City of Bloomington Common Council

Legislative Packet

26 March 2014

Regular Session

For material regarding Ordinance 14-03, please consult the
05 March 2014 Legislative Packet.
All other background material and legislation contained herein.

Office of the Common Council
P.O. Box 100
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City of Bloomington Indiana

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401 N. Morton St.
Post Office Box 100
Bloomington, Indiana 47402

Office of the Common Council
(812) 349-3409
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To: **Council Members**
From: **Council Office**
Re: **Weekly Packet Memo**
Date: **March 21, 2014**

Packet Related Material

Memo
Agenda
Calendar
Notices and Agendas:

- **Council Special Committee on Boards and Commissions** will meet on Wednesday, 26 March 2014 at 6:15 p.m. in the Council Library (Rm 110, City Hall)

Legislation for Second Reading:

- **Res 14-05** Waiving Current Payments in Lieu of Taxes by the Bloomington Housing Authority to the City
  - Memo from Lisa Abbott, Director of the Housing and Neighborhood Development (HAND) Department;
  - Payment in Lieu of Taxation (PILOT) Calculations

    Contact:
    Lisa Abbott at 349-3401 or abbottl@bloomington.in.gov
    Jennifer Osterholt at 339-3491 ext 122 or josterholt@blha.net

- **Res 14-04** To Approve an *Amended* Interlocal Cooperation Agreement Between the City of Bloomington and Monroe County, Indiana in Regard to the 2012 Edward Byrne Memorial Justice Assistance Grant (JAG)
  - Memo to Council from Patty Mulvihill, Assistant City Attorney;
  - Amended Interlocal Cooperation Agreement Regarding Use of the 2012 JAG Funds;

    Contact: Patty Mulvihill at 349-3426, mulvihip@bloomington.in.gov

- **Ord 14-03** To Rezone a 6.96 Acre Property from Residential Core (RC) to a Planned Unit Development to be Known as the B-Line Neighborhood and Approve a Preliminary Plan and District Ordinance - Re: 901 W. Cottage Grove Avenue (Habitat for Humanity of Monroe County, Petitioner)
    - **RC 01** (Rollo, Sponsor) – Re: Augmenting the Tree Preservation and Planting Plans – (Attached)
    - **RC 02** (Volan, Sponsor) – Re: Improving bike and pedestrian accessibility to the site – (In discussion)
    - **RC 03** (Sturbaum, Sponsor – Re: Requiring fiber cement instead of a vinyl surface to these homes – (Forthcoming)

  Contact: Pat Shay at 349-3524 or shayp@bloomington.in.gov

  Please see the Council Legislative Packet prepared for the 5 March 2014 Regular Session and Committee of the Whole for the legislation, summary, and related materials.

Legislation and Background Material for First Reading:

- ***Insert* Ord 14-04**

Ord 14-04 To Amend Title 14 of the Bloomington Muncipal Code Entitled "Peace and Safety" - Re: Amending Chapter 14.20 (Firearms – Deadly Weapons) to Allow for the Discharge of Firearms at the Griffy Lake Nature Preserve for the Purpose of Deer Reduction via Sharpshooting

- Memo from Sponsor; Map of Griffy Lake Nature Preserve; "Effects of abundant white-tailed deer on vegetation, animals, mycorrhizal fungi, and soils," Shelton, et al.; Letter from members of the City of Bloomington Board of Park Commissioners; Letter from City of Bloomington Parks and Recreation's Environmental Resources Advisory Council; Letter from the City of Bloomington Commission on Sustainability; Letter from Monroe County's Identify and Reduce Invasive Species; Letter from members of the Indiana University Department of Biology; and Letter from members of the Indiana University, Integrated Program in the Environment (SPEA).

Contact: Dave Rollo at 339-7916 or rollod@bloomington.in.gov
Andy Ruff at 349.3409 or ruffa@bloomington.in.gov

Minutes from Regular Session:

None

Memo

One Ordinance and Two Resolutions Ready for Action and One Ordinance Ready for Introduction at the Regular Session on Wednesday, March 26th:

There are three items under *Second Readings and Resolutions* and one ordinance under *First Readings* at the Regular Session on Wednesday, March 26th. The former three items include two resolutions that are included in this material and summarized below, and an ordinance that can be found as indicated above. Please note that there are three Reasonable Conditions associated with the ordinance ready for action mentioned below along with a question whether the Council wants to limit public comment of that item. The one ordinance to be introduced next week is included in this packet and summarized below.

Council Schedule – Possible Motions Regardng Upcoming Meetings for Your Consideration

The Annual Schedule avoided meeting over Spring Break by holding a Regular Session and Committee of the Whole on March 26th and then holding a Regular Session on April 2nd. In order to provide a typical three-Wednesday legislative cycle for **Ord 14-04** (Regarding Griffy) and make room for the next legislative cycle, the Council may want to consider some changes to the schedule. The following offer some ideas for those changes which, in some cases, would require motions next week:

- Cancel the Committee of the Whole on March 26th (next week) or reschedule it to April 2nd [1]; and
- either:
  - Cancel the Regular Session on April 2nd and hold a Special Session on April 9th; or
  - Reschedule the Regular Session from April 2nd to April 9th; and
- either:
  - Cancel the Committee of the Whole on April 9th; or

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[1] This is an odd occasion where, due to lack of business, you will need to cancel or reschedule the Committee of the Whole on March 26th earlier on the same evening that it is scheduled to be held. This could have been avoided had I raised this issue at the Special Session on March 12th.

- Reschedule that Committee to another night later the following week (perhaps, Thursday, April 17th).

Second Readings and Resolutions

Item One – Res 14-05 - Waiving Payments in Lieu of Taxation (PILOT) from the Bloomington Housing Authority to the City

Res 14-05 is the first of three items under *Second Readings and Resolutions* at the Regular Session next Wednesday. It is an annual resolution requested by the Bloomington Housing Authority which waives any payment in lieu of taxes (PILOT) we might require of them. I.C. 36-7-18-25 exempts housing authorities from the payment of property taxes, but allows these authorities to enter into agreements with political subdivisions to pay a PILOT for the estimated cost of services, improvements, and facilities that are provided by the political subdivisions. In the early 1960s, the Housing Authority agreed to pay the City a PILOT. After acknowledging the services performed by the Housing Authority that might have been provided by the City, and acknowledging the benefits we received from its other services, the resolution waives this obligation.

Lisa Abbott, Director of the Housing and Neighborhood Development (HAND) Department has submitted a memo explaining the history of the PILOT obligation. She has also submitted a payment calculation sheet provided by the Bloomington Housing Authority, which is a Housing and Urban Development (HUD) form used to estimate the $29,183 that they would otherwise pay the City for services received during the fiscal year ending September 30, 2013. Abbott and a representative from the Bloomington Housing Authority will be present on Wednesday to explain the resolution.

Item Two - (Res 14-04) – Approving an Amended Interlocal Cooperation Agreement with the County Regarding Use of 2012 Edward Byrne Memorial Justice Assistance Grant (JAG) Funds

The second item under *Second Readings and Resolutions* is **Res 14-04**. It authorizes the execution of an amended Interlocal Cooperation Agreement with the County regarding the disbursal of Edward Byrne Memorial Justice Assistance Grant (JAG) funds for 2012. The amendment, in particular, allows some of those monies to be used to purchase digital signage rather than to purchase a secure server to connect with a national criminal data exchange.

Before explaining the amendment, I thought it might be helpful to remind the Council of what these grants have purchased in the past. In brief, these grants have gone to the City Police Department and County Sheriff's Department and helped acquire: an NC4 *Street Smart* computer program, eDesk kiosks, a telephone system, digital interviewing equipment, polygraph equipment (and training for staff on its use), in-car cameras, vehicle locator equipment and software, and special vehicles.

In 2012, the parties agreed that the City would spend $10,936 to purchase two eDesk Kiosks to be placed in the Bloomington Police Department and the atrium of City Hall. Another $5,199 was to purchase a secure server for use by both the City and County departments. This server would connect to the Law Enforcement National Data Exchange (N-Dex) and help officers identify persons of interest and access their criminal histories.

Rather than purchase the N-Dex server, which was not deemed necessary, the grant administrator advised that the money could be used to purchase digital signage. According to Patty Mulvihill, Assistant City Attorney, this would mostly likely be in the form of televisions placed around the department and in the training room, and provide what "can best be categorized as a continuous and non-stop roll call—advising officers on a constant basis of current crimes, individuals of interest, mug shots, etc..."

<u>General Terms in Both Agreements</u>

As a requirement for an award, the City and the County must enter into an Agreement which is attached to the resolution. In brief, the Agreement:

- "reflects the commitments and understandings … of the governmental entities in order to efficiently and effectively utilize proceeds" from the award;
- allocates the grant between the two entities to be used as stated above;
- makes each party solely responsible for their own actions in furnishing services under this agreement;
- requires each party to communicate and cooperate with each other and to make good-faith efforts to obtain all necessary funds and otherwise comply with the Agreement;
- conditions performance of the duties under the Agreement on the receipt of sufficient JAG funds; and,
- is to be narrowly construed in regard to the obligations of the parties and does not create rights for persons who have not signed it.

Item Three – Ord 14-03 (Habitat PUD) - Deliberations - Reasonable Conditions

Ord 14-03 (Approving PUD for Habitat Project at 901 West Cottage Grove) is the third item on the agenda under *Second Readings and Resolutions* next Wednesday night. That evening, Council will be entering the third night and seventh hour of deliberations on this item. Please note that three Reasonable Conditions (akin to amendments) regarding this proposal are in process and are briefly mentioned below.

Given the time already spent on this item and the number of amendments likely to be considered, the Council may want to consider limiting discussion or public comment on this legislation Wednesday night. When doing so in the past, the Council has typically limited the public comment by offering only one opportunity for the public to speak on relevant motions for no more than a certain period of time. That period has varied from a low of two minutes and a high of five minutes. Please feel free to contact the Council Office or Council President regarding your preferences on limiting debate.

There are three Reasonable Conditions that may come forward Wednesday night. The following points enumerate them and their current status:

- **RC 01** (Rollo, Sponsor) – Re: Augmenting the Tree Preservation and Planting Plans – Status: Introduced and withdrawn at Special Session on March 26th (Attached);
- **RC 02** (Volan, Sponsor) – Re: Improving bicycle and pedestrian access to the site – Status: Councilmember Volan met with representatives of the petitioner as well as staff on Thursday afternoon and should hear back from the petitioner on Monday or Tuesday of next week;
- **RC 03** (Sturbaum, Sponsor) – Re: Requiring fiber cement instead of a vinyl siding on these homes – Status: Councilmember Sturbaum has communicated with Kerry Thomson, who estimated the additional cost at about $1,000 per home (plus the added maintenance for home owners). It's my understanding that she wanted to account for the costs associated with *all* of the changes proposed by members of the Council and discuss the matter with her board before responding to this proposed condition.

First Readings

Ord 14-04 - Amending Title 14 to Allow for Sharpshooting at the Griffy Lake Preserve for the purpose of deer reduction via sharpshooting

Please note that, subject to motions by the Council, Ord 14-04 is scheduled for First Reading on 26 March, for Committee of the Whole Discussion on 02 April and for Second Reading on 09 April.

Ordinance 14-04 is sponsored by Councilmembers Rollo and Ruff. The ordinance amends the Bloomington Municipal Code (BMC) by adding an exception to the general prohibition against the discharge of firearms within the City limits. The addition excepts contractors of the City of Bloomington Board of Park Commissioners hired for the purpose of deer reduction via sharpshooting at the Griffy Lake Nature Preserve. This proposal comes as a response to documented ecosystem damage caused by deer overabundance and a request by members of the City's Board of Park Commissioners to implement measures to address deer overabundance at Griffy. This ordinance provides the Park Commissioners and staff an additional tool they need to manage Griffy.

Management of deer at Griffy via sharpshooting requires approval by three public entities. First, the effort requires enabling legislation from the Council providing for an exception to the general prohibition against the discharge of a firearm in City limits. If the Council makes such an exception, the Board of Park Commissioners must approve the effort. If approved, Parks staff would have to apply for a Special Purpose permit and the Indiana Department of Natural Resources (IDNR) would have to approve such permit. Issuance of a permit is based on satisfaction of a number of criteria.

The IDNR exercises exclusive jurisdiction over the State's wildlife, including deer. Any proposal to care for, manage or otherwise regulate deer on public or private property must first be approved by IDNR. Sharpshooting is defined in IDNRs' "Policies and Procedures for Division of Fish and Wildlife" as follows:

> Sharp shooting is a wildlife management technique used in and adjacent to human populated areas which can be employed to address societal issues, such as safety and humaneness, while providing for the efficient removal of deer. Sharp shooting is an intensive method of deer removal by competent marksmen and should not be considered or mistaken for a form of hunting. IDNR, PO 66, *Human Conflicts with White-Tailed Deer*, C 2(b)(2) (April 26, 2012).

Sharpshooters use high-powered rifles and typically shoot from elevated stands. The use of elevated stands ensures that a shot is aimed at the ground and not toward buildings or elsewhere. Sharpshooting is usually conducted over bait during the winter months to maximize effectiveness. Sound-suppression devices are used. This keeps the practice quiet for neighbors, reduces the stress to deer and other animals, and increases the effectiveness of the reduction effort. This technique is administered by trained professionals and deer are shot in a manner to ensure instantaneous death. As documented in Ord 14-04, the use of an accurately-delivered gunshot has been determined to be humane euthanasia by the American Veterinary Medical Association.

The concern with deer damage to the Griffy ecosystem is not new. The 2008 City Griffy Lake Nature Preserve Master Plan stated that deer browsing and trampling were damaging the woods, particularly the Mesic Upland Forest and Floodplain Forest. The Plan called for further study and stated that it may be necessary to introduce deer population controls to reduce the number of deer. The City of Bloomington's Parks and Recreation's Environmental Resources Advisory Council (ERAC) has made concern with deer browsing at Griffy Woods a regular agenda item since 2009. In 2010, the Council and County Commissioners established a Joint City of Bloomington-Monroe County Deer Task Force. The group commenced its work in late 2010 and submitted its advisory report Common Ground: Toward Balance and Stewardship" to the Council in late 2012. (*See also*, FAQs issued subsequent to the Report.)

The Task Force documented the effect of an overabundant deer population on the Griffy ecosystem. Relying on deer exclosure research conducted by scientists at the IU Research and Teaching Preserve since 2005, the Report made clear that deer browsing is causing widespread negative ecosystem effects. These effects are recounted in Ord 14-04 and point out that deer herbivory is:

- Decreasing overall native vegetative diversity and density of both woody and herbaceous species;
- Severely compromising the regeneration of native trees. Since the study's inception, a significant number of native tree seedlings have been observed inside the deer exclosures; however, no native hardwood tree seedlings have been observed in control plots;
- Encouraging the growth of invasive species such as garlic mustard and Japanese stiltgrass and native plants unpalatable to deer, such as spicebush and pawpaw;
- Causing soil compaction, which reduces water infiltration and causes erosion; and

- Reducing habitat for terrestrial species such as the white-footed mouse -- a food source relied upon by other animals such as snakes, owls, hawks, skunks, foxes and coyotes;

The research upon which the Task Force relied was conducted by Dr. Angie Shelton and her team. Dr. Shelton's work will soon be published in the peer-reviewed journal *Forest Ecology and Management*. The article, "Effects of abundant white-tailed deer on vegetation, animals, mycorrhizal fungi, and soils," as it will appear in the journal, is included in this packet.

The ordinance tracks many of the points made by the Task Force, including that deer have significant reproductive capacity and that overbrowsing poses the risk of producing an "alternate stable state" – a condition in which a forest would never return to its natural state, even if browsing pressure were diminished by a permanent reduction in deer densities. The Task Force pointed to the comparative successful experience of ecosystem restoration in Indiana State Parks through the implementation of hunting and, based on the advice of biologists, recommended that a substantial number of deer should be culled to restore the ecosystem. If a sizable number of deer are not culled, those that remain will browse new shoots and the effort would be ineffective for plant restoration. For that reason, the Task Force recommended that the deer herd at Griffy be reduced via sharpshooting. The group determined that this was the safest, most effective, and most humane method for controlling the deer population at Griffy. The Task Force recommended that any deer killed through this effort should be donated to the food bank.

As recounted above, the Bloomington Municipal Code prohibits the discharge of firearms anywhere within the City's corporate boundaries, with the exception of law enforcement and in self defense (BMC §14.20.020). This is a general prohibition to attaches to all areas within the City's corporate boundaries. A similar, more specific, prohibition is located in the chapter of local code governing Griffy Lake, BMC §11.08. This provision prohibits the use of firearms on Griffy Lake or any of the City-owned land surrounding it, but provides that "The board of park commissioners, at their discretion, may grant permission to engage in select activities for authorized management purposes." (BMC §11.08.040). As indicated in the letter included in this legislative packet, members of the Parks Board have requested that the Council act on the Deer Task Force recommendations and "take the necessary actions, that will allow the Parks Board and the Parks Department to move quickly" to protect Griffy. With Ord 14-04, Council sponsors are acting on one recommendation of the Task Force. This change to Code is required before the Parks Board may authorize any sharpshooting effort.

The Bloomington Municipal Code currently provides two exceptions to the general prohibition against the discharge of a firearem within City limits: an exception for any legally appointed officer in the discharge of his or her duty and any person acting in self-defense. Ord 14-04 adds a third exception. The exception is narrow and applies only to a contractor of the City of Bloomington Board of Park Commissioners hired for the purpose of deer reduction via sharpshooting at the Griffy Lake Nature Preserve, provided that the contractor takes action in accordance with:

- a currently valid contract executed by the contractor and the Board of Park Commissioners
- a currently valid IDNR permit for such action; and
- all applicable City of Bloomington laws and regulations; and
- all applicable State of Indiana laws and regulations; and

Significantly, the discharge of a firearm authorized under Ord 14-04 is limited *only* to areas within the boundaries of the Griffy Lake Nature Preserve as defined by §11.08.010(7) of the Bloomington Municipal Code. This provision of the Code defines the Griffy Lake Nature Preserve as "the land surrounding Griffy Lake owned by the city and managed by the board of park commissioners" (BMC §11.08.010). A map of the Preserve is included in this packet. Violations of this provision of the Code are subject the City's general penalty provisions found in BMC §1.01.130 (up to $2,500 per occurrence.)

