants. In the Marcellus region, where natural gas resources are being intensively exploited by HVHHF, the impacts could be as great as those of the historic deforestation of the eastern states that took place in the 1700s and early 1800s.

Some of the impacts of HVHHF on biological resources can potentially be reduced or mitigated. Siting installations in already-altered areas rather than high quality habitats; reducing the width, length, and numbers of access roads and pipelines and the size of well pads; redesigning the chemical constituents of fracking fluids to use less toxic materials; treating some of the contaminants in wastewater; and strengthening legislative and regulatory controls on acceptable levels of contamination would all lessen impacts. The Environmental Impact Statement[18] proposes some steps in that direction. It is unclear, however, what level of environmental review each permit application for an individual well site will receive, and whether wetlands, streams, and rare species will be accorded appropriate consideration. Nonetheless, HVHHF is an activity that at best is very likely to have severe impacts on biological resources in the Marcellus region. In practical terms, HVHHF impacts are unlikely to be effectively controlled for financial, political, and regulatory reasons. The proposed additions to NYSDEC staff will help but in reality someone would probably have to monitor each HVHHF installation 24 hours per day to acceptably reduce the risk of spills, leaks, and other violations. One of the most important impacts, fragmentation of extensive forest habitats, may be impossible to control because HVHHF is by necessity a highly dispersed activity. Another very important impact, salinization from salt in frack waters, will be expensive and challenging to avoid, and drilling companies will probably not want to pay for this.

Our observations during many years in the Marcellus region, and our review of information on both shallow drilling and HVHHF in the Marcellus region and elsewhere, indicate strongly that many elements of biodiversity

Continued on page 10

Fracking continued from page 9

would be vulnerable to the impacts of HVHHF. These biological resources include not only economically important animals and plants such as trout, and a long list of other species of conservation concern, but also habitats including forests and wetlands that play crucial roles in maintenance of water quality and many other environmental services provided essentially free to human society. Avoiding or mitigating serious impacts to biodiversity and environmental services may cost more than industry, governments, and the public are willing to pay. ■

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REFERENCES CITED

1. Adams, M.B., P.J.Edwards, M.W.Ford et.al. 2011. Effects of development of a natural gas well and associated pipeline on the natural and scientific resources of the Fernow Experimental Forest. General Technical Report NRS-76. U.S. Department of Agriculture, Forest Service, Northern Research Station, Newtown Square, Pennsylvania. 24 p.
2. Anonymous. 2010. Academy of Natural Sciences: Marcellus shale needs scientific study to set guidelines. PA Environmental Digest (18 October 2010). Available at: http://www.paenvironmentdigest.com/newsletter/default.asp?NewsletterArticleID=17078 (viewed September 2011).
3. Armendariz, A. 2009. Emissions from natural gas production in the Barnett Shale area and opportunities for cost-effective improvements. Report to Environmental Defense Fund, Austin, Texas. Southern Methodist University, Dallas, Texas. 43 p. Available at: www.edf.org/documents/9235_Barnett_Shale_Report.pdf (viewed September 2011).
4. Bayne, E.M. & B.C. Dale. 2011. Effects of energy development on songbirds. P. 95-114 in D.E. Naugle, ed. Energy Development and Wildlife Conservation in Western North America. Island Press, Washington, DC.
5. Gagnon, D. 1999. An analysis of the sustainability of American Ginseng harvesting from the wild: The problem and possible solutions: Final report to the Office of Scientific Authority of the US Fish and Wildlife Service. Not paginated. Available at: http://www.nps.gov/plants/medicinal/pubs/ginseng.htm (viewed October 2011).
6. Helman, C. 2011. Chesapeake energy suffers gas well blowout on anniversary of BP spill. Forbes. Available at: www.forbes.com (viewed September 2011).
7. Johnson, N. 2010. Pennsylvania energy impacts assessment: Report 1: Marcellus shale natural gas and wind. Nature Conservancy – Pennsylvania Chapter. Available at: http://www.nature.org/media/pa/pa_energy_assessment_report.pdf (viewed September 2011).
8. Kiviat, E. & K. MacDonald. 2002. Hackensack Meadowlands, New Jersey, biodiversity: A review and synthesis. Hackensack Meadowlands Partnership. 112 p. Available at: www.hudsonia.org.
9. Kiviat, E. & K. MacDonald. 2004. Biodiversity patterns and conservation in the Hackensack Meadowlands, NJ. Urban Habitats 2(1):28-61. Available at: http://urbanhabitats.org/v02n01/biodiversitypatterns_pdf.pdf (viewed October 2011).
10. Kiviat, E. & K. MacDonald-Beyers. In press. Urban biodiversity in the New Jersey Meadowlands. Rutgers University Press, Parsippany, Parsipanny, NJ.
11. Kiviat, E. 2011. Frog call surveys in an urban wetland complex, the Hackensack Meadowlands, New Jersey. Urban Habitats 6. Available at: http://urbanhabitats.org/v06n01/frogcallsurveys_full.html (viewed October 2011).
12. Kiviat et al. Unpublished data.
13. Michaels, C., J. Simpson & W. Wegner. 2010. Fractured communities: Case studies of the environmental impacts of industrial gas drilling. Riverkeeper. Ossining, New York. 39 p.
14. NatureServe. 2010. NatureServe Explorer. Available at: http://www.natureserve.org/explorer/ (viewed 19 April 2011).
15. NYNHP (New York Natural Heritage Program). 2009a. Online conservation guide for *Podostemum ceratophyllum*. Available at: http://acris.nynhp.org/guide.php?id=9250. acris.nynhp.org/guide.php?id=9250 (viewed October 2011).
16. NYNHP (New York Natural Heritage Program). 2009b. Online conservation guide for *Pieris virginiensis*. Available at: http://acris.nynhp.org/guide.php?id=7830 (viewed October 2011).
17. NYSDEC (New York State Department of Environmental Conservation). No date. Eastern hellbender fact sheet. New York State Department of Environmental Conservation. Available at: http://www.dec.ny.gov/animals/7160.html (viewed October 2011).
18. NYSDEC. 2011. Revised Draft SGEIS on the Oil, Gas and Solution Mining Regulatory Program (September 2011): Well permit issuance for horizontal drilling and high-volume hydraulic fracturing in the Marcellus shale and other low-permeability gas reservoirs. Available at: http://www.dec.ny.gov/energy/75370.html (viewed October 2011).
19. NYSDEC. [2010?] New York State oil, gas and mineral resources 2009. New York State Department of Environmental Conservation Division of Mineral Resources. 42 p. + appendices. Available at: http://www.dec.ny.gov/docs/materials_minerals_pdf/09anrpt1.pdf (viewed October 2011).
20. Rich, C. & T. Longcore, eds. 2006. Ecological consequences of artificial night lighting. Island Press, Covelo, CA.
21. Smith, C.L. 1985. The inland fishes of New York State. New York State Department of Environmental Conservation, Albany. 522 p.
22. Stein, B.A., L.S. Kutner & J.S. Adams. 2000. Precious heritage: The status of biodiversity in the United States. Oxford University Press, Oxford, U.K. 399 p.
23. U.S. House of Representatives Committee on Energy and Commerce Minority Staff. 2011. Chemicals used in hydraulic fracturing. 30 p. Available at: http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf (viewed October 2011).
24. Weldy, T. & D. Werier. 2011. New York flora atlas. New York Flora Association, Albany. Available at: http://www.newyork.plantatlas.usf.edu/ (viewed October 2011).

