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Section of Wildlife Research
Annual Job Progress Report
Submitted to
ILLINOIS DEPARTMENT OF CONSERVATION
DIVISION OF WILDLIFE RESOURCES
Project Number W-87-R-10
Biology, Ecology, and Management of Deer in the Chicago Metropolitan Area
1 July 1988 - 30 June 1989
by
James H. Witham and Jon M. Jones
15 August 1989
State: Illinois

Project Number: W-87-R-10

Project Type: Research

Project Title: Cooperative Forest Wildlife Research

Sub-Project VII-D: Biology, Ecology, and Management of Deer in the Chicago Metropolitan Area

Study No. 104-1: Life History and Ecology of an Urban Deer Herd

Study Objectives: To investigate and quantify pertinent aspects of life history, ecology, health, abundance, dynamics, and distribution of deer in metropolitan areas of northeastern Illinois relative and necessary to their successful management.

Study No. 104-2: Deer Range Evaluation for Metropolitan Northeastern Illinois

Study Objectives: To measure, map, and otherwise quantify and qualify the present and potential deer range of northeastern Illinois including assessments of present impacts of deer on vegetation.

Study No. 104-3: Management Strategies and Implementation of Experimental Control of Urban Deer

Study Objectives: To design, implement, and evaluate possible alternative strategies for management of deer in urban areas with special respect to northeastern Illinois. Pilot management programs to be undertaken as cooperative programs with the Illinois Department of Conservation and local public agencies sustaining significant deer problems.

Study No. 104-4: Data Base Management, Analysis, and Reporting on Urban Deer Research

Study Objectives: To compile; organize; computerize; and manage for ready access, security, and preservation all data resulting from this study relating to deer, deer range, and other aspects of natural resource information generated by this project. Data to be integrated into data base management system. To generate file and management reports, scientific and professional manuscripts for publication, and news releases for local and statewide distribution.
Need: White-tailed deer (Odocoileus virginianus) numbers in northeast Illinois have increased substantially during the past 30 years. As a consequence of larger deer numbers and rapid urbanization, the frequency of negative deer-human interactions, such as deer-vehicle collisions and damage to ornamental vegetation, has increased to problem proportions. It is apparent that deer numbers have increased to a level where some form of deer control will probably be necessary. Although white-tailed deer have been extensively studied, no research has comprehensively addressed the complex array of factors that influence abundance and constrain deer management in urban environments. In northeastern Illinois, existing data on the white-tailed deer population have been inadequate to define guidelines for managing local herds.

Statement on project closure

A wide range of substudies were initiated as part of the Urban Deer Study since its inception in 1983. Because of the diversity of subjects, it will be a challenge to integrate these substudies smoothly into a comprehensive job completion report. The job completion report will clearly address each objective. The text will be a compilation of extended abstracts that are supported by appended manuscripts. Some substudies will be summarized within the text entirely. The assembled edge of abstracts and summaries will be unified by an introductory section; a discussion and summary will integrate concepts and provide closure. In Appendix A, we outline the principal headings of a monograph on Urban Deer Management that will be included as a section of the project completion report.
Contents of this report:

The final contract period for the Urban Deer Study will conclude on 31 December 1989; the project completion report will be forthcoming on 28 February 1990. At this time, we are moving toward project closure by completing individual substudies. In this performance progress report, we describe the status of the project substudies and discuss accomplishments that occurred during FY89. Our activities during FY89 centered on analysis of data (Study No. 104.4) that were collected for Studies 104.1-104.3. Additionally, we routinely provided recommendations on urban deer management organizations; we view the provision of recommendations as a component of Study No. 104.3.

Project substudies that have been completed are noted. Manuscripts that have been drafted for submission to journals or symposia are appended to this report, or have been appended to previous annual performance reports. The project completion report will include all manuscripts.

For the purpose of simplicity and to reduce redundancy, previous annual performance progress reports are referenced in this report as follows:

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(a) Activity

Study No. 104-1: Life History and Ecology of an Urban Deer Herd

Objectives: To investigate and quantify pertinent aspects of life history, ecology, health, abundance, dynamics, and distribution of deer in metropolitan areas of northeastern Illinois relative and necessary to their successful management.

Aerial counts and deer distribution

INHS performed 1 project-related aerial survey during FY89. This survey was a count of deer at the Ned Brown Preserve (Busse Woods) on 12 February 1989. The 70 deer observed, representing a minimum winter density of 5.7 deer/km², was within the population goal (4-8 deer/km²) that we established for the Ned Brown Preserve during our experimental deer control program.

All aerial counts of deer made during the Urban Deer Study were summarized previously (AR88:Tables 1-5). A manuscript entitled "Minimum winter density of white-tailed deer on urban sanctuaries in northeastern Illinois" (AR88:Appendix A) was submitted to the Wildlife Society Bulletin and is currently in review.

During the course of the Urban Deer Study, we invited county forest preserve biologists to participate in counting deer on their properties. The rationale for this was two-fold. First, we benefited from their knowledge of preserve boundaries which were at time difficult to discern from the air. Secondly, we used the opportunities to demonstrate survey methods, to discuss the limitations of aerial counts, and to stress the need for including funding for aerial counts of deer as part of their annual operating budgets.

Acceptance of responsibility for monitoring deer abundance
has varied among organizations, but we are pleased with progress that has been established. DuPage Forest Preserve District (FY88), Lake County Forest Preserve District (FY88 and FY89), and Morton Arboretum (FY89) each reimbursed the state completely for helicopter surveys. The Lake County Forest Preserve District used a commercial charter service for some of their counts during FY89. The Cook County Forest Preserve District budgeted for aerial surveys that were to be conducted with a commercial helicopter service, but did not fly during FY89.

Analysis of Iodine Concentration

The project completion report will include the results of this analysis.

Body composition and condition evaluation of white-tailed deer fawns

This cooperative substudy was completed during FY89. A manuscript entitled "Body composition and condition evaluation of white-tailed deer fawns" was included in AR88:Appendix B. Dr. Bruce Watkins submitted the manuscript to the Journal of Wildlife Management during FY89 and the manuscript is currently in review.

Determination of body composition of white-tailed deer fawns from deuterium oxide dilution

This cooperative substudy was completed during FY89. A manuscript entitled "Field evaluation of deuterium oxide for estimating body composition of white-tailed deer", was submitted by Dr. Watkins to the Journal of Wildlife Management (Appendix B) and the manuscript is currently in review.
Nutritional assessment of deer herds in NE Illinois

Data analysis for this substudy was completed. Errors in the analysis that were reported in AR88:6 were corrected. We described variation among selected condition and skeletal measurements of deer by sex, age, season, and location using ANOVA and Tukey's test to determine statistical significance. A first draft manuscript was prepared and is being revised. Tables 1-14 are included in this report without accompanying discussion.

Age specific fetal rates

Data analysis was completed; results will be included in the Urban Deer Management monograph and in the manuscript on nutritional assessment of deer herds in northeastern Illinois.

Toxicology Studies

Data analysis has been completed; results will be summarized in the project completion report.

Helminthic and Protozoan Parasite Analyses

We reported on the completion of this substudy in AR87:Appendix A.

Reconstruction of Busse Woods Herd Age Structure

We reported on preliminary analyses in AR87:6-7 and AR88:8-9. These data will be reported in the Urban Deer Management monograph.

Study No. 104-2: Deer Range Evaluation for Metropolitan Northeastern Illinois

Study Objectives: To measure, map, and otherwise quantify and qualify the present and potential deer range of northeastern Illinois including assessments of present impacts of deer on vegetation.
Mapping and quantifying present and potential deer range

Data analysis on this substudy will be completed in October 1989. We are cooperatively using analyses, based on LANDSAT photograph interpretation, that have been developed by Elizabeth Cook (INHS-Botany) for northeastern Illinois.

Changes in land use—insularization of the Ned Brown Preserve

Preliminary results were reported in AR87:8-10. A summary will be reported in the project completion report.

County Forest Preserve Maps

Preliminary results were reported in AR88:10. Data analysis has been completed and stored on a computer data base using pMAP software—a geographic information system for personal computers.

Effects of deer on forest vegetation

Field and statistical analyses of the effects that high density deer herds have on forest understory vegetation continued during FY89. Results will be presented in the Urban Deer Management monograph and the project completion report.

Study No. 104-3: Management Strategies and Implementation of Experimental Control of Urban Deer

Study Objectives: To design, implement, and evaluate possible alternative strategies for management of deer in urban areas with special respect to northeastern Illinois. Pilot management programs to be undertaken as cooperative programs with the Illinois Department of Conservation and local public agencies sustaining significant deer problems.

Annual trends in deer-vehicle accidents

The project completion report will include a manuscript describing interannual and seasonal trends in deer-vehicle accidents from 1978-1988, the changing distribution of deer-
vehicle accidents within the 4-county study area over time, and the average cost of deer-vehicle accidents in Cook County from 1984-1988 determined from questionnaire responses.

**Average cost of deer vehicle accidents**

We completed our evaluation of the average cost of deer-vehicle accidents in Cook County by sending standard questionnaires (AR86:Appendix Z) to persons involved in deer-vehicle accidents that were investigated by the Cook County Sheriff's Police during 1988. Methods used and preliminary results have been described previously (AR86:40-42).