This change does not allow for general public firearm hunting nor does it provide for private firearm hunting. This change is intended to address deer abundance at Griffy specifically; it is not intended to address the concerns expressed by some residents about deer in neighborhoods.

Should Council make this change to the Bloomington Municipal Code and should the Parks Board provide the necessary authorization, the City's Parks Department advises that it would work with an experienced, professional sharpshooter and that sharpshooting activity would occur no closer than approximately 100 yards from any residence. Please note that State law prohibits shooting from within, into, upon, or across a public highway (I.C. §14-22-6-9) and prohibits shooting into or across waters in pursuit of deer (I.C. §14-22-6-10).

Sharpshooting requires a special purpose permit from the IDNR. To obtain a permit, an applicant must submit a detailed plan to the IDNR that addresses: the history of the concern; authority to conduct the activity; goals; a review of alternatives, including the reasons the alternatives are not viable; and logistics (number of deer to be culled, when the activity will occur, who will conduct the activity, methodology, safety concerns, long-term management, public information, and lead contact).

Included in this packet please find letters on this subject from: members of the City Bloomington Board of Park Commissions, the City of Bloomington Parks and Recreation's Environmental Resources Advisory Council, The City of Bloomington Commission on Sustainability, Monroe County's Identify and Reduce Invasive Species, members of the Indiana University Department of Biology, and members of the Indiana University, Integrated Program in the Environment.(SPEA).

Happy Birthday Chris Sturbaum – March 27th

NOTICE AND AGENDA
BLOOMINGTON COMMON COUNCIL REGULAR SESSION
7:30 P.M., WEDNESDAY, MARCH 26, 2014
COUNCIL CHAMBERS
SHOWERS BUILDING, 401 N. MORTON ST.

REGULAR SESSION

I. ROLL CALL

II. AGENDA SUMMATION

III. APPROVAL OF MINUTES FOR: *None*

IV. REPORTS (A maximum of twenty minutes is set aside for each part of this section.)
1. **Councilmembers**
2. **The Mayor and City Offices**
3. **Council Committees**
4. **Public***

V. APPOINTMENTS TO BOARDS AND COMMISSIONS

VI. LEGISLATION FOR SECOND READING AND RESOLUTIONS

1. <u>Resolution 14-05</u> Waiving Current Payments in Lieu of Taxes By the Bloomington Housing Authority to the City

    Committee Recommendation: None *(not heard at Committee)*
    Asked to Attend: Lisa Abbott, Director of Housing and Neighborhood Development
    Jennifer Osterholt, Director of the Bloomington Housing Authority

2. <u>Resolution 14-04</u> To Approve an *Amended* Interlocal Cooperation Agreement between the City of Bloomington and Monroe County, Indiana in Regard to the 2012 Edward Byrne Memorial Justice Assistance Grant (Jag)

    Committee Recommendation: None *(not heard at Committee)*
    Asked to Attend: Patty Mulvihill, Assistant City Attorney

3. <u>Ordinance 14-03</u> To Rezone a 6.96 Acre Property from Residential Core (RC) to a Planned Unit Development to be Known as the B-Line Neighborhood and Approve a Preliminary Plan and District Ordinance - Re: 901 W. Cottage Grove Avenue (Habitat for Humanity of Monroe County, Petitioner)

Committee Recommendation (*recommended 3/5)*:	Do Pass	3 – 1 – 5
Special Session Committee Action *(taken 3/12)*:	Forward Final Vote to 3/26	9 – 0 – 0
Reasonable Conditions Expected *(3/26)*		

VII. LEGISLATION FOR FIRST READING

1. <u>Ordinance 14-04</u> To Amend Title 14 of the Bloomington Municipal Code Entitled “Peace and Safety” Re: Amending Chapter 14.20 (Firearms – Deadly Weapons) to Allow for the Discharge of Firearms at the Griffy Lake Nature Preserve for the Purpose of Deer Reduction via Sharpshooting

VIII. ADDITIONAL PUBLIC COMMENT* (A maximum of twenty-five minutes is set aside for this section.)

IX. COUNCIL SCHEDULE

Motion to cancel or reschedule the March 26th Committee of the Whole anticipated

X. ADJOURNMENT

* Members of the public may speak on matters of community concern not listed on the agenda at one of the two *Reports from the Public* opportunities. Citizens may speak at one of these periods, but not both. Speakers are allowed five minutes; this time allotment may be reduced by the presiding officer if numerous people wish to speak.

Posted & Distributed: Friday, 21 March 2014

City of Bloomington
Office of the Common Council

To Council Members
From Council Office
Re Weekly Calendar – 24 – 28 March 2014

Monday, 24 March

5:00 pm Utilities Service Board – Utilities, 600 E Miller Dr.
5:30 pm Bloomington Human Rights Commission, McCloskey

Tuesday, 25 March

4:00 pm Board of Public Safety, McCloskey
4:00 pm Board of Park Commissioners, Council Chambers
5:30 pm Board of Public Works, Council Chambers
5:30 pm Bloomington Public Transportation Corporation – Transit, 130 W Grimes Ln.
5:30 pm Commission on the Status of Children and Youth, Hooker Room

Wednesday, 26 March

10:00 am Metropolitan Planning Organization Technical Advisory Committee, McCloskey
5:30 pm Dr. Martin Luther King, Jr. Birthday Commission, McCloskey
6:15 pm Special Council Committee on Boards and Commissions, Council Library
6:30 pm Metropolitan Planning Organization Citizens' Advisory Committee, McCloskey
7:30 pm Common Council Regular Session & Committee of the Whole, Council Chambers

Please Note: *There is no legislation up for discussion at the Committee of the Whole. It is anticipated that this meeting will be cancelled or rescheduled during the Regular Session.*

Thursday, 27 March

12:00 pm Monroe County Suicide Prevention Coalition, McCloskey
4:30 pm Bloomington Historic Preservation Commission, McCloskey
5:30 pm Board of Zoning Appeals, Council Chambers
7:00 pm Environmental Commission, McCloskey

Happy Birthday to Councilmember Chris Sturbaum!

Friday, 28 March

No meetings are scheduled for this date.

Posted and Distributed: Friday, 21 March 2014

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City of Bloomington
Office of the Common Council

NOTICE

Please note that there is no legislation up for discussion at the 26 March 2014 Committee of the Whole. It is anticipated that the Committee of the Whole will be cancelled or rescheduled.

Posted: Friday, 21 March 2014

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City of Bloomington
Office of the Common Council

NOTICE

SPECIAL COMMITTEE ON BOARDS AND COMMISSIONS

WEDNESDAY, 26 MARCH 2014
6:15 pm
COUNCIL LIBRARY, SUITE 110
CITY HALL, 401 N. MORTON

Per Indiana Open Door Law (I.C. §5-14-1.5), this provides notice that this meeting will occur and is open for the public to attend, observe, and record what transpires.

Posted: Friday, 21 March 2014

RESOLUTION 14-05

**WAIVING CURRENT PAYMENTS IN LIEU OF TAXES
BY THE BLOOMINGTON HOUSING AUTHORITY TO THE CITY**

WHEREAS, the Bloomington Housing Authority provides a public service to the Bloomington community by providing sanitary, safe and affordable housing for low income people; and

WHEREAS, according to I.C. 36-7-18-25, the Bloomington Housing Authority is exempt from all property taxes, but may enter into an agreement with a political subdivision to pay no more than the estimated costs of services, improvements, or facilities provided by that political subdivision; and

WHEREAS, on May 2, 1961, the Bloomington Housing Authority and City of Bloomington entered into a Cooperation Agreement under which the Bloomington Housing Authority agreed to make annual payments in lieu of taxation based upon the value of services established by Housing and Urban Development guidelines; and

WHEREAS, the City of Bloomington does not desire for the Bloomington Housing Authority to make these payments in lieu of taxes this year;

NOW, THEREFORE, BE IT HEREBY RESOLVED BY THE COMMON COUNCIL OF THE CITY OF BLOOMINGTON, MONROE COUNTY, INDIANA, THAT:

SECTION I. In consideration for the provision of services to its residents and property by the Bloomington Housing Authority, the City of Bloomington hereby waives its right to any and all payments in lieu of taxes for the year 2013.

PASSED AND ADOPTED by the Common Council of the City of Bloomington, Monroe County, Indiana, upon this ______ day of ___________________, 2014.

____
DARRYL NEHER, President
Bloomington Common Council

ATTEST:

____
REGINA MOORE, Clerk
City of Bloomington

PRESENTED by me to the Mayor of the City of Bloomington, Monroe County, Indiana, upon this ______ day of ______________________, 2014.

____
REGINA MOORE, Clerk
City of Bloomington

SIGNED and APPROVED by me upon this _______ day of ______________________, 2014.

____
MARK KRUZAN, Mayor
City of Bloomington

SYNOPSIS

This resolution waives the right of the City of Bloomington to receive payments in lieu of taxes from the Bloomington Housing Authority for the year 2013.

Housing and Neighborhood Development

Memo

To: Council Members

From: Lisa Abbott, Director

CC: Doris Sims, Asst. Director

Date: March 20, 2014

Re: BHA PILOT

Resolution 14-05 is an annual request by the Bloomington Housing Authority to waive any payment in lieu of taxes (PILOT) as may be required of the entity. In 1961, the Bloomington Housing Authority entered into a cooperation agreement with the City of Bloomington, which was part of the creation of the Housing Authority. The cooperation agreement states, “Under the constitution and statues of the State of Indiana, all Projects are exempt from all real and personal property taxes levied or imposed by the Taxing Body, as long as the project continues to serve low income citizens this rule applies.”

This year, the BHA is requesting that the City forgive the $29,183.00 Payment in Lieu of Taxes as computed on the attached form.

Computation of Payments in Lieu of Taxes

U.S. Department of Housing and Urban Development
Office of Public and Indian Housing

For Fiscal Year Ended 2013

OMB Approval No. 2577-0026 (Exp. 10/31/2009)

Name of Local Agency:	Location:	Contract Number:	Project Number:
Bloomington Housing Authority	Bloomington, IN	C-0894	IN022

Part I - Computation of Shelter Rent Charged.

1. Tenant Rental Revenue (FDS Line 703) $ 608,672.00
2. Tenant Revenue Other (FDS Line 704) 173,947.00
3. **Total Rental Charged** (Lines 1 & 2) $ 782,619.00
4. Utilities Expense (FDS Line 931 - 939) 429,975.00
5. Shelter Rent Charged (Line 3 minus Line 4) 352,644

Part II - Computation of Shelter Rent Collected. To be completed only if Cooperation Agreement provides for payment of PILOT on basis of Shelter Rent Collected.)

1. Shelter Rent Charged (Line 5 of Part I, above) $ 352,644
2. Add: Accounts Receivable - Tenants (FDS Lines 126, 126.1, & 126.2) at beginning of fiscal year 3,006.00
3. Less: Tenant Bad Debt Expense (FDS Line 964) 60,478.00
4. Less: Accounts Receivable - Tenants (FDS Lines 126, 126.1, & 126.2) at end of fiscal year 3,333.00
5. Shelter Rent Collected (Line 1 plus Line 2 minus Lines 3 & 4) 291,830

Part III - Computation of Approximate Full Real Property Taxes.

(1) Taxing Districts	(2) Assessable Value	(3) Tax Rate	(4) Approximate Full Real Property Taxes
Total			0.00

Part IV - Limitation Based on Annual Contribution. (To be completed if Cooperation Agreement limits PILOT to an amount by which real property taxes exceed 20% of annual contribution.)

1. Approximate full real property taxes $ 0.00
2. Accruing annual contribution for all projects under the contract $
3. Prorata share of accruing annual contribution*
4. 20% of accruing annual contribution (20% of Line 3) 0.00
5. Approximate full real property taxes less 20% of accruing annual contribution (Line 1 minus Line 4, if Line 4 exceeds Line 1, enter zero) $

Part V - Payments in Lieu of Taxes.

1. 10% of shelter rent (10% of Line 6 of Part I or 10% of Line 5 of Part II, whichever is applicable)** $ 29,183.00
2. Payments in Lieu of Taxes (If Part IV is not applicable, enter the amount shown on Line 1, above, or the total in Part III, whichever is the lower. If Part IV is applicable, enter the amount shown on Line 1, above, or the amount shown on Line 5 of Part IV, whichever is lower.) $ 29,183.00

* Same as Line 2 if the statement includes all projects under the Annual Contributions Contract. If this statement does not include all projects under the Annual Contributions Contract, enter prorata share based upon the development cost of each project.
** If the percentage specified in the Cooperation Agreement or the Annual Contributions Contract with HUD is lower, such lower percentage shall be used.

Warning: HUD will prosecute false claims and statements. Conviction may result in criminal and/or civil penalties (18 U.S.C. 1001, 1010, 1012: 31 U.S.C. 3729, 3802).

Prepared By: Ashley Thurman	**Approved By:** Jennifer J. Osterholt
Name: Ashley Thurman	**Name:** Jennifer J. Osterholt
Title: Controller **Date:** 12/02/2013	**Title:** Executive Director **Date:** 12/02/2013

Print Reset

RESOLUTION 14-04

TO APPROVE AN *AMENDED* INTERLOCAL COOPERATION AGREEMENT BETWEEN THE CITY OF BLOOMINGTON AND MONROE COUNTY, INDIANA IN REGARD TO A 2012 EDWARD BYRNE MEMORIAL JUSTICE ASSISTANCE GRANT (JAG)

WHEREAS, the City of Bloomington and Monroe County are authorized by I.C. 36-1-7-1, *et seq.*, to enter into agreements for the joint exercise of their powers for the provision of services to the public; and

WHEREAS, this ***Amended*** Interlocal Cooperation Agreement reflects the commitments and understandings agreed to by the governmental entities in order to efficiently and effectively utilize proceeds received from the 2012 Edward Byrne Memorial Justice Assistance Grant (JAG).

NOW, THEREFORE BE IT HEREBY RESOLVED BY THE COMMON COUNCIL OF THE CITY OF BLOOMINGTON, MONROE COUNTY, INDIANA, THAT:

SECTION 1. The ***Amended*** Interlocal Cooperation Agreement between the City of Bloomington and Monroe County, Indiana in regard to a 2012 Edward Byrne Memorial Justice Assistance Grant, a copy of which is attached hereto and made a part hereof, is hereby approved.

SECTION 2. If any sections, sentence or provision of this ordinance, or the application thereof to any person or circumstances shall be declared invalid, such invalidity shall not affect any of the other sections, sentences, provisions, or applications of this ordinance which can be given effect without the invalid provision or application, and to this end the provisions of this ordinance are declared to be severable.

SECTION 3. This resolution shall be in full force and effect from and after its passage by the Common Council of the City of Bloomington and approval of the Mayor.

PASSED AND ADOPTED by the Common Council of the City of Bloomington, Monroe County, Indiana, upon this _____________ day of _____________________, 2014.

____
DARRYL NEHER, President
Bloomington Common Council

ATTEST:

____
REGINA MOORE, Clerk
City of Bloomington

PRESENTED by me to the Mayor of the City of Bloomington, Monroe County, Indiana, upon this ______ day of ______________________, 2014.

SIGNED and APPROVED by me upon this _______ day of ______________________, 2014.

____
MARK KRUZAN, Mayor
City of Bloomington

SYNOPSIS

This resolution approves the ***Amended*** Interlocal Cooperation Agreement between the City of Bloomington and Monroe County, Indiana regarding the use of the 2012 Edward Byrne Memorial Justice Assistance Grant. The Interlocal Agreement provides that the City will utilize all of the available funds to purchase a digital signage package that will allow the Police Department to connect and interact with members of the public by providing the public with scheduling information, compelling announcements, snapshots, videos of action, and social media updates and to share roll call and other important law enforcement information with the different shifts and divisions in the different police buildings. The County will use its share in accordance with the original interlocal.

MEMO:

To: Bloomington City Council
CC: Mark Kruzan, Mayor
John Whikehart, Deputy Mayor
From: Patty Mulvihill, Assistant City Attorney
Date: March 20, 2014
Re: Resolution to Approve Interlocal for Amendment to 2012 JAG

The City and the County were jointly awarded $34,023.00 in grant funds from the federal government. The funds are to be utilized for public safety purposes. The County Sherriff's Department and the City's Police Department originally determined that the best use of the funds would be for the Sheriff's Department to use $17,325.00 to purchase three complete in-car video systems and the City would use $10,936.00 to purchase two eDesk Kiosks and $5,199.00 to purchase a N-Dex server. In order for the City and County to utilize all of the funding, the County and the City needed to enter into an interlocal agreement.

The N-Dex server was not necessary and not purchased. The City recently was advised by the Grant Administrator that the $5,199.00 could be utilized to purchase digital signage to allow the Police Department to connect and interact with members of the public and to share roll call and other important law enforcement information with the different shifts and divisions in the different police buildings. The digital signage package can best be classified as a continuous and non-stop roll-call--advising officers on a constant basis of current crimes, individuals of interest, mug shots, etc... In order for the money to be utilized for the purchase of this digital signage the original 2012 JAG interlocal needs to be amended.

AMENDED
INTERLOCAL COOPERATION AGREEMENT
BETWEEN
THE CITY OF BLOOMINGTON AND
MONROE COUNTY, INDIANA
IN REGARDS TO 2012 EDWARD BYRNE MEMORIAL
JUSTICE ASSISTANCE GRANT (JAG)

WHEREAS, Indiana Code § 36-1-7-1 *et seq.* permits governmental entities to jointly exercise powers through Interlocal Cooperation Agreements; and

WHEREAS, each governmental entity, in performing their governmental functions or in paying for the performance of governmental functions hereunder, shall make that performance or those payments from current revenues legally available to that party; and

WHEREAS, each governmental entity finds that the performance of this Interlocal Cooperation Agreement is in the best interests of both entities, that the undertaking will benefit the public, and that the division of costs fairly compensates the performing party for the services or functions under this Interlocal Cooperation Agreement; and

WHEREAS, this Interlocal Cooperation Agreement reflects the commitments and understandings agreed to by the governmental entities in order to efficiently and effectively utilize proceeds received from the 2012 Edward Byrne Memorial Justice Assistance Grant (JAG); and

WHEREAS, the original Interlocal Cooperation Agreement was approved by the Monroe County Commissioners on June 29, 2012; the City of Bloomington Common Council on June 27, 2012; and approved by the Mayor of Bloomington on July 2, 2012; and

WHEREAS, the City of Bloomington and Monroe County were unable to utilize the $5,199.00 allocation for the purchase a N-Dex; and

WHEREAS, the Department of Justice has advised the City of Bloomington that the $5,199.00 can still be used and allocated to the City, provided the City instead utilizes said money for the purchase of digital signage to allow the Police Department to connect and interact with members of the public and to share roll call and other important law enforcement information with the different shifts and divisions in the different police buildings; and

WHEREAS, the Department of Justice has advised the City of Bloomington that in order to utilize the $5,199.00 for the purchase of digital signage an *Amended* Interlocal Cooperation Agreement must be entered into between the City of Bloomington and Monroe County; and

NOW, THEREFORE, City of Bloomington and Monroe County, Indiana, hereby agree as follows:

Section 1. Payment

The City of Bloomington (hereinafter, "City") paid Monroe County, Indiana (hereinafter, "County"), a total of $17,325 of funds received from the Recovery Act: Justice Assistance Grant (hereinafter "JAG").