JOAN EHRENFELD

Gone too soon

Joan Ehrenfeld, a professor of ecology at Rutgers University for many years, and a member of Hudsonia's Advisory Board, died in June 2011. She and her students conducted research across New Jersey, from the Pine Barrens to the Highlands to the Meadowlands. I had been in touch with her husband David from time to time due to a mutual interest in turtles, but did not work with Joan until 2001 when she provided very helpful comments on a draft of the long first paper about Meadowlands biodiversity that I wrote with colleague and then Rutgers graduate student Kristi MacDonald-Beyers. I discovered that Joan's interests and expertise were as wide-ranging as our attempt to treat the subject comprehensively. She was a pioneer in the study of urban wetlands, and had strong research interests in non-native plants, vegetation ecology, and biogeochemistry. I always enjoyed a conversation with her and I deeply regret there will be no more such discussions. Hudsonia has lost a good advisor and supporter, and the world of conservation science has lost a keen practitioner.

—Erik Kiviat

Donations in Joan's memory may be made to the New York – New Jersey Trail Conference (www.nynjtc.org/donatenow).

NOTICE

Earlier this year we closed our Red Hook office and consolidated our work space at the Bard College Ecology Field Station, our base of operations since 1984. Hudsonia has shared the Field Station with Bard students and faculty, and the Hudson River National Estuarine Research Reserve, since 1984, and was instrumental in raising funds for facilities expansion at that time. This arrangement has enabled many productive collaborations. The Field Station supports research and education in the field sciences and other environmental fields. For the time being, mail sent to the Red Hook office (PO Box 66) is forwarded to our current address (PO Box 5000, Annandale, NY 12504), but we will be phasing out the old address over the next few months. Our longtime phone number, 845-758-7053, can be used to reach all Hudsonia staff.

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SPECIAL THANKS

Stacey Adams, **Jim Glomb**, and **David Lewis** for helping move Hudsonia's office.

Maribel Pregnall, Marshall Pregnall, and their students and colleagues at Arlington High School and Vassar College for monitoring Blanding's turtles and their environment at our long-term research site.

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Mark Peritz, Kevin Smith, and **John Winter** for help with contacting Woodstock landowners for the habitat mapping project.

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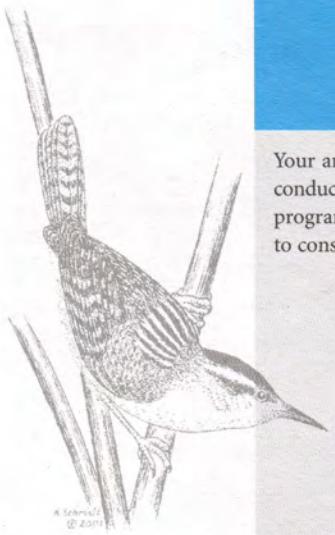

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