The average total cost of a deer-vehicle accident in Cook County during 1988 was $1,600.18. Among the 5 years surveyed, this value is second only to 1986 when the average cost per accident was $1,622.77. The latter was influenced by several accidents where the vehicle was irreparably damaged; the highest loss for a single accident among 541 responses received over a 5-year period was $14,050.00 during 1986. The highest loss sustained by a single accident victim in 1988 was $10,157.00.

The average costs of deer-vehicle accidents by category type during 1984 to 1988 are summarized in Table 13. Several patterns were apparent in these data. First, values varied substantially within cost categories for individual years; therefore, standard errors associated with mean values are relatively high. Secondly, medical costs for an individual accident were always <$1,500.00.; these were unexpectedly low maximum values. The frequency of injuries where medical treatment was required was <10% of the respondents within each year. The occurrence of a
major injury involving long-term medical care and loss of wages, or loss of human life, would have increased average cost estimates substantially during any single year. Apparently few major injuries were involved, and our responses did not include a human fatality. Finally, the relative percentages of each cost category within years remained consistent among years (Table 14). Average annual repair costs were 90.6% to 93.7% of the average annual total cost of a deer-vehicle accident.

Distribution of deer-vehicle accidents

Preliminary results were presented in AR8816-18. The project completion report will include a quantitative analysis of these data.

Experimental herd reduction: Ned Brown Preserve (Busse Woods)

The Urban Deer Management monograph will include presentation of results and detailed discussion all aspects of the deer reduction and control program at the Ned Brown Preserve.

Experimental herd reduction: O'Hare International Airport

Recommendations for deer removal on O'Hare International Airport were included in AR87:Appendix C. During FY88, these recommendations were implemented by INHS as a cooperative substudy with the City of Chicago-O'Hare International Airport Authority (AR88:Appendix C). The work has been summarized and will be included in the Urban Deer Management monograph.

Deer management on Ryerson Conservation Area, Lake County

The Ryerson Conservation Area (RCA), located on the Des Plaines River corridor near the village of Deerfield in southern
Lake County, is a 223-ha preserve that includes a dedicated state nature preserve. During FY88, INHS Urban Deer personnel actively consulted with the Lake County Forest Preserve District on deer management alternatives for the Ryerson Conservation Area (RCA). In FY89, we designed and drafted the LCFPD proposal for reducing and controlling deer numbers on the RCA. This program was implemented by the LCFPD during FY89 with much controversy.

The Ryerson deer management program represents the third deer management program in the Chicago Metropolitan Area that involved INHS personnel. The Ryerson program was important to INHS research because it provided an opportunity for INHS to clearly define the degree of state involvement in urban deer management. Previously deer population control programs at the Ned Brown Preserve and on O'Hare Airport were performed by state employees (INHS) as a part of INHS research. Deer population control at Ryerson set a precedent because the financing and implementation of the control was assumed by the landowner. Although the Ryerson program was designed by INHS and regulated by the IDOC and the INPC, all deer removals were performed and paid for by Lake County and the public. We will evaluate the Ryerson deer removal program as a section in the Urban Deer Management monograph.

Recommendations: State involvement in urban deer management

We participated in several meetings with the IDOC that established the need for initiating a permanent Urban Deer Project Manager position in northeastern Illinois. This position was created and filled by the IDOC in November 1988. The Urban Deer Project Manager will: 1) Serve as the IDOC spokesperson on
Acquire and maintain a compendium of literature on deer damage abatement methods and provide this information to the public upon request, and 3) Provide training on deer damage abatement and population control techniques to both public and private landowners.

A paper entitled "Managing urban deer in Illinois: the role of state government" was presented at the Ninth Great Plains Wildlife Damage Control Workshop, Fort Collins, Colorado. The manuscript submitted for the symposium proceedings includes suggested urban deer management goals and recommends a specific level of state involvement in urban deer management (Appendix C). Specifically, we believe that the IDOC must be an active cooperator in urban deer management by providing information and technical expertise via wildlife extension services. It has been valuable for the IDOC Urban Deer Management Project to overlap with the last year of INHS urban deer research. INHS personnel have closely interacted with the Urban Deer Project manager to provide a smooth transition from research to management and have cooperatively developed procedural guidelines on various aspects of urban deer management. Examples of regulations that were cooperatively developed include guidelines for the "Preparation of site-specific deer management proposals and application for a deer removal permit", and regulations on the capture, handling, and translocation of urban deer (Appendix D).

Recommendations: Control of deer on Illinois Nature Preserves

Deer at moderate to high densities that we observed on many
urban preserves can adversely impact plant resources and cause a decline in the diversity of native flora and fauna. This may not be of great concern on some preserves where human recreation is the principal management objective. However, extensive browsing by deer that causes changes in plant composition, density, or structure may conflict with the "values" ascribed to sites where protection and maintenance of remnant ecological characteristics are the principal objectives. Properties that have been dedicated as part of the Illinois Nature Preserve System have recognized ecological values that can be adversely affected by deer. INHS cooperatively drafted guidelines for the management of white-tailed deer on Illinois Nature Preserves that were adopted by the Commission during FY89. The elements of the guidelines are outlined in Appendix E.

Recommendations: Donation of venison to charitable organizations

As more agencies/organizations become involved in urban deer population control, there remains a need to improve the existing state guidelines for disposal of deer carcasses. Specifically, organizations that kill deer under removal permit authorization should be able to donate field-dressed carcasses directly to charitable organizations that have processing capabilities. This would eliminate the $50.00 cost of processing an individual deer carcass and would reduce costs associated with transporting carcasses to processing facilities. We recommended that the IDOC support an amendment to the Good Samaritan Food Donor Act, Public Act 82-580 which would indemnify donors of field-dressed wild game (Appendix F).
During the spring 1989 legislative session, the IDOC included the proposed amendment as part of Illinois State Senate Bill 1427, sponsored by State Senator Laura Kent Donahue. The bill did not pass out of committee because parts of the bill associated with fishing regulations (e.g., gill-netting on Lake Michigan) were controversial. The IDOC will reintroduce the amendment during the spring 1990 legislative session (T. Miller, IDOC, pers. commun.).

INHS and IDOC personnel tested a captive-bolt stunner used to mechanically euthanize animals. For euthanizing deer that are restrained, we favor the captive-bolt system over chemical euthanasia and shooting. The positive qualities of the system include: 1) approval by the American Veterinarian Association as a method of humane euthanasia, 2) human safety because no weapons are discharged, and 3) the opportunity to donate the carcass for human or animal consumption because no chemicals are introduced into the deer. The stunner was loaned to the Lake County Forest Preserve District and was used successfully on one deer. The venison from this deer, and 39 other deer that were shot by marksmen during the herd reduction program on Ryerson Conservation Area, was donated to not-for-profit charitable organizations using procedures previously established by INHS during research.

Cost-effectiveness of deer removal techniques

Statistical comparisons of various lethal and non-lethal deer removal methods that were used in our study were completed in August 1989. These results will be incorporated in the Urban Deer Management monograph.
Monitoring of radio-collared deer

A draft manuscript entitled "Post-translocation survival and movements of urban white-tailed deer" was submitted for in-house review and is currently being revised. The manuscript will be appended to the project completion report.

Study No. 104-4: Data Base Management, Analysis, and Reporting on Urban Deer Research

Study Objectives: To compile; organize; computerize; and manage for ready access, security, and preservation all data resulting from this study relating to deer, deer range, and other aspects of natural resource information generated by this project. Data to be integrated into data base management system. To generate file and management reports, scientific and professional manuscripts for publication, and news releases for local and statewide distribution.

Data base management and analysis

During FY89, we continued to summarize and analyze data. Analytical advice was obtained from the University of Illinois Statistical Consulting Office. Project related data will be saved on computer diskettes and will be maintained by the IDOC Urban Deer Project manager and the INHS.

Dissemination of Information

INHS personnel gave presentations for:

- Cook County Forest Preserve District, Barrington
- Illinois Department of Conservation-Division of Wildlife
- Issac Walton League-Elgin Chapter
- Oak Woodland and Management Symposium, Peoria

Meetings on urban deer management attended by INHS personnel

- Chicago Community Trust
- Lake County Board of Commissioners (Finance Committee)
- Lake County Board of Commissioners (Full Board)
- Illinois Department of Conservation (3X)
- Illinois Nature Preserves Commission (2X)
- McHenry County Chapter-Whitetails Unlimited
- Northeast Illinois Natural Areas Managers

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INHS personnel were contacted throughout the year by the media who requested information on urban deer and deer-related issues. The presence of the new IDOC Urban Deer Project manager, working in the same field office as the INHS Urban Deer Study, substantially decreased the number of media contacts that would have been made by INHS personnel. The following is a partial list of media contacts made by the INHS during FY89:

Chicago Sun Times (2X)
Chicago Tribune (5X)
Chicago Reader (3X)
Daily Herald (3X)
Elgin Courier
Fox 32 television
Free-lance writers (2X)
Pioneer Press (2X)
Southtown Economist
Waukegan News Sun (2X)
WGN radio

Two press releases were drafted by INHS personnel. Project slides were loaned to the Cook County Department of Animal Control, the Cook County Forest Preserve District, and the Lake County Forest Preserve District.