Section 2. Use of Funds

Monroe County shall use its respective funds in accordance with the original JAG Grant allocation and interlocal.

The City of Bloomington shall use the $10,936.00 for the purchase or development of E-Kiosks. The City shall also use the $5,199.00 for the purchase of a digital signage package.

Section 3. Liability

Nothing in the performance of this Interlocal Cooperation Agreement (hereinafter, "Agreement") shall impose any liability for claims against either governmental entity other then claims for which liability may be imposed by the Indiana Tort Claims Act.

Section 4. Responsibility

Each entity to this Agreement shall be responsible for its own actions in providing services under this Agreement and shall not be liable for any civil liability that may arise from the furnishing of the services by the other party.

Section 5. Commitment

The entities shall communicate and cooperate with one another to ensure that the purposes of this Agreement are achieved on behalf of and to the benefit of the publics they serve.

Section 6. Third Parties

The entities to this Agreement do not intend for any third party to obtain a right by virtue of this Agreement.

Section 7. Intent

By entering into this Agreement, the entities do not intend to create any obligations express or implied other than those set out herein. Further, this Agreement shall not create any rights in any party not a signatory hereto.

Section 8. Severability

If any provision of this Agreement is declared, by a court of competent jurisdiction, to be invalid, null, void or unenforceable, the remaining provisions shall not be affected and shall have full force and effect.

Section 9. Appropriation of Funds

The entities acknowledge and agree that the performance of this Agreement is subject to the appropriation of sufficient funds by JAG. The parties agree to make a good faith effort to obtain all necessary appropriations and to comply with all provisions of this Agreement to the extent feasible under current or future appropriations.

Approved this ____________ day of ________________________, 2014, by the Monroe County, Indiana Commissioners:

MONROE COUNTY, INDIANA

ATTEST:

____
PATRICK STOFFERS, President
Monroe County Commissioners

____
STEVE SAULTER, Auditor

____
IRIS KIESLING, Vice President
Monroe County Commissioners

____
JULIE THOMAS, Commissioner
Monroe County Commissioners

Approved this ____________ day of ________________________, 2014, by the City of Bloomington Common Council.

____
DARRYL NEHER, President
Bloomington Common Council

ATTEST:

____
REGINA MOORE, Clerk

Approved this ____________ day of ________________________, 2014, by the City of Bloomington.

CITY OF BLOOMINGTON, INDIANA

ATTEST:

____
MARK KRUZAN, Mayor

____
REGINA MOORE, Clerk

Ord 14-03 To Rezone a 6.96 Acre Property from Residential Core (RC) to a Planned Unit Development to be Known as the B-Line Neighborhood and Approve a Preliminary Plan and District Ordinance - Re: 901 W. Cottage Grove Avenue (Habitat for Humanity of Monroe County, Petitioner)

Proposed Reasonable Conditions

- **RC 01** (Rollo, Sponsor) – Re: Augmenting the Tree Preservation and Planting Plans
  – Status: Introduced and withdrawn at Special Session on March 26th (Attached)

- **RC 02** (Volan, Sponsor) – Re: Improving bike and pedestrian access to the site
  – Status: Councilmember Volan met with representatives of the petitioner as well as staff on Thursday and should hear back from the petitioner on Monday or Tuesday of next week.

- **RC 03** (Sturbaum, Sponsor) – Re: Requiring fiber cement instead of a vinyl siding on these homes
  – Status: Councilmember Sturbaum has communicated with Kerry Thomson, who estimated the additional cost at about $1,000 per home (plus the added maintenance for home owners). It's my understanding that she wanted to account for the costs associated with *all* of the changes proposed by members of the Council and discuss the matter with her board before responding to this proposed condition.

*** Reasonable Conditions Form ***

Ordinance #: 14-03

Reasonable Condition #: 01

Submitted By: Councilmember Rollo, District 4

Date: March 12, 2014

Proposed Reasonable Condition:

1. Condition of Approval 9 to **<u>Ord 14-03</u>** (Habitat PUD) shall be revised to read as follows:

"The petitioner shall work with the Planning staff in consultation with the Environmental Commission at final plan stage to develop a detailed tree preservation plan as well as a native planting plan. This native planting plan shall focus on the following areas of the PUD:

Area 1 – Reclaiming the Forest Understory – The goal for this area should be the removal of exotic and invasive vegetation within the conservation areas on each side of the developed portion of the PUD. This vegetation shall be replaced by woodland perennials as well as appropriate, larger understory vegetation.

Area 2- Adding to Natural Perimeter Vegetation – Along the natural borders buffering the B-Line, active railroad line, and conservation areas, new native hardwood trees will be added where feasible to increase long-term native canopy coverage.

Area 3 – Supplementing the Common Green – In addition to the existing trees that will be preserved within this area, new native grasses, bushes, and other plant material should be added to supplement existing vegetation while still preserving the usability of the Common Green area.

Area 4 – Tree Plot Areas – All new canopy trees within the street tree plots shall be native species. Additionally, native grasses and other plant material should be considered as supplementary species.

Area 5 – Individual Yard Areas – The petitioner should work with interested homeowners to provide them with access to native plant species in order to enable homeowners to establish yards more suitable for wildlife.

The planting and preservation plan addressing the 5 areas outlined above is to be created within reason for the petitioner's budget, understanding the petitioner will be seeking donations and partnerships from community organizations to exceed the standard landscape plan required.

Planning staff will submit a report to the Council along with the final tree preservation and planting plans prior to presentation at the Plan Commission.

Synopsis

Reasonable Condition 01 is sponsored by Councilmember Rollo and would modify Condition of Approval 9 of this ordinance, which called for the petitioner to:

> "work with Planning Staff at the final plan stage to develop a detailed tree preservation and landscaping plan focused most specifically in creating maximum perimeter vegetation buffers and planting new larger caliper plant species (on this site)".

The change calls for the petitioner to work with the Planning Staff *in consultation with* the Environmental Commission and to develop a "native planting" rather than a "landscaping" plan. The native planting plan would focus on: 1) Reclaiming the Forest Understory in the conservation easements on the east and west ends of the site; 2) Adding native hardwoods along the perimeter of this site where feasible; 3) Supplementing the Common Green with native grasses, bushes, and other plant material while still preserving its usability; 4) Planting native hardwoods the Tree Plot Areas and consider planting native grasses and other plant material as well; and, 5) Providing home owners with "access to native plant species in order to enable homeowners to establish yards more suitable for wildlife."

The change also acknowledges that the planting and landscaping plans are "to be created within reason for the petitioner's budget, understanding the petitioner will be seeking donations and partnerships from community organizations to exceed the standard landscape plan required."

Lastly, the change calls for Planning staff to submit report to the Council along with final tree preservation and planting plans prior to presentation at Plan Commission.

3/5/14 Committee Action:	None
3/11/14 Regular Session Action:	Motion to Adopt – With Second Motion to Withdraw Motion to Adopt 8 – 1 (Mayer)

(March 12, 2014)

ORDINANCE 14-04

TO AMEND TITLE 14 OF THE BLOOMINGTON MUNCIPAL CODE ENTITLED "PEACE AND SAFETY"
Re: Amending Chapter 14.20 (Firearms – Deadly Weapons) to allow for the discharge of firearms at the Griffy Lake Nature Preserve for the purpose of deer reduction via sharpshooting

WHEREAS, Griffy Woods is a woodland area composed of approximately 1,200 acres owned by the City of Bloomington known as the "Griffy Lake Nature Preserve," a 185-acre research facility owned by Indiana University, known as the "Indiana University Research and Teaching Preserve" (IURTP), and adjacent private property;

WHEREAS, Larger than some Indiana State Parks, Griffy Woods is marked by extraordinary ecological diversity: it includes a 109-acre lake and at least ten distinct ecological communities, ranging from marsh and floodplain forest to dry mesic upland, conifer plantations, and old fields. Griffy is home to more than 500 terrestrial plant species (including 15 plant species identified as endangered, threatened, or rare), over 150 bird species, and numerous reptile, amphibian and mammal species;

WHEREAS, The existence of such a high-quality forest located so close to an urban core marks Griffy Woods as unique and provides Bloomington with an exceptional and significant natural amenity. Indeed, few cities the size of Bloomington have such a vast, biologically-rich resource in their municipal backyards. The proximity of this resource provides residents with ready access to nature, provides an outdoor classroom for students of all ages, attracts visitors and researchers to the community, and improves our collective quality of life;

WHEREAS, Griffy Woods is also home to an overabundant deer population. This overabundance is the direct result of human action: we have fragmented the landscape, providing deer with ideal "edge" habitat and we have eliminated all natural deer predators – wolves and mountain lions have been erased from the landscape and hunting by humans has long been prohibited at Griffy Woods;

WHEREAS, Based on pellet counts, research by scientists at the IURTP suggests that Griffy experiences 11-12 times more deer activity than other comparable area forests where hunting is permitted nearby;

WHEREAS, In forest ecosystems, deer are able to profoundly and negatively alter the structure and composition of ecological communities. High levels of deer browsing kills or reduces the size of plants, inhibits forest regeneration, redirects forest succession, facilitates invasive plant species, alters nutrient and carbon cycling, and reduces food resources and habitat for other wildlife;

WHEREAS, High levels of deer browsing can extirpate local plant species and ravage the forest understory. A well-developed understory has several different layers and contains many different species of young trees, shrubs, and wildflowers. A healthy understory provides food and critical habitat to many mammals and to birds and indicates a forest's ability to renew itself – a key indicator of forest health;

WHEREAS, Scientific research indicates that the density of deer in Griffy Woods is causing widespread negative ecosystem effects. Griffy Woods is characterized by a depauperate understory, an absence of native tree seedlings, markedly reduced size and abundance of wildflowers, and the predominance of exotic invasive species and plants deer do not eat;

WHEREAS, Since 2005, IURTP biologists have been using exclosure plots to study the effects of deer browsing at Griffy Woods. Exclosures are designed to keep deer out, but allow other plant-eaters in. IURTP scientists have found that deer herbivory is:

- Decreasing overall native vegetative diversity and density of both woody and herbaceous species;
- Severely compromising the regeneration of native trees. Since the study's inception, a significant number of native tree seedlings have been observed inside the deer exclosures; however, no native hardwood tree seedlings have been observed in unenclosed control plots;
- Encouraging the growth of invasive species such as garlic mustard and Japanese stiltgrass and native plants unpalatable to deer, such as spicebush and pawpaw;
- Causing soil compaction, which reduces water infiltration and causes erosion; and
- Reducing habitat for terrestrial species such as the white-footed mouse -- a food source relied upon by other animals such as snakes, owls, hawks, skunks, foxes, and coyotes;

WHEREAS, In Indiana, three plant species have been identified as indicators of the intensity of deer browsing in Indiana forests: white baneberry, sweet cicely, and jack-in-the-pulpit. IURTP scientists have found significant differences in the height and abundance of these species between exclosure and control plots at Griffy Woods;

WHEREAS, Left unchecked, a deer herd can grow rapidly and can quickly overwhelm the landscape;

WHEREAS, Left unchecked, deer overbrowsing poses the risk of producing an "alternate stable state" – a condition in which a forest would never return to its natural state, even if browsing pressure were diminished by a permanent reduction in deer densities;

WHEREAS, As deer overabundance is the result of human action, humans must assume responsibility for preventing deer from severely degrading the ecosystem and for keeping the deer herd in balance with the rest of the forest;

WHEREAS, Achieving a better balance between deer and the forest they inhabit is in the best interest of both the forest and the deer, allowing both to thrive;

WHEREAS, Deer overbrowsing can result in ecological simplification and a loss of biodiversity. We are experiencing a rapid loss of biodiversity on a global scale; working toward a better ecosystem balance at Griffy provides us with an opportunity to act locally to stem this loss;

WHEREAS, We have a responsibility to future generations to be good stewards of Griffy Woods;

WHEREAS, The Griffy Lake Nature Preserve Master Plan of 2008 observed that deer herbivory and trampling were having a particularly deleterious effect on the Griffy Lake Nature Preserve in the Mesic Upland Forest and Floodplain Forest; the Plan called for further study to determine the effects of deer browse using deer exclosure plots and advised that it may be necessary to introduce deer population controls to reduce the number of deer;

WHEREAS, The 2012 report of the Joint City of Bloomington-Monroe County Deer Task Force provided further documentation of the deleterious effects of deer overbrowsing at Griffy Woods and recommended the use of sharpshooting by wildlife professionals as the most effective and humane way of reducing the deer population;

WHEREAS, Deer management at Griffy Woods is supported by numerous community stakeholders;

WHEREAS, To be effective, deer management must be continually maintained and monitored;

WHEREAS, The need to manage deer in the interest of forest restoration is not new nor is it specific to Griffy -- the comparative experience of Indiana State Parks indicates that reducing the number of deer results in forest recovery. In Indiana State Parks, herbaceous percent cover, woody stem density, species richness, and species diversity have all increased markedly since hunting was implemented. Indeed, in 1995 the Indiana General Assembly passed legislation *requiring* IDNR to take action where a given species was causing measurable damage to the ecological balance within a State park;

WHEREAS, As articulated in the Humane Deer Management Policy Statement of the Joint City of Bloomington-Monroe County Deer Task Force, lethal deer management should be used only where it is determined that a problem exists, that is unlikely to be solved using non-lethal means. Where lethal means must be used, the most humane methods should be employed, as prescribed by the American Veterinary Medical Association. The most humane form of lethal action is one that makes death as painless and distress-free as possible;

WHEREAS, Non-lethal means would not effectively address the current level of deer abundance and deer herbivory at the Griffy Lake Nature Preserve;

WHEREAS, The most effective, safe, and humane way to reduce the deer population at Griffy Woods is sharpshooting by competent markspersons using firearms. The use of an accurately-delivered gunshot has been determined to be humane euthanasia by the American Veterinary Medical Association;

WHEREAS, The Indiana Department of Natural Resources (IDNR) exercises exclusive jurisdiction over deer management in Indiana (I.C. §14-22-1-1). IDNR sets the boundaries within which deer management options can be selected, but leaves it up to communities to decide how and if management should occur;

WHEREAS, The City of Bloomington Board of Park Commissioners exercises jurisdiction over the management of the Griffy Lake Nature Preserve;

WHEREAS, Members of the Board of Park Commissioners have made clear it that an overabundance of deer at the Griffy Lake Nature Preserve presents an imminent threat to the Griffy ecosystem; these members have asked the Council to take the necessary steps that will allow the Parks Board to move quickly to protect the Griffy Lake Nature Preserve ecosystem;

WHEREAS, In the interest of restoring ecosystem balance at Griffy Woods, the Common Council supports the reduction of the deer population at the Griffy Lake Nature Preserve through the use of sharpshooting;

WHEREAS, The Bloomington Municipal Code prohibits the discharge of firearms and hunting at the Griffy Lake and the Griffy Lake Nature Preserve, but provides that the Board of Park Commissioners may, at their discretion, grant permission to engage in select activities otherwise prohibited for “authorized management purposes” (BMC §11.08.040; *see also* BMC §11.08.300);

WHEREAS, For the Board of Park Commissioners to grant permission for sharpshooting at the Griffy Lake Nature Preserve, Bloomington Municipal Code §14.20.020, prohibiting the discharge of a firearm within the corporate boundaries of the City of Bloomington, must be amended;

NOW, THEREFORE, BE IT HEREBY ORDAINED BY THE COMMON COUNCIL OF THE CITY OF BLOOMINGTON, MONROE COUNTY, INDIANA, THAT:

SECTION 1. Section 14.20.020 of the Bloomington Municipal Code entitled "Discharging Firearms" shall be amended by deleting the existing provision and replacing it with the following:

14.20.020 Discharging firearms.

It is unlawful for any person to shoot any firearm within the limits of the city. However, this section shall not apply to:

(a) any legally appointed officer in the discharge of his or her duty;
(b) any person when acting in self-defense; nor
(c) any contractor of the City of Bloomington Board of Park Commissioners hired for the purpose of deer reduction via sharpshooting at the Griffy Lake Nature Preserve, provided that:
(1) the contractor takes such actions in accordance with:
(A) a currently valid contract executed by the City of Bloomington Board of Park Commissioners and such contractor; and
(B) a currently valid State of Indiana, Department of Natural Resources permit for such actions; and
(C) all applicable City of Bloomington laws and regulations; and
(D) all applicable State of Indiana laws and regulations; and
(2) the discharge of a firearm authorized under subsection (c) shall be limited to areas within the boundaries of the Griffy Lake Nature Preserve as defined by §11.08.010(7) of the Bloomington Municipal Code.

SECTION 2. This ordinance shall be in full force and effect from and after its passage by the Common Council of the City of Bloomington and approval of the Mayor.

PASSED by the Common Council of the City of Bloomington, Monroe County, Indiana, upon this ______ day of ____________________, 2014.

____
DARRYL NEHER, President
Bloomington Common Council

ATTEST:

____
REGINA MOORE, Clerk
City of Bloomington

PRESENTED by me to the Mayor of the City of Bloomington, Monroe County, Indiana, upon this ______ day of _______________________, 2014.

____
REGINA MOORE, Clerk
City of Bloomington

SIGNED and APPROVED by me upon this _______ day of ______________________, 2014.

____
MARK KRUZAN, Mayor
City of Bloomington

SYNOPSIS

This ordinance is sponsored by Councilmembers Rollo and Ruff. The ordinance amends the Bloomington Municipal Code by adding an exception to the general prohibition against discharging a firearm within the City's corporate boundaries. This exception is limited to the Griffy Lake Nature Preserve for the limited purpose of deer reduction via sharpshooting. The ordinance documents the widespread ecosystem damage at Griffy caused by an overabundance of deer. The ordinance points out that the City of Bloomington Board of Park Commissioners exercises jurisdiction over the management of the Griffy Lake Nature Preserve and that members of the Parks Board have requested that the Common Council take the necessary steps to allow the Board to act quickly to protect the Preserve. The ordinance finds that sharpshooting is the most effective, safe, and humane means to reduce the deer population at Griffy in the interest of ecosystem restoration.

City of Bloomington
Office of the Common Council

To: Council Members
From: Councilmember Dave Rollo, District IV
Re: Ordinance 14-04
Date: March 21, 2014

Griffy Lake Nature Preserve is a City owned, 1200-acre woodland north of the city of Bloomington, just minutes from downtown. It holds a remarkable diversity of plants and animals, and is a rare and valuable natural asset for the city. However, it is being degraded and endangered due to high deer density that are over-browsing the understory of the forest.

This damage is readily observable and is becoming increasingly common in the eastern U.S. and elsewhere.[1] It was first reported to the City in the Griffy Lake Master Plan, which was prepared by JFNew consultants.[2] The Master Plan advised study, ideally with deer exclosure experiments, which permit smaller animal entry but exclude deer.

Fortunately, this work was undertaken by scientists at the Indiana University Research and Teaching Preserve, which is adjacent to the eastern edge of the Griffy Lake Nature Preserve. This work involved studying vegetation, animals and other organisms inside and outside exclosures in a multi-year study.[3]

The IU research demonstrates profound impacts on the woodland, most notably lack of any native tree seedlings in the plots outside the exclosures. Reduction of other understory vegetation indicates that the woodland is losing native biodiversity at an alarming rate. No new tree recruitment means that eventually the woodland will become grassland. The research also indicated that deer browsing reduced numbers of white-footed mice, a prey item of owls, hawks, and foxes.

It is our responsibility as the Common Council to aid in the rescue of Griffy Lake Nature Preserve by providing its land managers with the means to reduce deer numbers. The City of Bloomington Board of Park Commissioners is responsible for the management of the Preserve. Members of the Board agree with the degree of negative impact of deer overabundance and have asked the Council to provide them with the means to restore balance to the Griffy ecosystem.

The City of Bloomington/Monroe County Deer Task Force extensively reviewed the impact of deer on our community, and devoted a section specifically to the Griffy Lake Nature Preserve.[4] The Deer Task Force assessed all options available for deer management endorsed by the Indiana Department of Natural Resources (INDNR), which has ultimate jurisdiction over deer in the State of Indiana. The Deer Task Force recommended a sharpshoot for the immediate, substantial, and humane reduction of deer numbers in Griffy Woods.

Ordinance 14-04 amends Title 14 of the Bloomington Municipal Code entitled "Peace and Safety" to allow the discharge of firearms at the Griffy Lake Nature Preserve for the purpose of deer management. It provides the Parks Board of Commissioners the means to hire a contractor for the specific method of sharpshooting for deer population reduction.

As the damage within the Preserve is ongoing and severe, we must act soon to save the biodiversity and integrity of the woodlands, and safeguard this unique and rare natural area for our community, and for future generations.

I respectfully request your support of Ordinance 14-04.

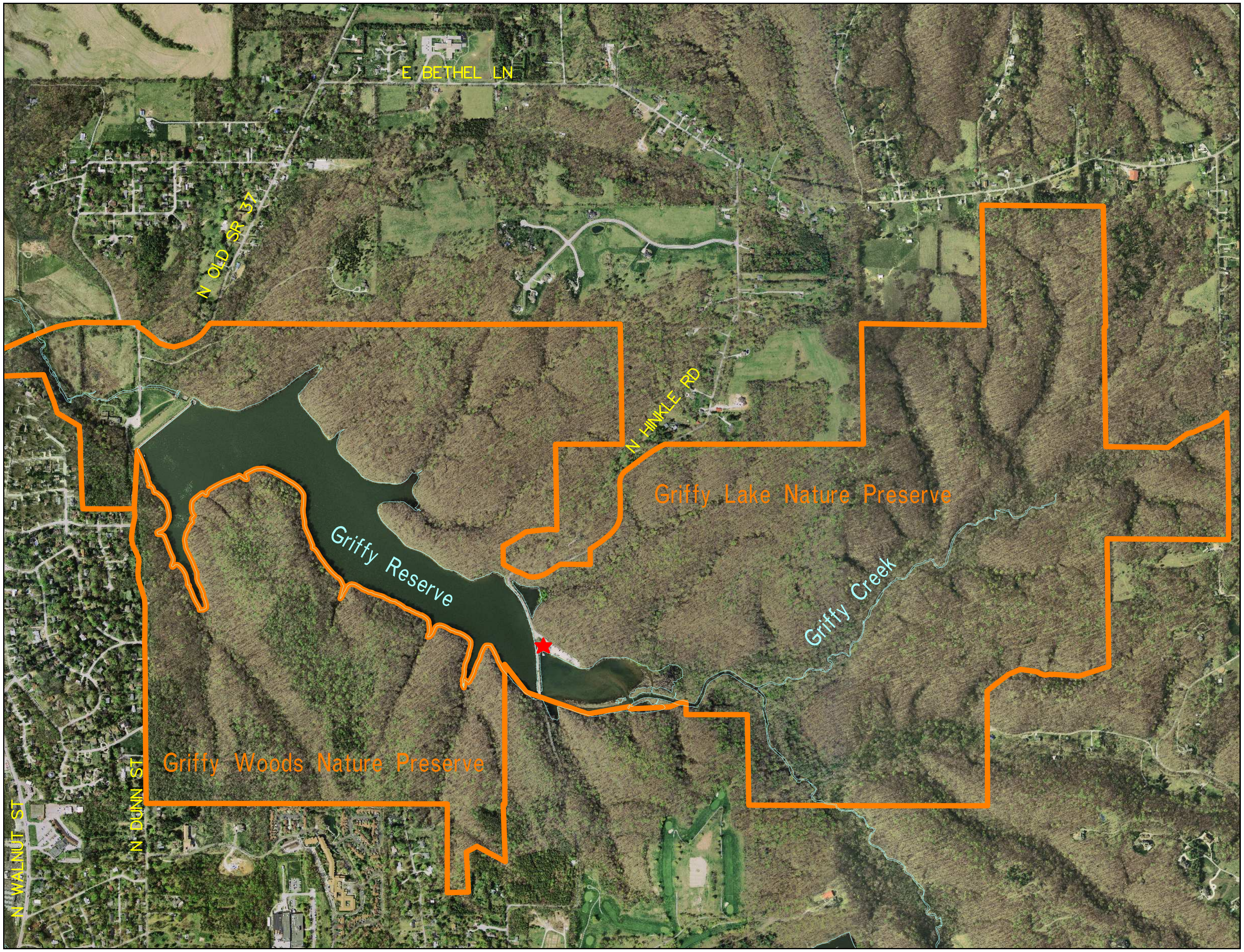
---

1. Impacts of White-Tailed Deer Overabundance in Forest Ecosystems: An Overview. http://www.na.fs.fed.us/fhp/special_interests/white_tailed_deer.pdf

2. Effects of Abundant White-Tailed Deer on Vegetation, Animals Mycorrhizal Fungi and Soils. Shelton et. al. Accepted for publication in Forest Ecology and Management 19 February, 2014.

3. City of Bloomington Griffy Lake Preserve Master Plan. Prepared by JF New, Summer 2008. http://bloomington.in.gov/media/media/application/pdf/3566.pdf

4. Common Ground: Toward Balance and Stewardship. Report of the Joint City of Bloomington/Monroe County Deer Task Force. October, 2012. https://bloomington.in.gov/media/media/application/pdf/12811.pdf



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For use as map information only, information is NOT warranted.

City of Bloomington
ITS Department

Geographic
Information System

-Legend-

Nature Preserve

Boathouse

Hydrology

Mar 18, 2014

N

Griffy Preserve Overview

TgrifovrL stierm

Forest Ecology and Management xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Effects of abundant white-tailed deer on vegetation, animals, mycorrhizal fungi, and soils

Angela L. Shelton *, Jeremiah A. Henning [1], Peggy Schultz, Keith Clay

Department of Biology, Indiana University, 1001 E. Third St., Bloomington, IN 47405, USA

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Central hardwood forests

ABSTRACT

The last several decades have seen dramatic increases in ungulate populations worldwide, and white-tailed deer in the eastern United States currently exist at unprecedented densities in many areas. Numerous studies have demonstrated the effects of high densities of white-tailed deer on forest communities. However, few studies have simultaneously examined the effects of deer on multiple components of forest communities across trophic levels. Here, we simultaneously examine effects of excluding white-tailed deer on responses of woody and herbaceous vegetation, terrestrial and subterranean animals, mycorrhizal fungi, and soil characteristics. This study was conducted in a forest preserve with high deer densities in the central hardwoods region of the Midwestern US, using a series of replicated deer exclosures (15 × 15 m) and adjacent unfenced controls that ranged in age from two to seven years. Despite significant tree recruitment inside exclosures, we recorded no native tree seedling recruitment in control plots. In addition, the growth rate of existing tree seedlings was significantly greater in exclosures than in controls, and the growth rate of invasive shrubs was approximately 30 times higher inside exclosures. Exclosures also had increased height, species diversity, and abundance of spring plants, and increased vegetation density in summer. We also found differences in terrestrial animals with higher densities of white-footed mice (*Peromyscus leucopus*) and dog ticks (*Dermacentor variabilis*) inside deer exclosures. However, there were no differences in salamanders or earthworms. Soil inside exclosures was significantly less compacted than in control plots despite the short period of deer exclusion, but there were no significant differences in soil nutrients or arbuscular mycorrhizal fungi. These results indicate that there are strong effects of high deer densities on all classes of understory vegetation and indirect effects on animals and soils. However, most belowground effects were nonsignificant, suggesting that responses of belowground communities to deer exclusion are weaker or slower to develop than aboveground effects.

1. Introduction

Ungulates are the dominant herbivores in many temperate forests and have become more abundant in many areas over the last several decades (McShea et al., 1997; Gortázar et al., 1998; Ward, 2005; Terborgh and Estes, 2010), reaching historically unprecedented densities (McCabe and McCabe, 1997; Côté et al., 2004). For example, white-tailed deer in North America, sika deer in Japan, and several species of deer in Britain and Europe have increased dramatically over the last several decades, causing ecological damage and increased conflicts with humans due to browsing on agricultural or landscaping plants, deer-vehicle collisions, and direct encounters (Gortázar et al., 1998; Kaji et al., 2000; Clutton-Brock et al., 2004; Ward, 2005). Increases in ungulate populations and increasing human–wildlife interactions, especially in suburban and exurban habitats, have reached a level where ecological degradation has become severe in many areas and the general public has become concerned, leading to numerous local discussions of population reductions (e.g. Sterba, 2012; Cambrone, 2013).

Like many other ungulate species in their native ranges, white-tailed deer (*Odocoileus virginianus*) are the most important large herbivores in eastern U.S. forests. Their range extends over the vast majority of North America, where they coexist with other ungulate species, but in most of the eastern U.S. they are the only large

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herbivore, and in many areas are highly abundant. They were extirpated from many parts of their range in the early 20th century, but were reintroduced in the mid-20th century and have since adjusted extremely well to the fragmented forests interspersed with agricultural and suburban lands that currently dominate the landscape, leading to potentially unprecedented densities in many parts of their range (McShea et al., 1997; Rooney, 2001).

At high densities, deer browsing can reduce the number of tree seedlings and saplings (e.g. Alverson et al., 1988; Rooney and Waller, 2003), reduce growth and reproduction of woodland herbs (Webster et al., 2005; Heckel et al., 2010), cause local extirpations of herbaceous species (Augustine and Frelich, 1998; Knight et al., 2009a), and decrease overall vegetation density (Rooney, 2009; Martin et al., 2010). Heavy deer browsing can lead to dominance by browse-tolerant or avoided plant species (Horsley et al., 2003; Gill and Morgan, 2010), increased spread of invasive species (Baiser et al., 2008), and alteration of forest succession (Côté et al., 2004). Such changes in vegetation can, in turn, lead to indirect effects on animals via altered food availability, cover from predators, or modified microenvironments (Rooney and Waller, 2003; Allan et al., 2010). For example, the density of birds (Chollet and Martin, 2013), small mammals (Parsons et al., 2013), amphibians (Brooks, 1999), reptiles (Greenwald et al., 2009), and insects (Teichman et al., 2013; Wheatall et al., 2013) have been shown to be indirectly affected by high deer densities.

High densities of deer may also affect belowground communities and processes. Sustained herbivory by deer can increase soil compaction (Heckel et al., 2010), decrease litter depth (Bressette et al., 2012), inhibit mycorrhizal communities (Rossow et al., 1997), and either accelerate or decelerate nutrient cycling (Harrison and Bardgett, 2008). Soil and litter animals, such as arthropods (Lessard et al., 2012), nematodes (Bardgett et al., 1998), and earthworms (Rearick et al., 2011), may also be affected, but due to the complexity of belowground interactions, the directions of these effects varies.

We measured direct and indirect effects of deer exclusion on a suite of ecosystem characteristics over several years in a central hardwood forest in southern Indiana. Using a series of replicated deer exclosures, we asked the following questions: (1) Do deer exclosures allow recovery of the abundance, size, and diversity of herbaceous and woody vegetation? We assumed that herbaceous and woody vegetation would both respond to deer exclusion, with herbaceous perennials showing the most rapid response. (2) Does the exclusion of deer affect terrestrial and subterranean animal populations? We hypothesized that vegetation recovery when deer are excluded would alter the amount of cover, food resources, and microenvironmental conditions for small animals with relative small habitat use areas and nesting sites. We surveyed mice, ticks, woodland salamanders, and earthworms to include both aboveground and belowground species and because these species are small enough to easily move through the fences and because they have home range sizes relevant to the size of the 15 m × 15 m exclosures, allowing them to select for habitat preference between the exclosures and control plots. (3) Do deer affect soil properties, nutrient cycling, and mycorrhizal fungal communities? We predicted that the vegetation recovery caused by protection from deer could alter soil properties and increase host plants for arbuscular mycorrhizal fungi, which associate with most herbaceous plants as well as trees. We also expected that decreased nitrogen inputs from deer urine and feces might decrease total available nitrogen and affect nitrogen mineralization rates within exclosures compared to controls. The answers to these questions will provide a more complete picture of how high densities of deer directly and indirectly affect deciduous forest ecosystems and how this suite of effects may interact.

2. Methods

2.1. Study site and exclosures

This study was conducted at the Griffy Woods property (30°11′27″N, 86°30′7″W) of the Indiana University Research and Teaching Preserve in Monroe County, Indiana, USA. This site is in the Knobstone region of Indiana (Homoya et al., 1985), which is just south of the glaciation boundary and is characterized by steep, narrow hills and valleys. The forest community consists of a combination of oak-hickory forests on dry slopes and beech-maple forests on moister slopes (Bailey, 1995). Bottomland forest is characterized by black walnut (*Juglans nigra*), sycamore (*Platanus occidentalis*), black cherry (*Prunus serotina*), and other deciduous species. The only evergreen species present are sporadic red cedar and some areas of planted non-native pines. Griffy Woods is an urban-border preserve that consists of just over 800 ha of contiguous, mostly protected forest adjacent to two reservoirs, a golf course, and suburban development. Hunting is not permitted. The area has been a primary focus of local concern about deer overpopulation (Bloomington–Monroe County Deer Task Force, 2012). In pellet count surveys (Appendix A.1) conducted in March 2011, we found an average of 200 ± 50 SE pellet piles/ha compared to 18 ± 5 and 17 ± 8 at two other nearby unhunted preserves, suggesting this site has 11–12 times more deer activity than these other comparable preserves, although it is difficult to accurately estimate actual deer densities from pellet counts due to variations in defecation rates depending on food quality and decomposition rates depending on temperature and moisture (Forsyth et al., 2007; deCalesta, 2013).

Between 2005 and 2010, 15 deer exclosures (15 × 15 m) were constructed across a range of lowland, ridgetop, and hillside habitats at Griffy Woods. Each exclosure was paired with an equal sized control plot with similar vegetation and slope located 5–10 m from the exclosure to allow comparison of similar vegetation, slope aspect and soil conditions inside and outside the exclosures. A permanently marked 12 × 12 m sampling area divided into nine 4 × 4 m subplots was established in each plot. Each paired exclosure and control plot were considered a block for statistical analyses. Two exclosures were constructed in the summer of 2005, nine in winter 2009 and four in winter 2010. Although the exclosures were of different ages, we included exclosure age in all of our analyses and found it was not significant for all of the measured variables, indicating that effects were consistent across all ages of exclosures. Details of the exclosure construction are in Appendix A.2.

2.2. Vegetation sampling

To measure the response of woody vegetation to deer exclusion, we marked and measured all woody stems, including trees and shrubs, in four of the 4 × 4 m subplots of each plot in January 2010. We recorded species identity and diameter at breast height (DBH, stems >5 cm DBH) or root collar diameter (RCD, <5 cm DBH but >30 cm tall). In January 2012, we resurveyed two of the subplots in each plot, remeasured all existing woody plants, and marked and measured all new seedlings over 30 cm high. Newly marked seedlings were considered new recruits since 2010. We calculated the relative growth rate (RGR) of all individuals for which we had diameter measurements from both 2010 and 2012. We calculated RGR as:

$$(\mathrm{diam}_{2012} - \mathrm{diam}_{2010})/\mathrm{diam}_{2010} \quad (1)$$

This measure of percent growth is independent of initial tree size, allowing us to compare relative growth among plants of different size classes. To compare diameter growth rates of different size classes of woody plants, we defined plants <5 cm DBH as seedlings, plants 5–10 cm DBH as saplings, and plants >10 cm DBH as trees.