The set of deer-related articles and reprints that we offered to the public and media upon request (AR88:26-27), will be maintained and expanded by the IDOC Urban Deer Project manager.

(b) Target Date of Achievement: Final Report due 28 February 1990
(c) Date of Accomplishment: The Urban Deer Study was scheduled to conclude on 30 June 1989. The program received a 6-month project extension that will terminate on 31 December 1989.
(d) Significant Deviations: Project was extended 6 months to compensate for loss of project assistant J. M. Jones who accepted
a permanent position with the Illinois Department of Conservation.

(e) Remarks: None

(f) Recommendations: None

(g) Cost: Sub-Project VII-D: Biology, Ecology, and Management of Deer in the Chicago Metropolitan Area.

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LITERATURE CITED


Table 1. Seasonal and site variation of physical measurements of female white-tailed deer < 1 year old collected from 5 locations in the Chicago Metropolitan Area.

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- Palos-Sag Valley = 11
- Non-Cook County = 16
- Ned Brown = 6
- Des Plaines = 7
Table 2. Seasonal and site variation of physical measurements of male white-tailed deer < 1 year old collected from 5 locations in the Chicago Metropolitan Area.

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**Areas:**

Northwest Cook County = 3  
Palos-Sag Valley = 11  
Ned Brown = 6  
Des Plaines = 7
Table 3. Seasonal and site variation of measurements of the condition of female white-tailed deer < 1-year old collected from 5 locations in the Chicago Metropolitan Area.

<table>
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<th>Kidney Fat Index</th>
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Areas:
Northwest Cook County = 3  Palos-Sag Valley = 11  Ned Brown = 6
Non-Cook County = 16  Des Plaines = 7
Table 4. Seasonal and site variation of measurements of the condition of male white-tailed deer < 1-year old collected from 5 locations in the Chicago Metropolitan Area.

<table>
<thead>
<tr>
<th>Area</th>
<th>Girth (mm)</th>
<th>Whole Body Weight (kg)</th>
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<th>Kidney Fat Index</th>
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a Areas:

Northwest Cook County = 3  Palos-Sag Valley = 11  Ned Brown = 6  
Non-Cook County = 16  Des Plaines = 7
Table 5. Seasonal and site variation of physical measurements of female yearling white-tailed deer collected from 5 locations in the Chicago Metropolitan Area.

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<td>n  x  SE</td>
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Areas:  
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Palos-Sag Valley = 11  
Ned Brown = 6  
Non-Cook County = 16  
Des Plaines = 7
Table 6. Seasonal and site variation in the condition of female yearling white-tailed deer collected from 5 locations in the Chicago Metropolitan Area.

<table>
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<th>Kidney Fat Index</th>
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Areas:
Northwest Cook County = 3
Non-Cook County = 16
Palos-Sag Valley = 11
Ned Brown = 6
Des Plaines = 7
Table 7. Seasonal and site variation of physical measurements of male yearling white-tailed deer collected from 5 locations in the Chicago Metropolitan Area.

<table>
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<tr>
<th>Area</th>
<th>Total length</th>
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a Areas:

Northwest Cook County = 3  
Palos-Sag Valley = 11  
Ned Brown = 6  
Des Plaines = 7
Table 8. Seasonal and site variation in the condition of male yearling white-tailed deer collected from 5 locations in the Chicago Metropolitan Area.

<table>
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<tr>
<th></th>
<th>Girth (mm)</th>
<th>Whole Body Weight (kg)</th>
<th>Kistner Evaluation</th>
<th>Kidney Fat Index</th>
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<td>n  x     SE</td>
<td>n  x     SE</td>
<td>n  x     SE</td>
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<td>2 0.41 0.18</td>
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<td>1 0.55</td>
</tr>
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(P = 0.4230)  (P = 0.8252)  (P = 0.8870)  (P = 0.6269)

| **Autumn** | | | | | |
| 16 | 6 1000.0 27.8 | 8 76.2 2.5 | 9 71.7 6.3 | 12 1.21 0.18 |
| 3  | 4 1004.0 27.1 | 4 79.5 6.4 | 4 78.8 6.3 | 8 1.27 0.27 |
| 11 | 2 893.0 9.0  | 4 71.2 3.3 | 5 78.0 4.3 | 5 1.33 0.41 |
| 7  | 2 918.0 89.0 | 5 66.6 4.2 | 5 74.0 4.6 | 11 1.36 0.24 |
| 6  | 3 856.7 50.6 | 3 67.9 6.2 | 4 82.5 7.5 | 4 1.59 0.51 |

(P = 0.0602)  (P = 0.1977)  (P = 0.7749)  (P = 0.9373)

| **Winter** | | | | | |
| 16 | 0 0.0 0.0  | 1 50.0 0.0  | 1 0.39 |
| 3  | 1 920.0 1.0 | 1 56.2 1.0 | 1 1.09 |
| 11 | 0 0.0 0.0  | 1 64.0 0.0 | 1 0.81 |
| 7  | 0 0.0 0.0  | 0 0.0 0.0  | 1 0.56 |
| 6  | 3 834.7 7.7 | 2 43.1 5.9 | 2 27.5 2.75 | 3 0.19 0.05 |

(P = 0.0310)  (P = 0.4230)  (P = 0.7082)  (P = 0.0315)

6 < 3

| **Spring** | | | | | |
| 16 | 10 857.8 14.6 | 11 53.1 1.1 | 14 43.6 4.8 | 15 0.21 0.03 |
| 3  | 3 883.7 25.8 | 4 54.4 4.2 | 4 37.5 6.0 | 4 0.21 0.03 |
| 11 | 1 904.0 1.0  | 1 65.8 1.0  | 1 45.0 23.7 | 1 0.24 |
| 7  | 2 897.0 75.0 | 2 51.5 9.8 | 3 31.7 11.7 | 4 0.44 0.22 |
| 6  | 2 823.5 7.5  | 2 51.0 0.2  | 2 40.0 5.0  | 3 0.22 0.06 |

(P = 0.5416)  (P = 0.3392)  (P = 0.8302)  (P = 0.3129)

a Areas:
Northwest Cook County = 3  Palos-Sag Valley = 11  Ned Brown = 6
Non-Cook County = 16  Des Plaines = 7
Table 9. Site variation of physical measurements of male white-tailed deer > 2-years old collected from 5 locations in the Chicago Metropolitan Area.

<table>
<thead>
<tr>
<th>Area</th>
<th>Total length</th>
<th>Hind Foot</th>
<th>Femur</th>
<th>Femur/HF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n  x  SE</td>
<td>n  x  SE</td>
<td>n  x  SE</td>
<td>n  x  SE</td>
</tr>
<tr>
<td>All Seasons</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>10 1839.6 38.7</td>
<td>15 493.0 4.5</td>
<td>15 278.3 5.0</td>
<td>11 0.56 0.01</td>
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<td>3</td>
<td>7 1848.4 44.1</td>
<td>10 510.9 4.9</td>
<td>9 283.7 5.1</td>
<td>9 0.56 0.01</td>
</tr>
<tr>
<td>11</td>
<td>6 1867.2 34.9</td>
<td>8 497.3 6.4</td>
<td>9 276.1 4.2</td>
<td>8 0.55 0.01</td>
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<td>18 1781.5 29.7</td>
<td>21 490.9 3.1</td>
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<td>17 0.55 0.01</td>
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<td>29 493.9 4.4</td>
<td>28 266.7 2.2</td>
<td>26 0.54 0</td>
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(P = 0.0614) (P = 0.0958) (P = 0.0087) (P = 0.0818)

6 < 3

Areas:
Northwest Cook County = 3
Non-Cook County = 16
Palos-Sag Valley = 11
Ned Brown = 6
Des Plaines = 7
Table 10. Site variation of physical measurements of female white-tailed deer > 2-years old collected from 5 locations in the Chicago Metropolitan Area.

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<th>Area</th>
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<th>Femur/HF</th>
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<td>n</td>
<td>x</td>
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<td>All Seasons</td>
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(P = 0.1390) (P = 0.5666) (P = 0.0123) (P = 0.1275)

6 < 3.16

Areas:
Northwest Cook County = 3
Non-Cook County = 16
Palos-Sag Valley = 11
Ned Brown = 6
Des Plaines = 7
Table 11. Seasonal and site variation in the condition of female white-tailed deer > 2-years old collected from 5 locations in the Chicago Metropolitan Area

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<th>Girth (mm)</th>
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<td>SE</td>
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<tr>
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<td>SE</td>
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</tr>
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<tr>
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Areas:
Northwest Cook County = 3   Palos-Sag Valley = 11   Ned Brown = 6
Non-Cook County = 16   Des Plaines = 7
Table 12. Seasonal and site variation in the condition of male white-tailed deer > 2-years old collected from 5 locations in the Chicago Metropolitan Area.