To measure the response of spring plants, we measured percent cover (2009–2011) or number of individuals (2012), maximum height, and number of flowers and buds for each species present in sample quadrats. Five to ten quadrats (50 × 50 cm), depending on year, were sampled in each plot between late-March and mid-May, timed to correspond with peak diversity of spring plants each year. We analyzed each year of data for spring plants separately because of weather differences among years. In particular, an unusually early spring in 2012 caused some, but not all, species to emerge three to four weeks earlier than usual, resulting in a need to resample plots later in the season to capture all species of spring plants. Diversity, height, and flowering of spring ephemeral plants are considered strong indicators of deer browsing intensity because spring ephemerals are the first new plant growth in spring, and deer typically consume the entire aboveground portion of these plant, depleting stored plant resources and reducing plant size and reproductive success over time (Knight et al., 2009a). Because different species of plants have inherently different heights, we tested differences in the height of each species in paired exclosures and controls with a sign test.

We measured the overall density of summer vegetation in August 2011 we used a modified line-intercept method, where we ran a tape across the center of the plot at 20, 60, and 140 cm above ground level and counted the number of times that vegetation touched the tape (# intercepts). We repeated the count by running a tape across the plot in the perpendicular direction. The mean number of intercepts of these two transects at each height were compared between each paired exclosure and control plot. The height classes correspond to different intensities of browsing by deer, which prefer mid-range plant growth, and are similar to those used in other studies (e.g. Webster et al., 2001).

2.3. Animal sampling

We surveyed the density of two terrestrial species, white-footed mice (*Peromyscus leucopus*) and dog ticks (*Dermacentor variabilis*), and two primarily subterranean groups of species, earthworms (Family Lumbricidae) and lungless salamanders (Family Plethodontidae). We selected these species because they are small enough to easily move through the fences and their home range sizes allow them to potentially move between exclosures and controls, but they are not likely to leave the block entirely.

Animals with much larger home ranges, e.g. birds, would not be expected to frequently utilize 15 × 15 m exclosures. White-footed mice (*Peromyscus leucopus*) mice are the most abundant small mammals at the site and can be ecological important as both herbivores and prey. They are sensitive to vegetative cover for protection from predators and food availability. The home range of *P. leucopus* mice, the only common species at the site, is 0.2–0.6 ha (Aguilar, 2002), but they tend to spend most of their time in a smaller area, especially when nesting. Ticks serve as an indicator for other arthropod species, are easily collected from a several meter wide area with CO_2 traps, and have important implications for human health. In addition, both mice (Flowerdew and Ellwood, 2001; Bush et al., 2012) and ticks (Allan et al., 2010) have been shown to be affected by high densities of deer in previous studies. Like most small arthropods, ticks often depend on vegetative cover for thermoregulation and protection from desiccation in the summer months. One previous study on interactions between deer and salamanders found no effect of high deer densities on salamander abundance (Brooks, 1999). These woodland salamanders spend most of their time belowground, coming aboveground to feed in the leaf litter. Redbacked and zigzag salamanders have home ranges of approximately 0.5 m^2 (Petranka, 1998), but we have observed marked individuals moving between exclosures and control plots. Two-lined salamanders seasonally migrate up to 100 m from hilltops to streams for breeding but spend most of the summer season in a much more localized area. Earthworms were selected because of their dramatic effects on soil structure and nutrient cycling, and because, like ungulates, they have been considered ecosystem engineers having strong ecosystem effects (Holdsworth et al., 2007). One previous study examined the interactions between deer and earthworms, and found increased densities of a native earthworm species with high deer densities, possibly due to increased soil nitrogen (Rearick et al., 2011).

We sampled mice using five Sherman live traps (H.B. Sherman Traps, Tallahassee, Florida, USA) in each exclosure and control plot. Each block was sampled 3–4 times in 2011 and twice in 2012 (not all plots were sampled each year) over a total of 13 trap nights between July and early November 2011 and eight trap nights between July and September 2012 (traps were set in only a subset of blocks on any given trap night). Captured mice were sexed, weighed, measured, classified as juveniles or adults, and then immediately released at the trap site.

We sampled ticks in July 2011 using CO_2 traps constructed from coolers with holes drilled near the bottom and filled with dry ice. As the dry ice sublimates, the CO_2 released attracts ticks in search of animal hosts (Barre et al., 1997). We placed one CO_2 trap in the center of each plot and returned 3–5 h later to collect ticks.

To attract salamanders we placed 12 artificial cover objects (ACOs) in a grid within each exclosure and control plot. Half of the ACOs in each plot were untreated pine boards (12″ × 12″ × 2″) and the other half were carpet padding covered with plastic (18″ × 12″ × ¾″). ACOs were placed in June 2011 and left in place for the remainder of the experiment. We looked for salamanders beneath the ACOs every 2–4 weeks from Fall 2011 through Winter 2012, identified all individuals to species and sex, recorded their size and weight, and then released them at the point of collection.

We sampled earthworms in May 2012 with mustard extraction (Hale, 2007) and in October 2012 with an electrosampler (Weyers et al., 2008). We conducted comparisons between these two methods and found no difference, similar to the results of Eisenhauer et al. (2008). We collected earthworms from a 30 × 30 cm square quadrat for mustard sampling and from a 50 cm diameter circle for electrosampling. Earthworms were transported to the lab, where they were identified to species and then dried in ethanol and weighed. We used the log-transformed biomass ($g\ m^{-2}$) of ethanol-dried worms for analysis.

2.4. Soil properties and arbuscular mycorrhizal fungi

To measure effects of deer activity on soils we measured ammonium, nitrate, and phosphorus levels, net nitrogen mineralization, soil organic matter, soil moisture, and arbuscular mycorrhizal fungi (AMF) in soil samples (2 cm diameter, 0–15 cm depth) collected in June 2011. We collected five soil samples per plot and bulked these prior to processing to obtain an average of soil properties and fungal activity across the plot. Soil samples were bulked to intentionally average over spatial variation within a plot and focus on between plot differences. Soil samples were kept on ice and processed the following day. We used a pocket soil penetrometer (SoilTest Model 29-3729, Loveland, Colorado) to measure soil compaction with three replicate readings at five locations within each plot in June 2011, and used the mean value for analyses. Details of the methods for soil analyses are described in Appendix A2.

We measured AMF with two different methods. First, we extracted fungal spores from the soil samples and microscopically identified and quantified AMF spores. We used spore abundance and the number of morphotypes as variables to compare between

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plots. Second, we conducted a mycorrhizal inoculation potential (MIP) experiment in which we grew sorghum-sudangrass hybrid seeds in a mixture of field-collected soil and sterilized sand. After three weeks of growth, we harvested the plants, collected roots, and examined them for AMF colonization. We used the total colonization of arbuscules, hyphae, and vesicles as the dependent variable. Details of the methods for AMF analyses are in Appendix A3.

2.5. Environmental data

To test whether vegetation in the exclosures and control plots led to differences in microclimate, we measured temperature and humidity above (1.5 m above ground level) and below (2 cm above ground level) the understory plant layer in both mornings (7:00–10:00 am EDT) and evenings (7:00–9:00 pm EDT) of Summer and Fall 2011, using a portable hygrothermometer (Model EA20, Extech Instruments, Nashua, NH, USA). We collected data concurrently with mouse trapping, and recorded AM and PM temperatures on two to four different days in each plot in the summer and on two to six days in each plot in the fall.

2.6. Statistical analyses

Because of the number of variables examined in the same plots, we used MANOVA analyses for each group of related variables (i.e. spring vegetation, summer vegetation, tree seedlings, salamanders, earthworms, physical soil properties, soil nutrients, mycorrhizal communities, and microclimate) using the GLM procedure in SAS 9.3 (SAS Institute Inc., 2003). We included fixed effects for Exclosure and Habitat (Lowland, Hillside, or Ridgetop), and interactions of Exclosure × Exclosure Age, Exclosure × Habitat, and a random effect of Block (paired plots) nested within Habitat. Type III sums of squares were used to account for unequal sample sizes as a result of missing data for some variables, and Pillai's Trace values were used to determine statistical significance in MANOVAs. We also ran individual ANOVAs on the individual variables. All variables were tested for normal residuals prior to MANOVA and data that did not fit these assumptions were transformed so that the residuals fit a normal distribution. Most data were log-transformed, with the following exceptions: percent cover of spring plants was transformed with an arcsine square root transformation which was more successful than a logit transformation, and MIP data were treated with a square root transformation.

The mice capture data followed a Poisson distribution and could not be transformed to fit the assumptions of MANOVA. Instead we analyzed these data with a generalized linear model using the GENMOD procedure in SAS 9.3 with a Poisson distribution, log-link function, and repeated effect of year in the covariance structure. Individual ANOVAs were also run on the data for each year. The tick data followed a Poisson structure, but a generalized linear model would not converge. Therefore, we excluded plots in which no ticks were found in either treatment and the remaining data fit a normal distribution after a natural log transformation and were analyzed with an ANOVA.

3. Results

3.1. Effects on vegetation

Tree seedlings were strongly affected by deer exclusion. No native hardwood trees recruited into any of the control plots, while 51 native tree seedlings of six species were found in the exclosures. In total, there were 153 new woody recruits, including shrub species, inside the 15 exclosures, but only 24 new recruits (all native or invasive shrubs) in the controls (Fig. 1; paired *t*-test:

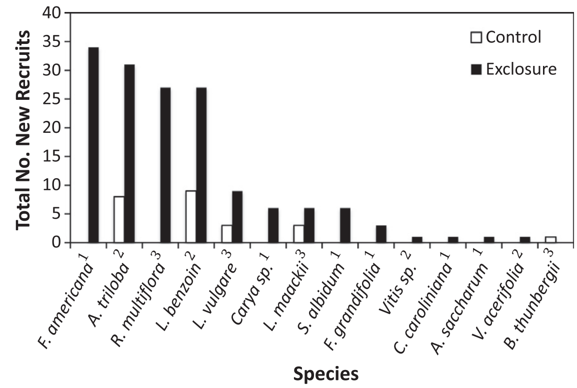

Fig. 1. Total number of new woody seedlings recruiting into all plots between 2010 and 2012. All six native hardwood tree species, one native shrub (*Viburnum acerifolia*), and one native vine (*Vitis* spp.) were found only in deer exclosure plots. The only new recruits in control plots were unpalatable native shrubs (*Asimina triloba* and *Lindera benzoin*) and invasive shrubs (*Rosa multiflora*, *Ligustrum vulgare*, *Lonicera maackii*, and *Berberis thunbergii*). Native tree species found were *Fraxinus americana*, *Carya* spp., *Sassafras albidum*, *Fagus grandifolia*, *Carpinus caroliniana*, and *Acer saccharum*. Subscripts with species names denote plant type: 1 = native hardwood tree, 2 = native shrub or vine, 3 = invasive shrub.

$T_{14} = 3.35$, $P < 0.005$). There was an average of 11 ± 3 (SE) new recruits in the surveyed area (32 m^2) of each exclosures and only 2 ± 1 in the same area of the control plots. The most common woody recruits found in control plots were *Lindera benzoin* (spicebush) and *Asimina triloba* (pawpaw), native shrubs considered unpalatable to deer. But even these species were 3–4 times more abundant in exclosures compared to controls. All other woody recruits found in control plots were non-native invasive shrubs: *Rosa multiflora* (multiflora rose), *Ligustrum vulgare* (European privet), *Lonicera maackii* (bush honeysuckle), and *Berberis thunbergii* (Japanese barberry).

We measured a total of 1363 woody stems between 2010 and 2012. Growth rates of existing seedlings were almost twice as great in exclosures compared to control plots. There was no difference in growth rates of saplings or mature trees (Fig. 2A; seedlings:

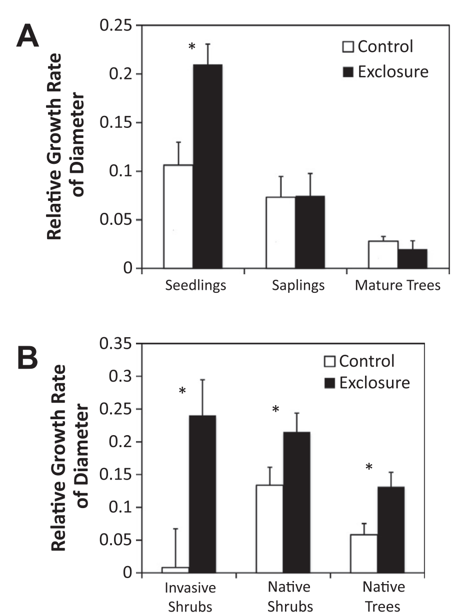

Fig. 2. Relative growth rates of woody plant diameter by size class (A) and among invasive shrubs and native trees and shrubs (B) in deer exclosures and adjacent, unfenced control plots. Seedlings were defined as individuals with diameter at breast height (DBH) <5 cm; saplings as 5 < DBH < 10; and mature trees as DBH >10 cm. Asterisks indicate significant differences between treatments ($P < 0.05$).

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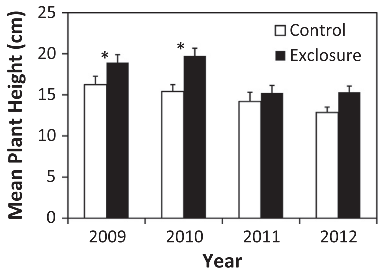

Fig. 3. Mean (±SE) maximum height of herbaceous plants inside deer exclosures and in unfenced controls for each spring from 2009 to 2012. Asterisks indicate significant differences between exclosure treatments ($P < 0.05$).

$F = 8.05$, $P = 0.005$; saplings: $F = 0.039$, $P = 0.85$; mature trees: $F = 0.14$, $P = 0.71$). We also compared relative growth rates of trees, native shrubs, and invasive shrubs. Each type of woody plant grew significantly more in exclosures than controls (Fig. 2B, $F = 3.49$, $P = 0.031$). Notably, invasive shrubs had very little growth in control plots and grew approximately 30 times more inside exclosures (Fig. 2B).

We recorded a total of 123 to 144 plant species each spring between 2009 and 2012. In each year, exclosure plots averaged 2–3 more species than control plots, but differences in species richness were statistically significant only in 2009 and 2011. The means (±SE) number of spring plant species in control plots (144 m^2) were 23 ± 2.5, 27 ± 2.5, 20 ± 1.7, and 15 ± 2.3 for 2009–2012, respectively. The means (±SE) in exclosure plots were 25 ± 3.1, 30 ± 3.0, 23 ± 2.4, and 17 ± 2.1 for each year respectively. Across all species, the average maximum height was greater in exclosures than controls in all years, but was statistically significantly only in 2009 and 2010, and marginally significant in the other years (Fig. 3, Table 1). Comparing individual species, significantly more species were taller in exclosures than in controls in all years. In 2009, 64% of species were taller in exclosures, 84% in 2010, 68% in 2011, and 77% in 2012 (Sign Test 2009: N = 88, S = 56, $P = 0.007$; 2010: N = 88, S = 74, $P < 0.0001$; 2011: N = 45, S = 31, $P = 0.008$; 2012: N = 74, S = 57, $P < 0.0001$). Plant height also differed significantly by Block in 2009 and 2010 and by Habitat in 2012. The effects of Exclosure Age and Habitat × Exclosure interaction were not significant in any year (Table 1.)

Webster and Parker (2000) identified three species as specific indicators of the intensity of deer browsing in Indiana forests:

Table 1
Statistical results for MANOVAs (shaded rows) and ANOVAs (unshaded rows) for vegetation data. *F*-values are Pillai's Trace values. *P*-values <0.05 are highlighted in bold.

		Exclosure	Habitat	Block × habitat	Exclosure × age	Exclosure × habitat
Spring vegetation	*F*	**8.05**	**9.27**	**6.94**	1.97	1.19
2009	*P*	**0.009**	**<0.001**	**<0.001**	0.12	0.36
Maximum height	*F*	**10.70**	1.32	**12.73**	2.98	0.56
	P	**0.008**	0.31	**<0.001**	0.10	0.59
Number of species	*F*	**5.29**	**8.08**	**19.82**	1.20	2.55
	P	**0.044**	**0.008**	**<0.001**	0.34	0.13
Total cover	*F*	0.02	**8.54**	**15.68**	0.47	0.48
	P	0.89	**0.007**	**<0.001**	0.64	0.63
Spring vegetation	*F*	**9.45**	**3.27**	**4.42**	0.85	0.39
2010	*P*	**0.005**	**0.024**	**<0.001**	0.55	0.88
Maximum height	*F*	**22.62**	0.22	**8.87**	0.54	0.15
	P	**<0.001**	0.81	**<0.001**	0.60	0.86
Number of species	*F*	4.66	**13.63**	**5.20**	1.43	1.05
	P	0.06	**0.001**	**0.008**	0.28	0.39
Total cover	*F*	0.26	**7.99**	**7.19**	0.84	0.13
	P	0.62	**0.008**	**0.002**	0.46	0.39
Spring vegetation	*F*	**6.99**	**9.97**	1.90	1.11	0.99
2011	*P*	**0.016**	**<0.001**	0.051	0.40	0.46
Maximum height	*F*	3.31	1.63	1.53	0.94	1.44
	P	0.10	0.25	0.27	0.43	0.29
Number of species	*F*	**16.95**	**7.92**	**6.95**	3.32	2.17
	P	**0.003**	**0.010**	**0.004**	0.08	0.17
Total cover	*F*	0.36	**23.76**	2.18	1.12	0.89
	P	0.56	**<0.001**	0.13	0.37	0.44
Spring vegetation	*F*	1.27	**5.21**	**2.51**	0.67	0.46
2012	*P*	0.35	**0.003**	**0.007**	0.68	0.83
Maximum height	*F*	3.64	**8.12**	2.32	0.27	0.20
	P	0.09	**0.008**	0.10	0.77	0.82
Number of species	*F*	0.59	**9.72**	2.70	1.67	1.06
	P	0.46	**0.005**	0.07	0.24	0.38
Total cover	*F*	0.03	**7.86**	**4.56**	0.34	0.44
	P	0.87	**0.009**	**0.012**	0.72	0.66
Summer vegetation	*F*	**4.73**	**5.92**	1.18	1.60	0.31
	P	**0.049**	**0.002**	0.33	0.21	0.92
20 cm Density	*F*	3.33	**5.30**	1.59	0.08	0.19
	P	0.10	**0.030**	0.25	0.92	0.83
60 cm Density	*F*	**11.28**	1.56	**3.75**	2.31	0.50
	P	**0.008**	0.26	**0.031**	0.15	0.62
140 cm Density	*F*	**6.58**	2.28	1.09	3.50	0.66
	P	**0.030**	0.16	0.45	0.07	0.54
Tree seedlings	*F*	**13.92**	1.08	**2.68**	0.91	1.15
	P	**0.002**	0.39	**0.016**	0.48	0.36
No. new recruits	*F*	**19.01**	1.06	2.45	0.10	0.28
	P	**0.001**	0.38	0.09	0.90	0.76
No. species	*F*	4.50	0.04	**4.95**	1.73	2.05
	P	0.06	0.96	**0.009**	0.23	0.18

Please cite this article in press as: Shelton, A.L., et al. Effects of abundant white-tailed deer on vegetation, animals, mycorrhizal fungi, and soils. Forest Ecol. Manage. (2014), http://dx.doi.org/10.1016/j.foreco.2014.02.026

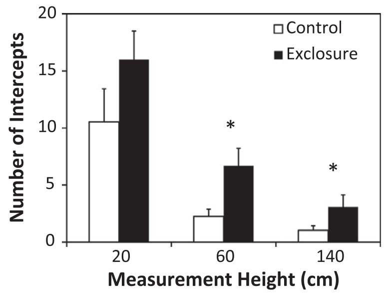

Fig. 4. Estimate of vegetation density measured as the number of times vegetation intercepted a tape strung across the plot at 20, 60, or 140 cm above ground level in August 2011. Asterisks indicate significant differences between deer exclosure plots and unfenced control plots ($P < 0.05$).

white baneberry (*Actaea pachypoda*), sweet cicely (*Osmorhiza claytonii*), and jack-in-the-pulpit (*Arisaema triphyllum*). We found significant differences in height and abundance of these species between exclosures and control plots. White baneberry was 100% taller in exclosures in 2010 ($F = 2.97$, $P = 0.13$, N = 9) and 60% taller in 2011 ($F = 8.30$, $P = 0.024$, N = 9). It was not found in either treatment in 2009 or in control plots in 2012. Sweet cicely was 67% taller in exclosures compared to controls in 2009 ($P = 0.024$, N = 12), and was found only in exclosures in all other years. Jack-in-the-pulpit was 16%, 32%, 113% and 17% taller in exclosures in 2009–2012, respectively (2009: $F = 1.23$, $P = 0.27$, N = 87; 2010: $F = 11.77$, $P < 0.001$, N = 91; 2011: $F = 39.56$, $P < 0.0001$, N = 35, 2012: $F = 0.28$, $P = 0.60$, N = 14). In 2012, jack-in-the-pulpit was not full grown at the time of sampling.