<table>
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<tr>
<th>Area</th>
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<th>Kidney Fat Index</th>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>16</td>
<td>4 1071.8</td>
<td>4 97.6</td>
<td>3 73.3</td>
<td>6 1.38 0.38</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>2 109.8</td>
<td>2 85.0</td>
<td>3 1.62 0.60</td>
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<tr>
<td>11</td>
<td>1 1060.0</td>
<td>1 80.3</td>
<td>1 80.0</td>
<td>1 1.14</td>
</tr>
<tr>
<td>7</td>
<td>7 1046.4</td>
<td>6 94.3</td>
<td>5 68.0</td>
<td>6 1.74 0.56</td>
</tr>
<tr>
<td>6</td>
<td>1 995.0</td>
<td>5 78.3</td>
<td>5 70.0</td>
<td>5 1.95 0.50</td>
</tr>
<tr>
<td></td>
<td>(P = 0.8793)</td>
<td></td>
<td></td>
<td>(P = 0.1617)</td>
</tr>
<tr>
<td></td>
<td>(P = 0.0897)</td>
<td></td>
<td></td>
<td>(P = 0.9205)</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>1 1108.0</td>
<td>0</td>
<td>1 40.0</td>
<td>1 0.52</td>
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<td>3</td>
<td>3 981.0</td>
<td>2 69.6</td>
<td>1 40.0</td>
<td>3 0.21 0.10</td>
</tr>
<tr>
<td>11</td>
<td>1 1010.0</td>
<td>1 89.8</td>
<td>1 10.0</td>
<td>2 0.39 0.09</td>
</tr>
<tr>
<td>7</td>
<td>2 927.5</td>
<td>2 59.6</td>
<td>4 38.8</td>
<td>4 0.59 0.18</td>
</tr>
<tr>
<td>6</td>
<td>11 939.8</td>
<td>10 59.7</td>
<td>11 15.0</td>
<td>12 0.29 0.14</td>
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<tr>
<td></td>
<td>(P = 0.2389)</td>
<td></td>
<td></td>
<td>(P = 0.2868)</td>
</tr>
<tr>
<td></td>
<td>(P = 0.4167)</td>
<td></td>
<td></td>
<td>(P = 0.7163)</td>
</tr>
<tr>
<td><strong>Spring</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>1 980.0</td>
<td>4 80.3</td>
<td>4 48.8</td>
<td>4 0.34 0.06</td>
</tr>
<tr>
<td>3</td>
<td>3 967.7</td>
<td>2 65.8</td>
<td>3 53.3</td>
<td>3 0.26 0.07</td>
</tr>
<tr>
<td>11</td>
<td>1 872.0</td>
<td>1 56.7</td>
<td>1 5.0</td>
<td>1 0.17</td>
</tr>
<tr>
<td>7</td>
<td>5 857.0</td>
<td>5 51.0</td>
<td>6 15.0</td>
<td>5 0.18 0.04</td>
</tr>
<tr>
<td>6</td>
<td>3 978.0</td>
<td>3 74.1</td>
<td>4 47.5</td>
<td>5 0.24 0.05</td>
</tr>
<tr>
<td></td>
<td>(P = 0.2751)</td>
<td></td>
<td></td>
<td>(P = 0.1033)</td>
</tr>
<tr>
<td></td>
<td>(P = 0.0136)</td>
<td></td>
<td></td>
<td>(P = 0.3286)</td>
</tr>
</tbody>
</table>

Areas:
Northwest Cook County = 3
Non-Cook County = 16
Palos-Sag Valley = 11
Ned Brown = 6
Des Plaines = 7
Table 13. Mean cost of deer-vehicle accidents in Cook County, a, b, c

<table>
<thead>
<tr>
<th>Cost Category by Year</th>
<th>Mean</th>
<th>SE</th>
<th>Range of Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 140 usable responses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle repair</td>
<td>$1,149.44</td>
<td>78.34</td>
<td>0.00 - 6,240.00</td>
</tr>
<tr>
<td>Towing</td>
<td>10.40</td>
<td>2.25</td>
<td>0.00 - 150.00</td>
</tr>
<tr>
<td>Substitute vehicle</td>
<td>35.25</td>
<td>8.72</td>
<td>0.00 - 600.00</td>
</tr>
<tr>
<td>Medical</td>
<td>13.57</td>
<td>10.82</td>
<td>0.00 - 1,500.00</td>
</tr>
<tr>
<td>Lost wages</td>
<td>17.35</td>
<td>11.37</td>
<td>0.00 - 1,500.00</td>
</tr>
<tr>
<td>Other</td>
<td>0.77</td>
<td>0.47</td>
<td>0.00 - 45.00</td>
</tr>
<tr>
<td>Total cost (d)</td>
<td>1,226.78</td>
<td>92.10</td>
<td>0.00 - 7,340.00</td>
</tr>
<tr>
<td>1985</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 79 usable responses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle repair</td>
<td>$1,328.71</td>
<td>133.61</td>
<td>0.00 - 8,010.25</td>
</tr>
<tr>
<td>Towing</td>
<td>10.65</td>
<td>2.53</td>
<td>0.00 - 125.00</td>
</tr>
<tr>
<td>Substitute vehicle</td>
<td>40.84</td>
<td>11.76</td>
<td>0.00 - 565.00</td>
</tr>
<tr>
<td>Medical</td>
<td>26.61</td>
<td>13.49</td>
<td>0.00 - 752.00</td>
</tr>
<tr>
<td>Lost wages</td>
<td>33.38</td>
<td>19.83</td>
<td>0.00 - 1,500.00</td>
</tr>
<tr>
<td>Other</td>
<td>6.13</td>
<td>4.93</td>
<td>0.00 - 384.00</td>
</tr>
<tr>
<td>Total cost (d)</td>
<td>1,446.32</td>
<td>156.65</td>
<td>55.00 -10,387.25</td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 94 usable responses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle repair</td>
<td>$1,470.66</td>
<td>183.33</td>
<td>0.00 -13,200.00</td>
</tr>
<tr>
<td>Towing</td>
<td>13.55</td>
<td>2.71</td>
<td>0.00 - 115.00</td>
</tr>
<tr>
<td>Substitute vehicle</td>
<td>83.00</td>
<td>22.26</td>
<td>0.00 - 1,700.00</td>
</tr>
<tr>
<td>Medical</td>
<td>18.37</td>
<td>8.03</td>
<td>0.00 - 500.00</td>
</tr>
<tr>
<td>Lost wages</td>
<td>28.14</td>
<td>11.78</td>
<td>0.00 - 800.00</td>
</tr>
<tr>
<td>Other</td>
<td>9.04</td>
<td>4.66</td>
<td>0.00 - 300.00</td>
</tr>
<tr>
<td>Total cost (d)</td>
<td>1,622.77</td>
<td>194.84</td>
<td>0.00 -14,050.00</td>
</tr>
</tbody>
</table>

(cont.)
Table 13. (cont.)

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Mean</th>
<th>SE</th>
<th>Range of Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>by Year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1987</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 118 usable responses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle repair</td>
<td>$1,247.03</td>
<td>98.36</td>
<td>0.00 - 8,000.00</td>
</tr>
<tr>
<td>Towing</td>
<td>9.26</td>
<td>2.41</td>
<td>0.00 - 130.00</td>
</tr>
<tr>
<td>Substitute vehicle</td>
<td>57.46</td>
<td>11.25</td>
<td>0.00 - 509.00</td>
</tr>
<tr>
<td>Medical</td>
<td>1.56</td>
<td>1.15</td>
<td>0.00 - 131.00</td>
</tr>
<tr>
<td>Lost wages</td>
<td>4.15</td>
<td>2.20</td>
<td>0.00 - 150.00</td>
</tr>
<tr>
<td>Other</td>
<td>31.66</td>
<td>14.28</td>
<td>0.00 - 1,500.00</td>
</tr>
<tr>
<td>Total cost (d)</td>
<td>1,351.13</td>
<td>109.43</td>
<td>10.00 - 8,621.00</td>
</tr>
</tbody>
</table>

**1988**

N = 110 usable responses

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Mean</th>
<th>SE</th>
<th>Range of Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>by Year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle repair</td>
<td>$1,478.38</td>
<td>133.20</td>
<td>0.00 - 8,900.00</td>
</tr>
<tr>
<td>Towing</td>
<td>9.65</td>
<td>2.37</td>
<td>0.00 - 125.00</td>
</tr>
<tr>
<td>Substitute vehicle</td>
<td>73.18</td>
<td>13.53</td>
<td>0.00 - 825.00</td>
</tr>
<tr>
<td>Medical</td>
<td>9.76</td>
<td>5.36</td>
<td>0.00 - 507.60</td>
</tr>
<tr>
<td>Lost wages</td>
<td>11.40</td>
<td>6.20</td>
<td>0.00 - 550.00</td>
</tr>
<tr>
<td>Other</td>
<td>17.82</td>
<td>12.10</td>
<td>0.00 - 1,300.00</td>
</tr>
<tr>
<td>Total cost (d)</td>
<td>1,600.18</td>
<td>144.21</td>
<td>10.00 - 10,157.00</td>
</tr>
</tbody>
</table>

a Questionnaires were sent to individuals involved in deer-vehicle accidents that were investigated by the Cook County Sheriff's Police.

b Responses in 1984 include X deer-vehicle accidents investigated by municipality police departments; total cost of these accidents was not significantly different from costs derived from Cook County Sheriff's Police responses.

c Cost in U.S. dollars

d Total Cost was determined by averaging the Total Cost of individual responses. Therefore, the Range of Values for Total Cost can have a minimum value > $ 0.00 even though the minimum value for each cost category (e.g., repair, towing etc.) was = $ 0.00.
Table 14. Relative comparison of the average costs associated with deer-vehicle accidents in Cook County, 1984-1988.