Species richness of spring plants was significantly greater in exclosures compared to controls in 2009 through 2011, but there was no significant difference in 2012 (Table 1). Species richness also varied significantly by Habitat and Block, with lowland plots have higher species diversity than upland plots, but not by Exclosure Age or Exclosure × Habitat interaction. The total cover of spring vegetation did not differ between exclosures and controls in any year, although it did differ by Block and Habitat with higher cover in lowland habitats (Table 1).

The density of summer vegetation was significantly greater inside exclosures compared to controls at 60 and 140 cm height, but not at 20 cm (Fig. 4, Table 1). One block had an extensive population of the invasive grass, Japanese stiltgrass (*Microstegium vimineum*), which had a dramatic effect on vegetation density at 20 cm above ground. This block had 246 intercepts of vegetation in the control and 125 in the exclosure, far beyond the range of other plots (maximum in other plots = 17.5 in controls and 31.5 in exclosures). Therefore, this block was excluded from statistical analyses and means shown in Fig. 4.

3.2. Effects on animals

Significantly more mice, and juvenile mice in particular, were captured inside exclosures in 2011. (Fig. 5A; Table 2). In 2011, we captured 31 mice (11 juveniles) in exclosures and 12 (0 juveniles) in controls. In 2012, we captured 35 mice (9 juveniles) in exclosures and 26 (4 juveniles) in controls. While the numbers were higher inside exclosures in 2012, the difference was not statistically significant (Table 2). Because we did not mark individuals, we do not know how many of these were recaptures, but by examining the weight, length, and sex of individuals we determined that most animals were unique individuals, with only one to two animals recaptured in a block. Therefore, these results reflect relative habitat use between exclosures and controls.

Exclosures had more ticks than control plots although the difference was not statistically significant (Fig. 5B, Table 2). However,

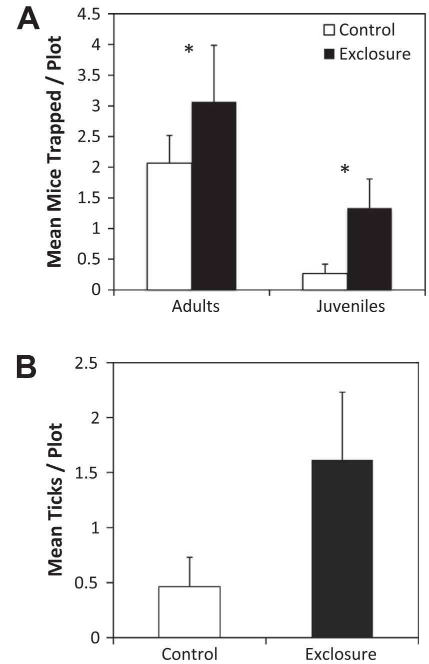

Fig. 5. (A) The mean number of *Peromyscus leucopus* mice (±SE) trapped between summer 2011 and Fall 2012 in fenced deer exclosures and unfenced control plots and (B) the mean number of *Dermacentor variabilis* ticks collected per plot in each treatment. Asterisks indicate significant differences between treatments ($P < 0.05$).

the overall number of ticks captured was low (1.6 ± 0.6 SE ticks per exclosure and 0.5 ± 0.3 SE per control plot) giving low statistical power to detect a difference. *Dermacentor variabilis*, the dog tick, was the only species found at the site.

There was no significant difference in the number of salamanders in exclosures compared to controls (Table 2). We collected a total of 854 salamanders: 219 *Plethodon cinereus* (red-backed salamander) in controls and 205 in exclosures, 197 *P. dorsalis* (zigzag salamander) in controls and 155 in exclosures, and 40 *Eurycea cirrigera* (two-lined salamander) in controls and 38 in exclosures. The number of salamanders varied with habitat and season with more salamanders present under ACOs in spring and fall and more in lowland plots than in ridgetop or hillside plots.

Earthworm densities also did not vary between exclosures and controls (Table 2), although there was a nonsignificant trend for greater worm density in control plots, particularly in lowland habitats. We found an average of 3.0 g ± 0.5 SE dry worm biomass ($g\ m^{-2}$) in exclosures and 4.6 ± 0.9 in control plots. Four species of earthworms were identified – *Lumbricus terrestris*, *Lumbricus rubellus*, *Octolasion cyaneum*, and *Apporectodea caliginosa* complex—all of which are introduced species in North America. Similar to salamanders, earthworms were more abundant in lowland habitats and least abundant on hillsides, likely due to differences in soil moisture.

3.3. Effects on microclimate

Temperatures above and below vegetation were slightly warmer in exclosures than controls on summer mornings and slightly cooler in exclosures on summer evenings, but this effect was not statistically significant (Table 3). The opposite pattern was seen in the fall where temperatures were warmer beneath vegetation in control plots in the morning and cooler beneath the vegetation in control plots in the evenings, but again this effect was not statistically significant (Table 3). Humidity tended to be higher below vegetation than above, but there were no differences between exclosures and controls.

Table 2
Statistical results for animals inside and outside deer exclosures. MANOVA results for multiple seasons are shaded and tests for individual seasons are not. Statistics with *P*-values <0.05 are highlighted in bold.

		Exclosure	Habitat	Block × habitat	Exclosure × habitat	Exclosure × age
Mice 2011[1]	χ^2	**14.31**	0.57	**18.51**	1.08	–
	P	**0.002**	0.45	**0.01**	0.30	–
Mice 2012[1]	χ^2	0.45	**15.2**	13.41	1.68	–
	P	0.50	**<0.001**	0.27	0.43	–
Ticks[2]	*F*	**15.38**	**17.10**	**2.68**	0.89	0.57
	P	**0.02**	**0.01**	**0.18**	0.13	0.49
Salamanders[3]	*F*	0.41	**20.03**	**2.90**	0.45	0.58
	P	0.80	**<0.001**	**0.001**	0.87	0.78
Fall 2011	*F*	0.90	**51.78**	2.73	0.02	0.34
	P	0.37	**<0.001**	0.08	0.98	0.72
Winter 2012	*F*	0.28	**24.86**	1.58	1.75	2.31
	P	0.61	**<0.001**	0.25	0.23	0.16
Spring 2012	*F*	0.46	**152.89**	**18.45**	0.42	0.31
	P	0.52	**<0.001**	**<0.001**	0.67	0.74
Fall 2012	*F*	1.86	**39.25**	**4.87**	0.97	1.31
	P	0.21	**<0.001**	**0.014**	0.41	0.32
Earthworm biomass[3]	*F*	1.25	**6.22**	0.80	0.56	0.57
	P	0.33	**0.002**	0.68	0.69	0.69
Spring 2012	*F*	0.02	3.15	1.18	0.54	0.64
	P	0.89	0.09	0.40	0.60	0.55
Fall 2012	*F*	2.74	**13.52**	0.52	0.52	0.39
	P	0.13	**0.001**	0.84	0.61	0.69

[1] Mice data were analyzed with a generalized linear model with a Poisson distribution and log-link function. Wald's χ^2 statistics are shown. Age was not included in the model due to lack of convergence.
[2] The log of tick numbers in plots with at least one tick was analyzed with an ANOVA.
[3] The log of salamander numbers and earthworm biomass were analyzed with MANOVA across all seasons (shaded) and ANOVA for individual seasons (unshaded).

Table 3
Results of MANOVA (shaded) and ANOVAs (unshaded) on the difference in temperature and humidity above and below vegetation. Pillai's Trace values are presented for MANOVA. *P*-values <0.05 are highlighted in bold.

		Exclosure	Habitat	Time	Block × habitat	Exclosure × age	Exclosure × time	Habitat × time	Excl × habitat × time
Environmental variables	*F*	2.33	**3.28**	**7.95**	**2.31**	1.65	1.58	**4.60**	1.29
	P	0.11	**0.01**	**<0.001**	**0.007**	0.17	0.16	**<0.001**	0.24
Temperature difference	*F*	**4.33**	**3.57**	0.25	1.84	2.91	2.70	1.72	1.05
	P	**0.04**	**0.04**	0.86	0.09	0.06	0.06	0.14	0.41
Humidity difference	*F*	0.13	**3.11**	**32.16**	**2.78**	0.82	1.11	**11.90**	1.72
	P	0.72	**0.05**	**<0.001**	**0.01**	0.45	0.35	**<0.001**	0.14

Table 4
Results of MANOVA (shaded row) and ANOVAs for physical soil properties inside and outside deer exclosures. Statistics with *P*-values <0.05 are highlighted in bold.

		Exclosure	Habitat	Block × habitat	Exclosure × age	Exclosure × habitat
Soil properties	*F*	3.37	2.38	**2.08**	1.25	0.98
	P	0.08	0.07	**0.02**	0.33	0.46
Compaction	*F*	**7.08**	0.91	**3.12**	3.49	3.24
	P	**0.02**	0.43	**0.04**	0.07	0.08
Organic Matter	*F*	0.70	0.02	2.01	0.78	0.00
	P	0.42	0.98	0.14	0.49	0.99
Moisture	*F*	0.33	2.36	2.19	0.06	0.12
	P	0.58	0.14	0.12	0.94	0.89

3.4. Effects on soil and arbuscular mycorrhizal fungi

Soil inside exclosures was significantly less compacted than soil in control plots, even in plots where deer had been excluded for only two years (Table 4). Mean compaction was 1.21 ± 0.13 (kg cm^{-2}, SE) in exclosures and 0.78 ± 0.13 in control plots ($F = 7.87$, $P < 0.0001$), and compaction was greater in all but one control plot compared to the paired controls. There were particularly large differences in compaction in the lowland plots and only minor differences in hillside plots. Soil moisture and soil organic matter had identical mean values in exclosures and controls (Table 4).

Initial concentrations of available ammonium, nitrate, and phosphorus, as well as net nitrogen mineralization, did not differ between exclosures and controls (Table 5). There was no significant difference in the abundance or richness of AMF spores between exclosures and controls, although there was a nonsignificant trend for more AMF in exclosures (Table 5). AMF abundance and diversity did vary across blocks, and there was greater AMF spore diversity in the top five cm of soil than at 5–15 cm. The mycorrhizal inoculation potential experiment showed marginally higher, but nonsignificant, AMF colonization in roots of plants grown in soil from exclosures.

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Table 5
Results of MANOVAs (shaded rows) and ANOVAs (unshaded rows) for soil nutrients and arbuscular mycorrhizal fungi (AMF). Statistics with $P < 0.05$ are highlighted in bold.

		Exclosure	Habitat	Depth[1]	Block × habitat	Habitat × depth	Fence × habitat
Soil – nutrients	*F*	0.91	**13.63**	**9.38**	**2.48**	1.80	0.97
	P	0.50	**<0.001**	**<0.001**	**<0.001**	0.07	0.49
Initial ammonium	*F*	2.18	**31.38**	**8.72**	**8.26**	0.06	**4.94**
	P	0.15	**<0.001**	**0.006**	**<0.001**	0.95	**0.01**
Initial nitrate	*F*	0.60	**36.77**	**26.57**	**10.07**	0.60	0.93
	P	0.44	**<0.001**	**<0.001**	**<0.001**	0.56	0.41
Nitrogen mineralization	*F*	2.98	**4.63**	**11.29**	**3.06**	**4.32**	1.34
	P	0.94	**0.02**	**0.002**	**0.008**	**0.02**	0.28
Phosphorus	*F*	0.11	**6.02**	**10.04**	0.49	1.79	0.16
	P	0.75	**0.006**	**0.003**	0.89	0.18	0.85
Arbuscular mycorrhizal fungi	*F*	1.67	**3.13**	**3.09**	**1.89**	1.12	1.61
	P	0.19	**0.01**	**0.04**	**0.006**	0.36	0.16
Number of spores	*F*	1.90	**4.92**	0.07	1.83	0.34	**3.223**
	P	0.18	**0.01**	0.79	0.08	0.71	**0.05**
Number of species	*F*	2.30	**5.15**	3.61	**3.63**	2.63	1.51
	P	0.14	**0.01**	0.06	**0.001**	0.09	0.23
Spore diversity[2]	*F*	1.58	2.93	**9.13**	**2.86**	0.15	0.85
	P	0.22	0.07	**0.005**	**0.007**	0.86	0.44
MIP total colonization	*F*	0.08	1.35	–	0.88	–	0.02
	P	0.78	0.26		0.57		0.98

[1] Depth categories: 0–5 cm and 5–15 cm.
[2] Spore diversity was calculated as the Shannon Diversity Index.

4. Discussion

4.1. Effects on vegetation

We found strong effects of deer exclusion on all aspects of understory vegetation measured. The complete lack of native tree recruitment in control plots is particularly dramatic given that deer had been excluded from the plots for only two or three years in 13 of 15 plots. The only woody plant recruitment in the control plots was by invasive shrubs and unpalatable native shrubs. Tree seedlings are often heavily browsed by deer, particularly in winter when little green vegetation is available. Reduced tree recruitment due to deer has been reported in several other studies (e.g. Horsley et al., 2003; Gill and Morgan, 2010; Martin et al., 2010). The rapid rebound in recruitment in exclosures found here, suggests that reducing deer density could restore tree regeneration, although sustained browsing could result in loss of an age class of trees from forests and potentially have long-term consequences for forest composition and structure.

In addition, there were no oak trees recruiting into any of the plots, despite the substantial presence of oaks in the canopy. Lack of oak regeneration is a problem throughout central hardwood forests and both intense deer browsing has been named as one contributing cause (McEwan et al., 2011) because deer have a strong preference for acorns (Duvendeck, 1962). In addition, established tree seedlings grew significantly faster inside exclosures and invasive shrubs grew almost thirty times faster in exclosures. These results suggest deer are having strong effects on woody vegetation, but recovery of local plant populations begins quickly after deer exclusion.

The growth of tree seedlings of native trees, native shrubs, and invasive shrubs were all significantly less in controls compared to exclosures, but the growth rate of invasive shrubs was affected most strongly. The relative growth rate of invasive shrubs was close to zero (0.008 ± 0.06 SE) in control plots but was approximately 30 times greater in exclosures (0.24 ± 0.05), indicating that deer are having a strong suppressive effect on invasive shrubs. The two oldest deer exclosures (constructed in 2005) have become dominated by invasive shrubs, particularly bush honeysuckle, multiflora rose, autumn olive (*Elaeagnus umbellata*), and privet, although numerous native tree seedlings are also present. Our results suggest that if deer numbers were reduced, invasive shrub species may grow and reproduce more, potentially leading to increased density of invasive shrub species (e.g. Baiser et al., 2008; Eschtruth and Battles, 2009). Observations of invasive shrubs outside deer exclosures have revealed extensive deer browsing on invasive shrubs, particularly bush honeysuckle and multiflora rose, suggesting that deer may help to keep these species in check. Moreover, all of the invasive species examined here are typically bird-dispersed via berries. The fences may provide a convenient perch for birds such that the increased prevalence of these invasive species may be an indirect effect of the fence.

Plant height is commonly used as an indicator of browsing intensity (e.g. Shelton and Inouye, 1995; Webster and Parker, 2000; Kirschbaum and Anacker, 2005) because most species of spring ephemerals are slow-growing perennials with size-dependent flowering. Browsing by deer typically removes the entire aboveground portion of the plant, eliminating the opportunity to flower and the ability to store resources for future years. This can result in plants becoming progressively smaller over years, delaying reproduction, or never reaching the threshold size for flowering. Thus, a decrease in the height of spring ephemerals can indicate reduced reproductive potential, which can lead to population declines and local extinctions (Ehrlen, 1995; Rooney and Gross, 2003; McGraw and Furedi, 2005). For example, Knight et al. (2009a) constructed a demographic model for *Trillium grandiflorum* at sites across a range of deer densities in Pennsylvania and found that local population extinction is expected when 15% or more of the individuals in the population are browsed annually. Thus, the differences in plant height found here are consistent with reduced reproductive potential of many spring ephemeral species.