<table>
<thead>
<tr>
<th>Year</th>
<th>Repair</th>
<th>Towing</th>
<th>Substitute Vehicle</th>
<th>Medical</th>
<th>Lost Wages</th>
<th>Other Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>93.7</td>
<td>0.8</td>
<td>2.9</td>
<td>1.1</td>
<td>1.4</td>
<td>0.1</td>
</tr>
<tr>
<td>1985</td>
<td>91.9</td>
<td>0.7</td>
<td>2.8</td>
<td>1.8</td>
<td>2.3</td>
<td>0.4</td>
</tr>
<tr>
<td>1986</td>
<td>90.6</td>
<td>0.8</td>
<td>5.1</td>
<td>1.1</td>
<td>1.7</td>
<td>0.6</td>
</tr>
<tr>
<td>1987</td>
<td>92.3</td>
<td>0.7</td>
<td>4.3</td>
<td>0.1</td>
<td>0.3</td>
<td>2.3</td>
</tr>
<tr>
<td>1988</td>
<td>92.4</td>
<td>0.6</td>
<td>4.6</td>
<td>0.6</td>
<td>0.7</td>
<td>1.1</td>
</tr>
</tbody>
</table>
Appendix A. Principal headings for the monograph on the management of white-tailed deer in the Chicago Metropolitan Area

James H. Witham and Jon M. Jones

I. INTRODUCTION
   A. Acknowledgments

II. STUDY AREAS
   A. Chicago Metropolitan Area
   B. Ned Brown Preserve
   C. Chicago-O'Hare International Airport
   D. Ryerson Conservation Area

III. METHODS

IV. RESULTS AND DISCUSSION
   A. Ned Brown Preserve
      1. Management Objectives
      2. Population dynamics
         a. Age-specific fecundity
         b. Sex and age structure
         c. Deer abundance
         d. Mortality rates of marked deer
      3. Reduction of Deer Numbers
         a. Live-capture
         b. Shooting by marksmen
      4. Modelling Effort Required to Stabilize Deer Numbers
      5. Evaluations of Management
         a. Responses of vegetation
         b. Deer-vehicle accidents on adjacent highways
         c. Condition of deer
         d. Cost-effectiveness of removal methods

   B. Chicago-O'Hare International Airport
      1. History of Deer Management on O'Hare Airport
      2. Deer abundance
      3. Management Objectives
      4. Reduction of Deer Numbers
      5. Evaluations of Management
         a. Deer abundance
         b. Deer-aircraft collisions
         c. Cost evaluation

   C. Ryerson Conservation Area
      1. Management Objectives
      2. Socio-political conflicts
      3. Reduction of Deer Numbers
         a. Live-capture and translocation
         b. Shooting by marksmen
      4. Evaluations
         a. Response of vegetation
         b. Cost evaluation

(cont.)
Appendix A. (cont.)

D. Review of Deer Management Alternatives
   1. Methods
      a. Damage abatement
      b. Population control
   2. Urban deer management programs
   3. Selection of management strategies

E. Deer Management Needs in the Chicago Metropolitan Area

F. Defining levels of involvement and responsibilities

G. Public participation in suburban deer management

V. CONCLUSIONS

VI. LITERATURE CITED

VII. APPENDICES
Appendix B. Field evaluation of deuterium oxide for estimating body composition of white-tailed deer.
FIELD EVALUATION OF DEUTERIUM OXIDE FOR ESTIMATING BODY COMPOSITION OF WHITE-TAILED DEER

BRUCE E. WATKINS, Chicago Zoological Society, Brookfield Zoo, Brookfield, IL 60513
DUANE E. ULLREY, Department of Animal Science, Michigan State University, E. Lansing, MI 48824
JAMES H. WITHAM, Illinois Natural History Survey, 607 E. Peabody, Champaign, IL 61820
JON M. JONES, Illinois Natural History Survey, 607 E. Peabody, Champaign, IL 61820

Abstract: The efficacy of using deuterium oxide (D2O) dilution under field conditions to predict body composition of wild white-tailed deer (Odocoileus virginianus) was evaluated using 10 fawns captured near Chicago, Illinois between November 1985 and March 1986. Estimated body water (EBW) was calculated using the average blood D2O concentration 1.5 and 2 hours after intravenous infusion of D2O. Although correlated with true body water (TBW)
Watkins (r = 0.93), EBW overestimated TBW by 23.8 + 1.4 %. EBW (kg) and live weight (kg) were correlated with ingesta-free body (IFB) ether extract (kg) (R = 0.93), IFB gross energy (mcal) (R = 0.95), and IFB crude protein (kg) (R = 0.93).

Key Words: body composition, condition, deuterium oxide, isotope dilution, Odocoileus virginianus, white-tailed deer, Illinois.

The condition of live, free-ranging deer is usually evaluated based on body weight, external morphometry or conformation, and/or blood and serum constituents (Watkins et al. 1989). Each of these methods has limitations for accurate condition assessment. We believe that condition of deer is best expressed in terms of whole-body gross energy (GE) within age class and season (Watkins et al. 1989). Prediction of whole-body GE in a live animal requires determination of body composition by nonchemical methods. Isotope dilution techniques have been successfully used to estimate gross body composition in a variety of live animals, including captive white-tailed deer (Rumpler et al. 1987). Unlike tritium, deuterium is a stable isotope that can be used safely in the field without special precautions. Isotope dilution using deuterium oxide (D2O), therefore, offers potential for estimating the body composition of free-ranging animals. The objective of this study was to evaluate the efficacy of D2O dilution for predicting body composition of white-tailed deer under field conditions.
We thank W. V. Rumpler of the United States Department of Agriculture for the deuterium analyses and P. A. Whetter of Michigan State University for tissue analyses. This research was a substudy of the Illinois Natural History Survey (INHS) Urban Deer Research Program, a contribution of the Federal Aid in Wildlife Restoration Project (W-87-R), the Illinois Department of Conservation, the U.S. Fish and Wildlife Service, and the INHS.

METHODS

Ten free-ranging, white-tailed deer fawns (8 males, 2 females) were captured near Chicago, Illinois in 1985 and 1986 during November (N = 2), December (N = 3), January (N = 2), and March (N = 3). Capture locations and capture and handling methods have been described elsewhere (Witham and Jones 1987, Watkins et al. 1989). After capture, each deer was anesthetized and immobilized using a combination of ketamine hydrochloride and xylazine hydrochloride (Watkins et al. 1983). Each of nine fawns was injected via the jugular vein with 10 g of D2O (DLM-4 deuterium 99.8% D, Cambridge Isotope Laboratories, Inc., Cambridge, MA), that had been preweighed in a 12 cc disposable syringe. One fawn was injected with 5.4 g of D2O via the jugular vein because additional D2O was not available. Blood samples were obtained by jugular venipuncture from the vein opposite the injected vein at 1.5 and 2 hours post-infusion. After the last blood sample had been obtained, each animal was killed by T-61 injection and processed as described by Watkins et al. (1989). The contents of the stomach (rumen, reticulum,
omasaum, abomasum) and intestines (small intestine, cecum, large intestine, rectum) were removed and weighed. Blood samples were frozen in sealed vacuum tubes for lyophilization. The water fraction of the blood samples was analyzed for deuterium using infrared spectrophotometry (Byers 1979). Blood and tissue samples were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), ash, and GE as described previously (Watkins et al. 1989). Samples of the stomach and intestinal contents from 8 deer were analyzed for water concentration. Water contents of the ingesta of 2 deer were predicted from the weights of stomach and intestinal contents using the average water concentrations of the 8 analyzed samples. True body water (TBW) was calculated by summing the water contained in the ingesta-free body (IFB) with that contained in the ingesta, as determined by analysis. Estimated body water (EBW) was calculated based on the ratio between blood deuterium concentration and the amount of injected deuterium.

Linear regression analysis was performed using the SPSS/PC+ statistical program (Norusis 1988). Forward multiple regression was used when inclusion of more than one independent variable significantly ($P < 0.05$) improved the regression. Homogeneity of regression coefficients was tested using an $F$-test (Snedecor and Cochran 1967). A paired $t$-test was used to test for differences between 1.5- and 2-hour blood deuterium concentrations.

RESULTS

Blood deuterium concentrations did not differ significantly
Watkins

between 1.5- and 2-hour post-infusion blood samples and did not allow extrapolation to 0 infusion time. The average of the two samples was used to calculate EBW.

EBW averaged 23.8 ± 1.4 % (x + SE, N = 10) higher than TBW (Table 1). EBW (% of live wt) and TBW (% of live wt) were each correlated with IFB EE (%, fresh weight basis (FWB)) (Fig. 1) and IFB GE (kcal/g, FWB) (Fig. 2). The slopes of the regressions did not differ significantly when either EBW (% of live wt) or TBW (% of live wt) was used as the independent variable.

IFB EE (kg), IFB CP (kg), and IFB GE (mcal) were highly correlated with either EBW (kg) and live weight or TBW (kg) and live weight (Table 2). Prediction of IFB ash (kg) was not significantly improved by inclusion of live weight in the regression when either EBW (kg) or TBW (kg) was used as an independent variable.