Summer vegetation was significantly denser inside exclosures, with almost three times more vegetation inside exclosures at 60 and 140 cm. There was no difference at 20 cm, which may indicate that deer prefer to browse on taller vegetation or that plants recover to this height quickly. The absence of vegetation between 60 and 140 cm indicates a depauperate understory with reduced cover for understory animal species. In the 1990s, a study of vegetation in Indiana State Parks, where deer hunting was prohibited, compared to forests where hunting was allowed, showed a significant decrease in the abundance of vegetation between 50 and 200 cm in unhunted parks (Webster and Parker, 1997). A follow-up survey of the same sites approximately 20 years after managed hunts were instituted at State Parks showed significant increases in vegetation density in the 50–200 cm size class, but no difference in vegetation <50 cm or >200 cm, which is beyond the browsing range of deer (Jenkins, 2011). Our results show a similar pattern, with increased vegetation density at 60 and 140 cm after a shorter period of deer reduction.

We also observed an interaction between deer exclusion and the growth of Japanese stiltgrass (*Microstegium vimineum*), a highly aggressive invasive species, in one block of the exclosure pairs. In 2009 this lowland block had 91% cover of Japanese stiltgrass in the control compared to 79% in the exclosure. By 2011 the cover had declined to 22% in the exclosure but remained high (86%) in the control plot. In late summer the control plot was dominated by Japanese stiltgrass with just a few emergent native species, whereas the exclosure was dominated by native vegetation with small Japanese stiltgrass plants beneath the canopy of natives. This suggests that in the absence of deer browsing, native species are able to compete with this invader, but when deer densities are high, deer preferentially consume natives and the Japanese stiltgrass is released from competition and able to dominate a site. While these patterns are based only on a single pair of plots, similar results have been observed elsewhere where areas with high densities of deer had more extensive invasions of Japanese stiltgrass than areas with lower deer density (Baiser et al., 2008; Webster et al., 2008). Deer avoid eating Japanese stiltgrass and, therefore, the presence of high deer populations may give this species a competitive advantage over native plants, and contribute to its dominance and rapid spread (Knight et al., 2009b).

Most of the above changes in vegetation can be attributed to direct effects of browsing, but even plant species that are rarely consumed directly can show declines due to high deer density. For example, Heckel et al. (2010) showed that jack-in-the-pulpit had reduced size, flower size and seed production at sites with higher deer densities. They attributed these effects to deer-driven effects on soil properties, particularly soil compaction. The same study by Heckel et al. also examined four other unpalatable species and found negative effects of high deer densities on all of them, suggesting that high deer abundances may negatively affect many spring ephemerals via indirect effects such as declines in soil quality. Similarly, deer rarely browse the native shrubs spicebush (*Lindera benzoin*) and pawpaw (*A. triloba*), but their abundance was significantly lower here in controls than in exclosures (Fig. 4). These two species have also increased over the last couple of decades at other sites in Indiana and deer browsing has been implicated as a contributing factor (Jenkins, 2011). White-tailed deer typically have varying preferences for different food types, and alter their diets when their most preferred foods are not available (Augustine and DeCalesta, 2003; Royo et al., 2010).

4.2. Effects on animals

We found significant effects of deer exclusion on ticks and mice in 2011 but not 2012. In 2011, no juvenile mice were found in control plots while 11 juveniles were captured in exclosures. Although mice were more abundant in exclosures in 2012, the difference was not statistically significant. Higher numbers of mice in exclosures may be due to increased food availability as a result of higher plant densities, better cover from predators, exclusion of ground predators, or more moderate microclimate. Our results mirror those found in other studies that have shown negative effects of deer on small mammal populations (Flowerdew and Ellwood, 2001; Bush et al., 2012).

The higher number of ticks in exclosures compared to controls may be related to the relative abundance of small mammals, which are the preferred hosts of nymphal ticks, or to differences in microclimate. On the other hand, deer also serve as hosts for ticks and high deer densities can lead to more dense tick populations (Allan et al., 2010). We found trends for slight moderation of temperature beneath vegetation in exclosures but not in controls, and it desiccation is the primary source of mortality for ticks, and microclimate can affect the risk of desiccation (Needham and Teel, 1991; Civitello et al., 2009). During summer at the time ticks were collected, temperatures beneath the vegetation compared to above the vegetation tended to be slightly warmer in mornings and slightly cooler in evenings in exclosures, but not in controls (Fig. 5, Table 3). This moderation of ground-level temperature may help small animals and arthropods avoid heat stress and desiccation, particularly during periods of high temperatures. This is more likely to be the case with ticks, which have been shown to have higher mortality in areas with less vegetative cover (Carroll, 2003; Civitello et al., 2009). Similar reductions in the density of arthropods in areas of high deer density have been seen in other studies (Miyashita et al., 2004; Allombert et al., 2005), suggesting this may be a general pattern. If ticks are a good indicator of other small arthropods, then higher numbers inside deer exclosures may relate to increased abundance of other arthropods, which would be important for a wide variety of insectivorous species.

In contrast to the increased numbers of terrestrial animals found inside exclosures, we found no effects of exclosures on salamanders or earthworms. These results suggest that terrestrial animals are more susceptible to indirect effects of high deer densities than are subterranean animals. It is possible that deposition of urine and feces from deer may provide nutrient resources to belowground animals, creating positive effects or buffering them from negative effects. However, we found no difference in nutrient concentrations or nitrogen mineralization between exclosures and controls, suggesting this is not likely to be important at this site. It is also possible that belowground communities are slower to respond to aboveground herbivores. Our exclosures ranged from two to seven years over the course of this study and indirect effects of deer may take longer to cascade to belowground communities.

In contrast to our results, two recent studies found significant effects of deer on belowground communities. Bressette et al. (2012) found decreased soil nutrients and increased AMF activity in plots where deer were excluded. Lessard et al. (2012) found higher species richness of soil and litter arthropods inside exclosures, but no difference in arthropod abundance except for ants, which were more abundant in exclosures. Although they predicted lower effect sizes for belowground trophic levels, they found equivalent effect sizes at each trophic level tested. On the other hand, Rearick et al. (2011) found higher densities of a native earthworm (*Eisenoides carolinensis*) in control plots compared to exclosures, which is the same trend found in this study. This difference may be due to increased nutrients from deer pellets and urine which have been shown to make a significant contribution to the nitrogen cycle (Hobbs, 1996).

4.3. Effects on soils and AMF communities

Soil inside exclosures quickly became less compacted than in control plots, even in plots where deer had been excluded for only two years. This rapid change in soil compaction was surprising because it seems unlikely that a release from trampling could cause such rapid changes. It could be due to increased plant root growth or mycorrhizal activity, although our study did not address possible mechanisms. We did see increased aboveground plant growth, however, and aboveground biomass and growth is usually strongly correlated with belowground biomass and growth, so increased root growth is a possible explanation. Earthworms were initially posited as a possible cause of reduced soil compaction in deer exclosures, but our data clearly confirmed that earthworm densities were equal or lower in exclosures and therefore this is not likely a cause for the difference in soil compaction. Similar differences in soil compaction across a gradient of deer densities have been shown in other studies (Heckel et al., 2010), confirming the results found here.

We found no differences in mycorrhizal spore community richness, abundance, or diversity between exclosures and control plots. In addition, the MIP experiments showed equivalent AMF colonization in soils from exclosures and controls. Because of the extensive herbivory over many years at Griffy Woods, we hypothesize that mycorrhizal communities may have been suppressed due to a lack of adequate host plants because AMF may increase with species richness or plant abundance, but AMF may be propagule limited within the exclosures. In addition, AMF and other soil properties may be slower to respond deer exclusion and two years may not be sufficient for any potential differences to occur. In contrast, Bressette et al. (2012) found higher AMF colonization in soils within exclosures, but their exclosures were much older (18 years) than those in this study.

5. Summary

Due to the high densities of deer at Griffy Woods, the vegetative community has been altered from its natural condition as evidenced by contrasts between exclosure and control plots. There was significantly reduced understory vegetation, including reduced size, abundance, and diversity of understory plants; reduced tree regeneration; altered microenvironmental conditions; and negative effects on mice and ticks. However, we did not find indirect effects of deer exclusion on belowground animals, arbuscular mycorrhizal fungi, or nutrient levels, but soils in exclosures were less compacted than in control plots. Belowground communities may be buffered from the effects of deer, or effects may be time-lagged and not appear until after longer periods of deer reduction or exclusion. Surprisingly exclosure age had no significant effect on any of the results and many measured variables were significantly different between exclosures and controls after only two years of deer exclusion. This indicates that responses to deer exclusion happen rapidly, often within two years after deer exclusion, regardless of environmental differences such as differences in weather patterns between years.

At high densities, the effects of ungulates on forest communities may be analogous to the effects of an introduced invasive species that is able to dominate an area due to release from natural enemies. Although white-tailed deer were extirpated from many areas, they were reintroduced in the mid-20th century, but their predators, which were also extirpated, were not. Combined with habitat modifications such as forest fragmentation, agricultural expansion, and the spread of exurban areas, deer populations have reached historically unprecedented densities in many areas. This same pattern of increasing ungulate populations, particularly in areas near human populations, has occurred in many temperate regions of the world, and this is simply one example of this widespread problem. These high densities of deer are altering the structure and diversity of forest communities and may lead to dramatic changes in forest structure if intensive deer browsing persists for long periods.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.foreco.2014.02.026.

References

Aguilar, S., 2002. Peromyscus leucopus. In, Animal Diversity Web.
Allan, B.F., Dutra, H.P., Goessling, L.S., Barnett, K., Chase, J.M., Marquis, R.J., Pang, G., Storch, G.A., Thach, R.E., Orrock, J.L., 2010. Invasive honeysuckle eradication reduces tick-borne disease risk by altering host dynamics. Proc. Natl. Acad. Sci. 107, 18523–18527.
Allombert, S., Stockton, S., Martin, J.-L., 2005. A natural experiment on the impact of overabundant deer on forest invertebrates. Conserv. Biol. 19, 1917–1929.
Alverson, W.S., Waller, D.M., Solheim, S.L., 1988. Forests too deer: edge effects in northern Wisconsin. Conserv. Biol. 2, 348–358.
Augustine, D.J., DeCalesta, D., 2003. Defining deer overabundance and threats to forest communities: from individual plants to landscape structure. Ecoscience 10, 472–486.
Augustine, D.J., Frelich, L.E., 1998. Effects of white-tailed deer on populations of an understory forb in fragmented deciduous forests. Conserv. Biol. 12, 995–1004.
Bailey, R.G., 1995. Description of the ecoregions of the United States. In. USDA Forest Service, Washington, D.C.
Baiser, B., Lockwood, J., La Puma, D., Aronson, M., 2008. A perfect storm: two ecosystem engineers interact to degrade deciduous forests of New Jersey. Biol. Invasions 10, 785–795.
Barre, N., Garris, G.I., Lorvelec, O., 1997. Field sampling of the tick *Amblyomma variegatum* (Acari: Ixodidae) on pastures in Guadeloupe: attraction of CO_2 and/or tick pheromones and conditions of use. Exp. Appl. Acarology 21, 95–108.
Bloomington–Monroe County Deer Task Force, 2012. Common ground: Toward balance and stewardship. Bloomington, Indiana, USA.
Bressette, J.W., Beck, H., Beauchamp, V.B., 2012. Beyond the browse line: complex cascade effects mediated by white-tailed deer. Oikos, 1–12.
Brooks, R.T., 1999. Residual effects of thinning and high white-tailed deer densities on northern redback salamanders in southern New England oak forests. J. Wildl. Manage. 63, 1172–1180.
Bush, E.R., Buesching, C.D., Slade, E.M., Macdonald, D.W., 2012. Woodland recovery after suppression of deer: cascade effects for small mammals, wood mice (Apodemus sylvaticus) and bank voles (Myodes glareolus). PLoS ONE 7, 1–9.
Cambrone, A., 2013. Deerland: America's Hunt for Ecological Balance and the Essence of Wildness Lyons Press, Guilford, Conn.
Carroll, J.F., 2003. Survival of larvae and nymphs of Ixodes scapularis Say (Acari: Ixodidae) in four habitats in Maryland. Proc. Entomol. Soc. Wash. 105, 120–126.
Chollet, S., Martin, J.-L., 2013. Declining woodland birds in North America: Should we blame Bambi? Divers. Distrib. 19, 481–483.
Civitello, D.J., Flory, S., Clay, K., 2009. Exotic grass invasion reduces survival of *Amblyomma americanum* and *Dermacentor variabilis* ticks. J. Med. Entomol. 45, 867–872.
Clutton-Brock, T., Coulson, T., Milner, J.M., 2004. Red deer stocks in the Highlands of Scotland. Nature 429, 261–262.
Côté, S.D., Rooney, T.P., Tremblay, J.-P., Dussault, C., Waller, D.M., 2004. Ecological impacts of deer overabundance. Ann. Rev. Ecol. Evol. Syst. 35, 113–147.
deCalesta, D.S., 2013. Reliability and precision of pellet-group counts for estimating landscape-level deer density. Human–Wildlife Interactions 7, 60–68.
Duvendeck, J.P., 1962. The value of acorns in the diet of Michigan deer. J. Wildl. Manage. 26, 371–379.
Ehrlen, J., 1995. Demography of the Perennial Herb *Lathyrus Vernus*. I. Herbivory and Individual Performance. J. Ecol. 83, 287–295.
Eisenhauer, N., Straube, D., Scheu, S., 2008. Efficiency of two widespread non-destructive extraction methods under dry soil conditions for different ecological earthworm groups. Eur. J. Soil Biol. 44, 141–145.
Eschtruth, A.K., Battles, J.J., 2009. Acceleration of exotic plant invasion in a forested ecosystem by a generalist herbivore. Conserv. Biol. 23, 388–399.
Flowerdew, J.R., Ellwood, S.A., 2001. Impacts of woodland deer on small mammal ecology. Forestry 74, 277–287.
Forsyth, D.M., Barker, R.J., Morriss, G., Scroggie, M.P., 2007. Modeling the relationship between fecal pellet indices and deer density. J. Wildl. Manage. 71, 964–970.
Gill, R.M.A., Morgan, G., 2010. The effects of varying deer density on natural regeneration in woodlands in lowland Britain. Forestry 83, 53–63.
Gortázar, C., Herrero, J., Villafuerte, R., Marco, J., 1998. Historical examination of the status of large mammals in Aragon, Spain. Mammalia 64, 411–422.
Greenwald, K.R., Petit, L.J., Waite, T.A., 2009. Indirect effects of a keystone herbivore elevate local animal diversity. J. Wildl. Manage. 72, 1318–1321.
Hale, C., 2007. Earthworms of the Great Lakes. Kollath+Stensaas Publishing, Duluth, Minnesota.