DISCUSSION

Rumpler et al. (1987) found that D2O equilibrated with the body water pool within 2 hours post-infusion in adult white-tailed deer does. TBW is overpredicted by EBW when a single, equilibrated blood D2O concentration is used to calculate dilution space. In domestic animals, single-point tracer measurements typically result in a calculated dilution space that is 10-15% greater than TBW (Robelin 1984). In our study, EBW was over 20% higher than TBW. The reason for this greater disparity is not known but might be related to species- and/or age-dependent in vivo isotope fractionation. Incomplete deuterium
recovery after vacuum sublimation (Johnson and Farrell 1988) might have also contributed to the overestimation. EBW more closely represents TBW when serial blood D2O measurements are used to extrapolate to 0 infusion time (Robelin 1984). In our study, the similarity between the 1.5 and 2 hour samples made extrapolation impossible. Taking more than 2 samples and extending the interval between samples might improve the accuracy of TBW estimates but would be impractical for field application.

Our results indicate that D2O dilution offers a non-lethal method with potential for estimating the body composition of deer in the field. The variability in our data indicates that D2O dilution performed under field conditions might be better suited to assessing the condition of a population than that of an individual. If animals are to be released, sodium chloride should be added to the D2O to make a 0.85% NaCl solution (physiological saline) and sterile techniques should be used. The combination of ketamine and xylazine we used was usually sufficient to keep the deer anesthetized and immobilized for over 2 hours. Captive white-tailed deer can be immobilized repeatedly with ketamine and xylazine with little drug-related mortality (Watkins et al. 1983). Yohimbine reverses the effects of ketamine and xylazine (Jessup et al. 1983) and could be used to hasten recovery after blood samples for D2O analysis have been collected. Ketamine, xylazine, and yohimbine are not approved for use in food-producing animals and therefore would have restricted use for deer populations harvested for human
LITERATURE CITED


1983. Effects of supplemental iodine and season on thyroid activity of white-tailed deer. J. Wildl. Manage. 47:45-58.


Table 1. Characteristics of white-tailed deer fawns collected between November and March from northern Illinois, 1985-1986.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N</th>
<th>x</th>
<th>SE</th>
<th>min.</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live wt (kg)</td>
<td>10</td>
<td>34.9</td>
<td>1.6</td>
<td>27.1</td>
<td>41.6</td>
</tr>
<tr>
<td>IFB wt (kg)</td>
<td>10</td>
<td>32.0</td>
<td>1.8</td>
<td>23.3</td>
<td>39.5</td>
</tr>
<tr>
<td>True body water (kg)</td>
<td>8</td>
<td>22.2</td>
<td>0.8</td>
<td>16.7</td>
<td>25.5</td>
</tr>
<tr>
<td>True body water (% of live wt)</td>
<td>8</td>
<td>61.1</td>
<td>1.6</td>
<td>55.9</td>
<td>71.2</td>
</tr>
<tr>
<td>Estimated body water (kg)</td>
<td>10</td>
<td>27.4</td>
<td>1.1</td>
<td>19.5</td>
<td>31.4</td>
</tr>
<tr>
<td>Estimated body water (% of live wt)</td>
<td>10</td>
<td>77.5</td>
<td>2.0</td>
<td>68.7</td>
<td>90.3</td>
</tr>
<tr>
<td>Stomach contents (kg)</td>
<td>10</td>
<td>2.26</td>
<td>0.24</td>
<td>1.48</td>
<td>4.1</td>
</tr>
<tr>
<td>Stomach water (%)</td>
<td>8</td>
<td>80.1</td>
<td>1.4</td>
<td>73.9</td>
<td>84.7</td>
</tr>
<tr>
<td>Intestinal contents (kg)</td>
<td>10</td>
<td>0.71</td>
<td>0.04</td>
<td>0.52</td>
<td>0.99</td>
</tr>
<tr>
<td>Intestinal water (%)</td>
<td>8</td>
<td>75.9</td>
<td>1.0</td>
<td>71.8</td>
<td>81.3</td>
</tr>
<tr>
<td>Ingesta water (% of true body water)</td>
<td>8</td>
<td>9.4</td>
<td>0.7</td>
<td>6.5</td>
<td>11.8</td>
</tr>
<tr>
<td>IFB ether extract (% DMB)</td>
<td>10</td>
<td>32.6</td>
<td>5.0</td>
<td>4.2</td>
<td>48.2</td>
</tr>
<tr>
<td>IFB crude protein (% DMB)</td>
<td>10</td>
<td>51.4</td>
<td>3.8</td>
<td>40.3</td>
<td>75.8</td>
</tr>
<tr>
<td>IFB ash (% DMB)</td>
<td>10</td>
<td>10.8</td>
<td>1.3</td>
<td>6.6</td>
<td>17.8</td>
</tr>
<tr>
<td>IFB gross energy (mcal/kg DMB)</td>
<td>10</td>
<td>6.15</td>
<td>0.27</td>
<td>4.6</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Ingesta-free body

Dry matter basis
Table 2. Linear regression models for predicting true body water (TBW), ingesta-free body (IFB) ether extract (EE), IFB crude protein (CP), IFB ash, and IFB gross energy (GE) from estimated body water (EBW) or TBW and live weight for white-tailed deer fawns from northern Illinois. All units are in kg except GE (mcal). \( N = 10 \).

<table>
<thead>
<tr>
<th>Regression Model</th>
<th>( r )</th>
<th>( R )</th>
<th>SEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBW = 0.67(EBW) + 3.684</td>
<td>0.933</td>
<td>0.669</td>
<td></td>
</tr>
<tr>
<td>IFB EE = 0.9184(Live wt) - 0.8704(EBW) - 4.041</td>
<td>0.934</td>
<td>0.854</td>
<td></td>
</tr>
<tr>
<td>IFB CP = 0.0748(Live wt) + 0.1685(EBW) - 0.997</td>
<td>0.933</td>
<td>0.295</td>
<td></td>
</tr>
<tr>
<td>IFB ash = 0.0418(EBW) + 0.1265</td>
<td>0.409</td>
<td>0.187</td>
<td></td>
</tr>
<tr>
<td>IFB GE = 9.348(Live wt) - 7.332(EBW) - 48.57</td>
<td>0.953</td>
<td>7.529</td>
<td></td>
</tr>
</tbody>
</table>

| IFB EE = 0.9072(Live wt) - 1.2583(TBW) + 0.243 | 0.977   | 0.506   |
| IFB CP = 0.0914(Live wt) + 0.2052(TBW) - 1.437 | 0.917   | 0.327   |
| IFB ash = 0.06(TBW) - 0.0514 | 0.405   | 0.188   |
| IFB GE = 9.381(Live wt) - 10.937(TBW) - 9.575 | 0.990   | 3.658   |

Standard error of estimate
LIST OF FIGURES

Fig. 1. Relationships between true body water (TBW) (% of live wt) or D2O estimated body water (EBW) (% of live wt) and ingesta-free body (IFB) ether extract (%, fresh weight basis (FWB)) for white-tailed deer fawns from northern Illinois.

Fig. 2. Relationships between true body water (TBW) (% of live wt) or D2O estimated body water (EBW) (% of live wt) and ingesta-free body (IFB) gross energy (mcal/kg, fresh weight basis (FWB)) for white-tailed deer fawns from northern Illinois.
ABSTRACT

ABSTRACT--White-tailed deer (Odocoileus virginianus) are abundant and increasing in the Chicago Metropolitan Area of northeastern Illinois. Choices made by local communities to preserve open space within highly developed landscapes have resulted in increasingly negative deer-human-habitat interactions. These conflicts can be best addressed after a community has developed an understanding of the problems and a consensus on management needs. In November 1988, the Illinois Department of Conservation initiated an urban deer management project to address the needs of urban residents for information on deer population control and damage abatement.

INTRODUCTION

White-tailed deer (Odocoileus virginianus) are abundant, widely distributed, and increasing in numbers in the Chicago Metropolitan Area (CMA). Many suburban residents have developed an emotional bond with these deer; some individuals relate philosophically to urban deer by passive coexistence or through a perception of mutual interdependence (Heintzelman 1988). Other residents perceive deer as a component of natural communities but also demand that coexistence be conditionally dependent on the level of problems that deer cause. Conditional thresholds vary and are defined by the degree that individuals tolerate damage or direct economic loss (Caslick and Decker 1979, Porter 1983), reduced property aesthetics (Moen 1984, Conover and Kania 1988), increased health risk (Miller 1987, Lastavica et al. 1989), or ecological impacts (Goldsmith 1982) that are often associated with wild free-ranging deer in suburban environments (Decker and Connelly 1989).

1
2
3
4
Deer management activities in urban environments are frequently focused on symptoms rather than causes. Deer-vehicle accidents, browsing damage to native vegetation and ornamental plantings, and the transmittal of pathogens are the predictable consequences of deer-human coexistence. These symptoms are common in the CMA (Witham and Jones 1987). Treating symptoms through use of site-specific damage abatement techniques (Craven 1984) is generally accepted by the public without significant issue. However, programs that involve population reduction require a comprehensive understanding of the complexity of deer-related issues and a greater acceptance of responsibility for their solution among all involved parties.

In a region such as the CMA, where deer conflicts are abundant and repetitive, a state wildlife agency is well advised to define clearly its level of responsibility for, and involvement in, local urban deer management. Failure to formulate a definitive position increases probabilities for misunderstandings that will reflect negatively on the state agency and contribute to further divisiveness.

In 1983, the Illinois Department of Conservation (IDC) contracted the Illinois Natural History Survey (INHS) to study deer-human-habitat relationships in urban northeastern Illinois. Research by INHS provided baseline biological data, identified and assessed conflicts, evaluated alternative management strategies, and implemented experimental pilot programs that explored issues and established management precedence (Witham and Jones 1987). In November 1988, the IDC initiated a permanent Urban Deer Management Project that overlaps the final 14 months of the INHS research program. During this transition period, the IDC will define its role in urban deer management.

In this paper we describe factors that contribute to the recurrence of deer-human-habitat conflicts in the CMA, identify management needs, and suggest opportunities for IDC participation in urban deer management.

CAUSES OF DEER-HUMAN CONFLICTS IN CHICAGO

Urban environs typically lack the normal complement of natural mechanisms that limit deer abundance. Local habitats have been extensively altered by humans. In such settings, choices made by individuals and communities are the fundamental cause(s) of deer-related conflicts.

Insular Refuges: A Paradox of Preservation and Development

County forest preserves form the principal deer habitat in urban northeastern Illinois. Since 1915, counties have acquired large areas of non-developed and rural landscape for the "purpose of protecting and preserving the flora, fauna, and scenic beauties...in their natural state and condition, for...the education, pleasure and recreation of the public (Wendling et al. 1981). In concept, forest preserve systems were designed as a network of interconnected refuges (Forest Preserve District of Cook County 1918). Some forest preserves were developed for educational and recreational uses, including nature centers, zoological facilities, botanical gardens, and an extensive system of maintained picnic and recreation sites. Non-developed properties are a diverse mixture of native woodlands, reforestations, riparian systems, old-field successions, and leased agricultural fields.
In 1988, forest preserves in northeastern Illinois totalled 394 km², or 8.7% of Cook, DuPage, and Lake counties. The human population of 6.3 million in the 3-county CMA is projected to increase during the next decade (1 July 1986 census, U.S. Census Bureau, 1987). Because of their aesthetic quality and/or higher economic value, private lands around many urban forest preserves have been extensively developed for residential, commercial, and industrial uses. Deer concentrate on preserves but readily cross heavily used highways seeking resources on adjacent private properties. Urban forest preserves will only become more insular over time, thereby contributing to the escalation of deer-human conflicts in the CMA.

Demographic Responses of Deer on Preserves

Demographic responses of deer on quasi-insular preserves are similar to those of deer that are protected from natural predators and hunting. In the CMA, large predators are absent. Winter weather is harsh but within the normal limits of the northern range of the white-tailed deer. In these urban forest preserves, deer survival and productivity fluctuate predominately under the constraints of weather and interannual variations in available nutrition. In rural settings temporal increases in deer abundance are more likely to be offset by a combination of dispersal and recreational hunting. However, on relatively small, non-hunted, insular urban sanctuaries the negative consequences of increased deer abundance are acutely accentuated. High deer numbers on urban preserves will decline only as a result of catastrophic dieoffs triggered by severe weather or disease, or both; or from reductions caused by protracted malnutrition which is a result of degradation of plant resources. Eventual reduction of numbers of deer by malnutrition best characterizes the conditions that currently exist on several CMA preserves.

Human Values and Management Efficacy

Moralistic and humanistic characteristics that predominate urban public values (Kellert 1980) affect the selection of methods used to control local deer numbers. In general, urban publics strongly favor nonlethal techniques; however, those methods have demonstrated only limited effectiveness in reducing and controlling deer abundance. In contrast, lethal methods of deer control have been more effective but less acceptable to urban publics.

The inverse relationship between effectiveness and acceptability of methods of deer control creates polarization between government agencies and the general public. This polarization is reinforced by different perceptions of the value of wildlife management literature. Wildlife professionals are aware of the scope and value of deer management literature (see Wallmo 1981, Halls 1984); without public intervention managers will use published information to improve efficiency without resorting to techniques that have failed previously. Acceptance of a demonstrated successful technique is appropriate if it is refined by critical evaluation—a necessity because results presented in literature are at times ambiguous. Failure to recognize ambiguous results perpetuates dogma and reflects poorly on the credibility of wildlife professionals. In contrast, those with opposing viewpoints may have limited knowledge of wildlife management literature or may reject it entirely. They frequently demand that all nonlethal alternatives should be attempted before lethal control is considered. This syndrome of "reinventing the wheel" at each site is often performed by managers as a compromise to reduce socio-political conflicts.
DEER MANAGEMENT NEEDS IN THE CHICAGO METROPOLITAN AREA

The resolution of suburban deer conflicts requires cooperation among the state wildlife agency, local governments, the affected individual(s) or landowner(s), and public groups with special interests. None of these parties can resolve deer issues independently. The state wildlife agency regulates the use of wildlife resources as defined by legislative mandated laws, whereas, land-use established by property owners is the principal determinant of wildlife abundance and population quality (Smith and Coggin 1984). Because deer, and often times deer habitat, are resources held in public trust, interested citizens profoundly influence management decisions through socio-political processes.

The IDC has no direct control over land-use decisions in the CMA; landowners must therefore assume a direct participatory role in urban deer management. State wildlife regulations can only set the boundaries from which options for deer management can be selected. County commissioners and other officials of local governments are ultimately responsible for making specific decisions. Inherent in this responsibility is the need to balance human interests against the welfare of the natural resources within limitations of the available management options. The role of state government in this process is informational. Local public officials and landowners need unbiased information on deer biology, ecology, and deer management alternatives. They also need professional expertise to design, implement, and evaluate site-specific deer management programs. These management programs will necessarily be continuous, long-term programs as deer numbers change on an annual basis.

URBAN DEER MANAGEMENT IN THE CHICAGO METROPOLITAN AREA

Program Goals

- To establish continuing state-of-the-art expertise on urban wildlife management and local deer ecology for the purposes of management decisions and public education.

- To facilitate cooperative management programs that involve the state, local governments, individuals, and other groups by providing information and training by a locally-based professional staff of wildlife managers.

- To increase awareness of urban deer ecology and to promote broader understanding by the general public of the consequences of an urban environment shared with wildlife.

Recommendations for State Involvement

The primary responsibilities of the IDC are to regulate wildlife use and to provide information and technical expertise. In urban deer management, the IDC must clearly distinguish between technical solutions and value judgments; questions of human values cannot be resolved technically and must be reconciled on a local level (Creighton 1984). In this context, the IDC should facilitate the needs of landowners who experience deer-related conflicts, interact responsively with public groups that express special interests, but not arbitrate nor advocate values.
The IDC has approached urban deer issues proactively by establishing a deer specialist position in the CMA. Although much technical information exists on deer management strategies and methods to abate damage, no universal panacea will effectively eliminate deer-human conflicts (Matschke et al. 1984). Control methods often produce ambiguous results. The role the IDC must take is to present information fully and to predict as accurately as possible the consequences of specific alternative decisions. It should remain the choice of the landowner whether to use the expertise provided by the state. Effective control may require application of controversial methods well after their need is obvious to the public and even to some professional managers.

The urban deer specialist must be able to train landowners, or their representatives, in procedures for handling deer, controlling numbers, and abating damage. Some landowners will prefer to contract control work to an outside source; there are many "deer experts" in the CMA. Under these circumstances the IDC must define minimum standards that will qualify an individual or organization to perform deer management services. The qualifying criteria should demonstrate possession of a specified level of liability insurance, technical expertise, and an ability to use this expertise humanely and with maximum consideration for human safety.

Existing IDC policies and regulations on deer management may need to be adapted for application to local urban situations. Because urban deer management differs substantially from traditional deer management practices in Illinois, in some cases, new regulations will have to be developed. For example, during the first six months of the Urban Deer Management Project the IDC established regulations on the translocation and free-release of deer, requirements for handling deer during live-capture, and modified procedures for the charitable donation of venison from animals killed in population reduction programs.

Applications submitted by landowners for deer depredation permits should include a proposal with a well-defined problem statement, program objectives, assessment of damage (if assessment is not quantified, the proposal should include quantitative procedures that will be implemented in the future), proposed methods, and an evaluation process that will measure achievement of success. These minimal requirements will force landowners to articulate the exact nature of conflicts and how they expect them to be resolved. In doing so, the landowner must address problem specifics rather than use superfulous terminology such as "overpopulation," "overbrowsing," or "carrying capacity" (Macnab 1985).

We plan that the IDC Urban Deer Project will function as the central repository for deer-related data collected by local agencies. Centralization will encourage the standardization of data collected and will promote the exchange of information among landowners who manage deer on their properties.

**DISCUSSION**

Currently in the United States there is a general movement from a representative government to a participatory democracy. This tendency extends to wildlife management at a local level. Increased public participation in decision processes is viewed more as a right and a responsibility than as a
privilege (Creighton 1984). Urban deer issues provide a forum where this shift in attitude is readily apparent and, perhaps, accentuated.