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Harrison, K.A., Bardgett, R.D., 2008. Impacts of grazing and browsing by large herbivores on soils and soil biological properties. In: Gordon, I.J., Prins, H.H.T. (Eds.), The Ecology of Browsing and Grazing. Springer-Verlag, Heidelberg, Germany, pp. 201–216.
Heckel, C.D., Bourg, N.A., McShea, W.J., Kalisz, S., 2010. Nonconsumptive effects of a generalist ungulate herbivore drive decline of unpalatable forest herbs. Ecology 91, 319–326.
Hobbs, N.T., 1996. Modification of ecosystems by ungulates. J. Wildl. Manage. 60, 695–713.
Holdsworth, A.R., Frelich, L.E., Reich, P.B., 2007. Regional extent of an ecosystem engineer: earthworm invasion in northern hardwood forests. Ecol. Appl. 17, 1666–1677.
Homoya, M.A., Abrell, D.B., Aldrich, J.R., Post, T.W., 1985. The natural regions of Indiana. Proc. Indiana Acad. Sci. 94, 245–268.
Horsley, S.B., Stout, S.L., DeCalesta, D.S., 2003. White-tailed deer impact on the vegetation dynamics of a northern hardwood forest. Ecol. Appl. 13, 98–118.
Q3 Jenkins, L.H., 2011a. Evaluating the recovery of vegetation communities in Indiana State Parks after more than a decade of deer population reduction. M.S. Thesis. Forestry and Natural Resources Dept. Purdue University, West Lafayette, Indiana.
Kaji, K., Miyaki, M., Saitoh, T., Ono, S., Kaneko, M., 2000. Spatial distribution of an expanding sika deer population on Hokkaido Island, Japan. Wildl. Soc. Bull. 28, 699–707.
Kirschbaum, C.D., Anacker, B.L., 2005. The utility of *Trillium* and *Maianthemum* as phyto-indicators of deer impact in northwestern Pennsylvania, USA. For. Ecol. Manage. 217, 54–66.
Knight, T.M., Caswell, H., Kalisz, S., 2009a. Population growth rate of a common understory herb decreases non-linearly across a gradient of deer herbivory. For. Ecol. Manage. 257, 1095–1103.
Knight, T.M., Dunn, J.L., Smith, L.A., Davis, J., Kalisz, S., 2009b. Deer facilitate invasive plant success in a Pennsylvania forest understory. Nat. Areas J. 29, 110–116.
Lessard, J.-P., Reynolds, W.N., Bunn, W.A., Genung, M.A., Cregger, M.A., Felker-Quinn, E., Barrios-Garcia, M.N., Stevenson, M.L., Lawton, R.M., Brown, C.B., Patrick, M., Rock, J.H., Jenkins, M.A., Bailey, J.K., Schweitzer, J.A., 2012. Equivalence in the strength of deer herbivory on above and below ground communities. Basic Appl. Ecol. 13, 59–66.
Martin, J.-L., Stockton, S., Allombert, S., Gaston, A., 2010. Top-down and bottom-up consequences of unchecked ungulate browsing on plant and animal diversity in temperate forests: lessons from a deer introduction. Biol. Invasions 12, 353–371.
McCabe, T.R., McCabe, R.E., 1997. Recounting whitetails past. In: McShea, W.J., Underwood, H.B., Rappole, J.H. (Eds.), The Science of Overabundance: Deer Ecology and Population Management. Smithsonian Institution Press, Washington, D.C., pp. 11–26.
McEwan, R.W., Dyer, J.M., Pederson, N., 2011. Multiple interacting ecosystem drivers: toward an encompassing hypothesis of oak forest dynamics across eastern North America. Ecography 34, 244–256.
McGraw, J.B., Furedi, M.A., 2005. Deer browsing and population viability of a forest understory plant. Science 307, 920–922.
McShea, W.J., Underwood, H.B., Rappole, J.H. (Eds.), 1997. The Science of Overabundance: Deer Ecology and Population Management. Smithsonian Institution Press, Washington, D.C.
Miyashita, T., Takada, M., Shimazaki, A., 2004. Indirect effects of herbivory by deer reduce abundance and species richness of web spiders. Ecoscience 11, 74–79.
Needham, G.R., Teel, P.D., 1991. Off-host physiological ecology of Ixodid ticks. Annu. Rev. Entomol. 36, 659–681.
Parsons, E.W.R., Maron, J.L., Martin, T.E., 2013. Elk herbivory alters small mammal assemblages in high-elevation drainages. J. Anim. Ecol. 82, 459–467.
Petranka, J.W., 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C..
Rearick, D., Kintz, L., Burke, K.L., Ransom, T.S., 2011. Effects of white-tailed deer on the native earthworm, *Eisenoides carolinensis*, in the southern Appalachian Mountains, USA. Pedobiologia—Intl. J. Soil Biol..
Rooney, T.P., 2001. Deer impacts on forest ecosystems: a North American perspective. Forestry 74, 201–208.
Rooney, T.P., 2009. High white-tailed deer densities benefit graminoids and contribute to biotic homogenization of forest ground-layer vegetation. Plant Ecol. 202, 103–111.
Rooney, T.P., Gross, K., 2003. A demographic study of deer browsing impacts on *Trillium grandiflorum*. Plant Ecol. 168, 267–277.
Rooney, T.P., Waller, D.M., 2003. Direct and indirect effects of white-tailed deer in forest ecosystems. For. Ecol. Manage. 181, 165–176.
Rossow, L.J., Bryant, J.P., Kielland, K., 1997. Effects of above-ground browsing by mammals on mycorrhizal infection in an early successional taiga ecosystem. Oecologia 110, 94–98.
Royo, A.A., Collins, R., Adams, M.B., Kirschbaum, C., Carson, W.P., 2010. Pervasive interactions between ungulate browsers and disturbance regimes promote temperate forest herbaceous diversity. Ecology 91, 93–105.
SAS Institute Inc., 2003. SAS 9.2 for Windows. In, Cary, NC, USA.
Shelton, A.L., Inouye, R.S., 1995. Effect of browsing by deer on the growth and reproductive success of *Lactuca canadensis* (Asteraceae) in old fields in Minnesota. Am. Midl. Nat. 134, 332–339.
Sterba, J., 2012. Nature Wars. Crown Publishing Group, New York.
Teichman, K.J., Nielsen, S.E., Roland, J., 2013. Trophic cascades: linking ungulates to shrub-dependent birds and butterflies. J. Anim. Ecol. 82, 1288–1299.
Terborgh, J., Estes, J.A., 2010. Trophic Cascades: Predators, Prey, and the Changing Dynamics of Nature. Island Press, Washington, D.C..
Ward, A., 2005. Expanding ranges of wild and feral deer in Great Britain. Mamm. Rev. 35, 165–173.
Webster, C., Rock, J., Froese, R., Jenkins, M., 2008. Drought–herbivory interaction disrupts competitive displacement of native plants by *Microstegium vimineum*, 10-year results. Oecologia 157, 497–508.
Webster, C.R., Jenkins, M.A., Parker, G.R., 2001. A field test of herbaceous plant indicators of deer browsing intensity in mesic hardwood forests of Indiana, USA. Nat. Areas J. 21, 149–158.
Webster, C.R., Jenkins, M.A., Rock, J.H., 2005. Long-term response of spring flora to chronic herbivory and deer exclusion in Great Smoky Mountains National Park, USA. Biol. Conserv. 125, 297–307.
Webster, C.R., Parker, G.R., 1997. The effects of white-tailed deer on plant communities within Indiana state parks. Proc. Indiana Acad. Sci. 106, 213–231.
Webster, C.R., Parker, G.R., 2000. Evaluation of *Osmorhiza claytoni* (Michx.) C.B. Clarke, *Arisaema triphyllum* (L.) Schott, and *Actaea pachypoda* Ell. as potential indicators of white-tailed deer overabundance. Nat. Areas J. 20, 176–188.
Weyers, S.L., Schomberg, H.H., Hendrix, P.F., Spokas, K.A., Endale, D.M., 2008. Construction of an electrical device for sampling earthworm populations in the field. Appl. Eng. Agric. 24, 391–397.
Wheatall, L., Nuttle, T.I.M., Yerger, E., 2013. Indirect effects of pandemic deer overabundance Inferred from Caterpillar–Host relations. Conserv. Biol. 27, 1107–1116.

Dear Members of the Bloomington Common Council:

We write to you, as longtime members of the City of Bloomington Board of Park Commissioners, to ask you to make the necessary decisions, and take the necessary actions, that will allow the Parks Board and the Parks Department to move quickly to protect one of our city's most important and valued natural resources: Griffy Lake Nature Preserve.

Griffy Lake Nature Preserve faces a serious and imminent threat to its continued existence as a healthy and vital ecosystem. To put it bluntly, Griffy Woods is dying. And we need your help to try to save it.

The imminent threat comes from the massive overpopulation of deer at Griffy Woods. This problem arose in large part due to human interventions: the eradication of higher-level predators, and the proliferation of human development that supplied new food sources for the deer. Now, whether we like it or not, the problem has spiraled out of control and can be addressed effectively only through further human interventions. The deer are consuming the young plants at Griffy much faster than nature can replace them, literally altering the course of the forest's evolution in ways that will diminish it for present and future generations.

As you are most aware, in 2010 the City of Bloomington and Monroe County jointly formed the Deer Task Force. This blue-ribbon panel of citizens and experts studied the deer overpopulation problem for more than two years, with extensive public input, and in December 2012 issued a careful and thorough Final Report containing recommendations for dealing with the deer overpopulation crisis at Griffy Lake. This Report, entitled "Common Ground: Toward Balance and Stewardship," was "accepted" by the Common Council. But today, more than three years after the formation of the Deer Task Force, and more than a year after its Report was issued, those recommendations still sit idle. Meanwhile, the damage to Griffy Lake Nature Preserve continues unabated.

As the elected representatives of the residents of Bloomington, those of you who serve as members of the Common Council bear the responsibility to determine, as a matter of public policy, the most appropriate methods for controlling the rampant deer populations, both at Griffy Lake Nature Preserve and elsewhere throughout the City of Bloomington. The recommendations from the Deer Task Force are clear. The time to act on those recommendations is now. Griffy Woods can't wait any longer.

Please act on the Deer Task Force recommendations, and help us to save Griffy!

Sincerely,

Joseph Hoffmann
Member, Board of Park Commissioners

Sincerely,

Leslie J. Coyne
President, Board of Park Commissioners

March 17, 2014

To the Bloomington City Council:

On behalf of the Bloomington Parks and Recreation's Environmental Resources Advisory Council (ERAC), we strongly encourage you to support the legislation to allow lethal control of deer at the Griffy Lake Nature Preserve.

The Griffy Lake area is a jewel of the Bloomington community, including a wealth of biodiversity and natural habitats. However, over the last decade or so, it has shown great ecological damage due to the high deer population. Research from Indiana University using deer exclosures on the IU Research and Teaching Preserve's property at Griffy Woods has shown the deer population in the area is unusually high, with more than 10 times as many deer pellet piles at Griffy Woods compared to two other nearby forest preserves. This research also identified significant decreases in spring and summer plant abundance and the complete absence of native tree recruitment outside the deer exclosures. It also found negative effects of deer on soil compaction and mice populations, suggesting that the effects on plants are cascading throughout the ecosystem.

If nothing is done to manage the deer population, it will likely continue to increase, causing even greater ecological damage. If we wait to control the population, it could cause irreversible damage to the forest by eliminating native plants, losing an entire age class of native trees, and leading to increases of invasive plants and changes in soil communities. Lack of action to control the deer population at this point will almost certainly harm the biodiversity at Griffy Woods, harming both plant and animal species, and threatening the future health of the forest.

The deer issue at Griffy Woods has been a regular topic on ERAC's meeting agendas since 2009. The Joint Bloomington-Monroe County Deer Task Force spent many months studying the issue and determined that lethal control was the only viable option, and that it was certainly needed at Griffy Woods. ERAC agrees with and supports their conclusions. We encourage the City Council to accept this change to City rules to allow the management of deer at Griffy Woods.

Sincerely,

Melissa Clark

CITY OF BLOOMINGTON INDIANA
COMMISSION ON SUSTAINABILITY

Bloomington Commission On Sustainability

Letter of Support for Measures to Reduce Deer Population in Griffy Nature Preserve:

Approved by unanimous vote of all members present at regular meeting held 3/11/14

Dear Mayor Kruzan and Bloomington City Council Members,

The Bloomington Commission on Sustainability (BCOS) has learned that the Council is considering a resolution, which would allow the Bloomington Parks and Recreation Board to alleviate deer overpopulation in Griffy Nature Preserve. We believe this action to be absolutely necessary to reverse the damage occurring in the Griffy Nature Preserve ecosystem due to the excessive and unsustainable deer population. BCOS recommends that this proposal be adopted immediately, for three reasons related to our mandate to work for a sustainable local society.

First, major ecological changes are taking place in the preserve due to extreme deer overpopulation. The vegetation of the area has been drastically changed, with trees not reproducing and wildflowers that were once there now gone. Changes in vegetation have many measured and potential side-effects on other animals. Reducing the deer population is necessary to allow desirable ecological relationships to be restored and sustained.

Second, people living near the park are being affected by the large numbers of deer as well, with damage to vegetable gardens being a concern of BCOS, as it becomes ever more important for people to grow their own food.

Third, we would expect that at least some of the venison from the deer killed could be provided to local food pantries, and ensuring adequate food to low-income Bloomingtonians is another concern of BCOS.

We appreciate the exhaustive and thoughtful work and research of the Bloomington Deer Task Force and concur with their findings and recommendations, including the hiring of professional sharpshooters to return deer populations to sustainable levels in the Griffy Nature Preserve.

If we can provide any assistance, please contact us at sustain@blomington.in.gov

Respectfully,

Jeffrey Jewel
BCOS Co-Chair 2014

Molly O'Donnell
BCOS Co-Chair 2014

MC IRIS

Monroe County's
Identify and Reduce Invasive Species

8358 N. Mt. Tabor Rd.
Ellettsville, IN 47429

March 19, 2014

Dear Members of the City Council:

I am writing on behalf of Monroe County – Identify and Reduce Invasive Species, a local group dedicated to decreasing the impact of invasive species in Monroe County, to support the recommendations of the Joint City of Bloomington – Monroe County Deer Task Force (Deer Task Force) for deer reduction.

The environmental damage being caused by deer in Bloomington natural areas like Griffy Woods is clear and compelling. Our particular concern is the increase in invasive plant species caused by deer over browsing. The overpopulation of deer is resulting in heavy browse to native plants, in some cases such that bare ground is left. This bare ground is readily colonized by invasive plants like Japanese stiltgrass and garlic mustard. The deer exclosures established at Griffy Woods and the data collected by Dr. Angie Shelton clearly show the dramatic damage being caused to the forest. As Dr. Shelton accurately put it, "Right now, we are sacrificing the entire ecosystem for one species. We are holding deer above everything."

Landowners in the Bloomington area are spending increasing time and money controlling invasive plants in an effort to reestablish native plants on their land. However, until deer numbers are reduced, native establishment will be hindered by deer browse. Action must be taken to reduce deer numbers.

We strongly support the proposed ordinance that would amend Chapter 14.20 of the Bloomington Municipal Code to allow for the discharge of firearms at the Griffy lake Nature Preserve for the purpose of deer reduction via sharpshooting. It is time to move forward with this ordinance and decrease the forest damage that is occurring now.

Sincerely,

Ellen M. Jacquart
Chair, MC-IRIS

March 13, 2014

Dear City of Bloomington Common Council Members:

We, the undersigned biologists, strongly support the city's efforts, following the Deer Task Force's recommendations, for scientifically based, ecologically informed, and humane management of the city's deer population in the Griffy Lake area.

As herbivores, deer eat plants and are in turn eaten by predatory animals, including humans. Wild populations are normally kept in check by natural ecological factors, such as predation, disease, and competition. As the task force details, human activities have disturbed the ecological balance of deer within the environment through an interrelated combination of factors, including extirpation of large native predators and alteration of habitat via suburban sprawl, fragmentation of woodlands, and agriculture. Hunting is not currently allowed in the Griffy area, eliminating it as a form of population control. Deer numbers have risen accordingly, rebounding from the late 1800s, when deer were driven to local extinction, to levels of extreme abundance. Patterns of abundance have also shifted, such that deer have now become common in urban and suburban settings.

High numbers of deer mean high herbivore pressure on plants, including native woodland vegetation as well as landscaping plants and urban and rural crops. The impact of deer is particularly acute in Griffy Woods, where data collected by Indiana University biologists suggest that deer densities may be 10-fold higher than in comparable surrounding areas. Plants are the base of terrestrial food chains, converting the sun's energy into food that, either directly or indirectly, nourishes all other life, including humans. Plants also provide critical shelter and nesting habitat for other organisms. Thus, when deer numbers rise to levels high enough to deplete the forest understory of vegetation, as has been documented in Griffy and other Indiana woodlands, many other life forms suffer. This domino effect has been demonstrated for songbirds such as wood thrush and ovenbird. IU biologists have recently reported in the scientific literature (Shelton et al., 2014, Forest Ecology and Management) cascading negative effects of overabundant deer on plant and animal life in Griffy Woods, as well as impacts on the abiotic environment. Most concerning is their finding that no native hardwood trees are regenerating outside of deer exclosures, suggesting that the current forest will not persist. Furthermore, high deer grazing pressure exacerbates losses of species diversity by opening up space for the invasion of aggressive exotic plant species that outgrow native plants and are often of lesser value to wildlife.

We therefore agree with the Task Force's conclusions and support the city's initiative to reduce deer numbers in Griffy. We appreciate the Task Force and Common Council's thorough, evidence-based deliberations and the ecologically, socially, and ethically sensitive suite of management strategies they recommend. This includes using humane lethal methods for reducing the overabundant deer herd in Griffy Woods followed by comprehensive monitoring of results.

We also appreciate the need for sustained investment in managing the deer herd in Griffy Woods, such as the Indiana DNR management of deer herds in Indiana State Parks. So long as land development and other human activities continue to skew the ecological balance in favor of high deer numbers, there will be a need for human investment in managing the deer herd. Just as we are willing to invest in the infrastructure of our built environment, we should be willing to invest in the infrastructure of our remaining wild ecosystems. It is these ecosystems on which we depend for clean water, clean air, recreation, renewal, and many other life-supporting services.

Sincerely:

Dr. Clay Fuqua (Professor and Chair, Department of Biology, Indiana University)

See over for additional Biology Department signatories

Additional Signatories, Department of Biology, Indiana University

Farrah Bashey-Visser
Assistant Scientist & Lecturer

Alan Bender
Associate Professor of Biology

James D. Bever
Professor of Biology
Evolution, Ecology and Behavior

Roger Beckman
Head, Life Sciences Library and Chemistry Library

Volker Brendel
Professor of Biology and Computer Science

Karen Bush
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Roger Innes
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Armin Moczek
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Leonie Moyle
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Jeffrey Palmer
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Craig Pikaard
Carlos O. Miller Professor of Biology; Howard Hughes Medical Investigator

Rich Phillips
Assistant Professor of Biology

See over for additional Biology Department signatories

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Professor of Geological Sciences, Biology and Anthropology

R. Taylor Raborn
Postdoctoral Fellow in Biology
Indiana University

Elizabeth C. Raff
Professor of Biology

Rudolf A. Raff
Distinguished Professor of Biology

Heather Reynolds
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Dean Rowe-Magnus
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Professor Emeritus of Biology

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Milton Taylor
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Matthew Helm
Graduate Student

LaDonna Jones
Graduate Student

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PhD Candidate and Associate Instructor

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Andrew Russell
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Daniel Schwab
Graduate Student

Marta Shocket
PhD Candidate

Sam Slowinski
PhD Candidate

Briana Kathleen Whitaker
Graduate Student

INTEGRATED PROGRAM
IN THE ENVIRONMENT

INDIANA UNIVERSITY

To: Bloomington Common Council, City of Bloomington, IN
From: Concerned Faculty
Date: March 18, 2014
Subject: Implementation of a Deer Reduction Program

White-tailed deer have become a growing concern in our community. Evidence suggests that overpopulation of deer in the city and nearby natural areas has reached a crisis. Deer may be threatening the long-term sustainability of our community's treasured natural areas. Local woodland habitats are being over-browsed by deer causing a decline in native wildflower populations and in native tree seedlings. Recent deer exclosure studies at Indiana University's Research and Teaching Preserve property at Griffy Woods show compelling evidence that seedlings of hardwood trees have been nearly eliminated by the intense browsing pressure in that area. The long-term effects of inaction likely include significant declines in the natural regeneration of native plants in our local woodland areas.

We understand that the City Council will soon be considering the implementation of Deer Task Force recommendations that the City of Bloomington institute a program for reducing the deer population in the Griffy Lake area by humane means via professional sharpshooters. We the undersigned fully support the recommendations of the Deer Task Force and encourage the City of Bloomington to move quickly to implement these recommendations. Continuing to pursue a course of inaction will only quicken the decline in local woodland habitats that are one of the great assets of the Bloomington community.

Signatories:

Jennifer Brass, Professor, SPEA
Sanya Carley, Professor, SPEA
Melissa Clark, Lecturer, SPEA
Chris Craft, Professor, SPEA
Michael Edwards, Clinical Professor, SPEA
Stephen Glaholt, Lab Director, SPEA
Henk Haitjema, Professor Emeritus, SPEA
Diane Henshel, Professor, SPEA
Bill Jones, Professor Emeritus, SPEA
Marc Lame, Clinical Professor, SPEA
Vicky Meretsky, Professor, SPEA
Kim Novick, Professor, SPEA
Flynn Picardal, Professor, SPEA
Jonathan Raff, Professor, SPEA
Todd Royer, Professor, SPEA
Tom Simon, Clinical Professor, SPEA
Phil Stevens, Professor, SPEA
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