If urban communities choose to preserve open space and yet promote development—and thus impair or eliminate forms of natural limitations of wildlife abundance—and then request abatement of deer-related damage but place limitations on the acceptability of techniques—communities must be prepared to accept an active role in the management process. The IDC initiated the urban deer management project to help communities resolve deer-human conflicts. Success will depend on the ability of the communities to define site-specific deer management needs and to select management responses that will effectively meet those needs. Communities will need continuing professional expertise to meet those needs.

LITERATURE CITED


Appendix D. Guidelines for preparation of a site-specific deer management proposal--application for a deer removal permit.
Prior to the issuance of a Deer Removal Permit, the Illinois Department of Conservation must receive written documentation of deer-related problems and the need for a deer population control program. A management proposal clarifies goals, objectives, methodologies, and evaluation procedures, and insures the use of effective, safe, and humane techniques. The suggested format and contents for a site-specific deer management proposal are listed below:

1) Title page: the proposal should include a title (i.e., Control of white-tailed deer in Jackson Arboretum), name and address of the organization submitting the proposal, and date submitted.

2) Introduction and problem statement: include a brief description of the size, location, and function/mission statement of the area to be managed. This section should also contain a general statement of the problem(s) caused by deer.

3) Program goal: describe the long-term purpose of the proposed management program.

4) Program objectives: provide specific descriptions of the management tasks to be accomplished.

5) Site description: include a detailed description of the area, evaluate deer numbers on site, and list past deer management activities.

6) Documentation of problem/deer-related damage: quantitative (i.e., number and type of plants damaged/destroyed, replacement costs) data is preferred and should be collected as part of the program evaluation. However, qualitative (i.e., photographs or observations of damage) documentation is adequate initially for issuance of a removal permit.

7) Proposed methods and procedures: include number of animals to be removed and techniques to be used to accomplish short-term and long-term objectives. This section should list reasons for selecting techniques and proposed methods of deer/carcass disposition. NOTE: The cost of any deer removal program and carcass processing fees are the responsibility of the landowner(s) implementing the management program and should be considered during the planning phase.

8) Evaluation of management program: list criteria that will determine the effectiveness of proposed techniques in achieving the program objectives (i.e., the number of plants damaged, extent of damage acceptable, and/or number of deer to remain on site).

9) Chronology of management activities: approximate dates for submitting proposal, initiating management program, completing program, evaluating success, and submitting summary of activities to IDOC.

10) Literature cited.

11) Tables, graphs, appendices that support your proposal.
A. The live-capture, translocation and release of deer into a free-ranging situation will not be permitted. Justification for not translocating deer include:

1. The population of white-tailed deer in Illinois is at an all-time high for this century. The increase in deer numbers statewide is exemplified by record hunter harvests (i.e., over 47,000 white-tails were harvested during the 1988 6-day shotgun season) and increased numbers of reported deer-vehicle accidents (i.e., reported deer-vehicle accidents on state-maintained roads have increased from 2345 in 1981 to 6301 in 1987) over the past decade.

2. Concern for potential impacts upon deer existing on release site. These potential impacts include transmission of diseases and parasites (i.e., Lyme disease, "bluetongue", and epizootic hemorrhagic disease), and competition for resources with the resident deer.

3. Low survival of translocated deer. A large percentage of the translocated animals could be expected to die due to traumatic causes, including capture myopathy, deer-vehicle accidents, and hunting.

B. Live-trapping and translocation of deer will be permitted only to not-for-profit zoological institutions approved by the Department (such as Brookfield Zoo or Wildlife Prairie Park at Peoria) subject to the following conditions:

1. Individual animals must be certified free of Lyme disease and bluetongue by a blood test ... before translocation may occur.

2. All translocation and handling must be conducted under the direct supervision of a professional wildlife biologist or veterinarian.

3. Translocation will only be allowed to zoological institutions having deer-proof enclosures to ensure against escape to the wild.

4. If animals are to be moved across state lines, permits must be obtained from the natural resource agency in that state.

5. All animals, upon which drugs have been used, must be permanently marked in a highly visible manner.

6. Translocated animals must be accompanied by a copy of the deer removal permit and a numbered metal tag provided by the Department. Should mortality occur during translocation, the metal tag must be affixed to the carcass.
C. Live-trapping and euthanasia will be permitted providing the method of euthanasia does not render the carcass unsuitable for human consumption.

1. Use of standard pharmacologic euthanatizing agents would render carcasses unfit for human consumption.
2. Mechanical euthanasia should be substituted (i.e., use of a captive bolt system was evaluated as humane euthanasia by the American Veterinary Medical Association. 1986. Report of the AVMA panel on euthanasia. J. Amer. Vet. Med. Assoc. 188(3):252-268).

D. Selective shooting by professional marksmen, using techniques described in the proposal that maximize both safety and humaneness, will be permitted. The proposed methods are consistent with the 1986 Report of the American Veterinary Medical Association Panel on Euthanasia which listed "... competently performed gunshot" as "an acceptable method of euthanasia".

E. Deer carcasses must be field-dressed, processed by a state-licensed packing facility and then donated to charitable organizations for human consumption. Exceptions include deer that:

1. are emaciated or diseased
2. have open wounds, fractures, or infections
3. have been injected or implanted with chemicals

The Department received an exception to the State Property Control Act from the Department of Central Management Services which allows donation of the processed meat to the charity.

I. Problem statement- deer at moderate to high densities can:
   A. Eliminate woody plant regeneration
   B. Reduce vertical structure in forest understory
   C. Extirpate more palatable plant species
   D. Cause secondary negative effects to fauna
   E. Contribute to chronic malnutrition or starvation among deer

II. Provisions for management- deer may be removed where:
   A. Deer have caused, or are likely to cause, negative impacts to preserve flora
   B. The IDOC has
      1. Authorized population management
      2. Designated specific methods of removal
   C. The INPC has
      1. Approved removal in a Master Plan
      2. Or, issued a Special Use Permit

III. Documentation of Problem
   A. Supportive evidence of need for control is required
   B. Qualitative or photographic evidence is sufficient initially if submitted with plan for long-term quantitative documentation.
   C. Acceptable documentation includes
      1. Loss of herbaceous plants
      2. High % of browsed twigs
      3. Direct or indirect estimates of deer abundance
      4. Damage to other exceptional preserve features

IV. Population management philosophy
   A. No universal standard of deer density can be applied to predict the degree of browsing impact--appropriate densities are best determined by site-specific reduction of deer numbers in conjunction with evaluation of the responses of impacted plants.
   B. Adjustments of deer density should be made in accordance with plant recovery.
   C. Two forms of population regulation are recognized
      1. Population reduction- a corrective action where the number of animals removed exceeds annual recruitment
      2. Population control- a preventative or maintenance action where number of animals removed approximates annual recruitment.

( cont. )
Appendix E. (cont.)

D. Goal--to maintain the natural quality of the preserve while minimizing the absolute number of deer removed on a long-term basis. Two options are available:
1. Low-density management
   a. Minimizes impacts to plant resources
   b. High net recruitment of deer
   c. Excellent condition of deer
   d. Strategy for sensitive habitats or ecotypes
2. High-density management
   a. Moderate to high impact to plant resources
   b. Low net recruitment
   c. Poor to moderate condition of deer
   d. Strategy for less sensitive habitats or ecotypes

V. Development of a population reduction program

A. Must be developed by nature preserve owner or representative
B. Mandatory consultation during planning with IDOC
   1. District wildlife biologist
   2. District natural heritage biologist
C. Program must include
   1. Problem identification
   2. Clearly defined management objectives
   3. Description of site characteristics
   4. Methods
      a. Only methods that are field-proven to be effective will be allowed
      b. Translocation of deer from one nature preserve to another will not be allowed.
   5. Quantitative method of evaluation
   6. A chronology for achieving objectives

VI. Public notice

A. Public must be notified by at least 1 of these methods
   1. Publication in newspaper with greatest circulation
   2. Public hearing
   3. or, Administrative Rule
B. If public hunting is used
   1. Prominent signs must be posted at each entrance
   2. A preserve may be closed for the duration of removal

VII. Reporting Provisions
Appendix F. Recommended amendment to Public Act 82-580 that will allow donation of field-dressed wild game to charitable organizations for human consumption. Recommended amendments are underlined.

Section 2.12. "Wild Game" includes, but is not limited to those species specified as game birds or mammals in Section 2.2, Article II of Chapter 61, Illinois Revised Statutes or species not native to Illinois that have been brought into the state for the purpose of holding, releasing or propagating. All "Wild Game" as referred to in this section shall have had their entrails removed.

Section 2.13. "Wild Game Donor" means any person, organization or governmental agency that has taken wild game in a manner authorized by the Department of Conservation including scientific collection permit, depredation permit or other removal permit.

Sec. 3. (a) Except as provided in subsection (b), no farmer, food producer, processor, distributor, wholesaler, retailer, wild game donor or gleaner of food who in good faith donates perishable canned or farm food items or prepared food or wild game to a not for profit corporation or charitable organization for distribution to needy or poor persons shall be liable in any civil action based on the theory of warranty, negligence or strict liability in tort, for damages incurred resulting from any illness or disease contracted by the ultimate users or recipients of the food due to the nature, age, condition, or packaging of the food.