INTEGRATED PEST MANAGEMENT

NATIONAL PARK SERVICE
NATIONAL CAPITAL REGION

Year Two
November 1, 1980 - October 1, 1981

Contract No. CX-3006-0-0036

Center for the Integration of Applied Sciences
John Muir Institute
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I. Executive Summary

Major accomplishments during Year Two were:

- development of field programs as demonstrations which are effective, cost efficient, and environmentally benign.
- to begin transfer of these methodologies and technologies to Park personnel through informal field instruction and training sessions.
- an analysis of the pest management system.

IPM Field Demonstrations

The IPM Project achieved effective, cost efficient, and environmentally compatible management of rats, yellowjackets, azalea lace bug, mosquitoes, eastern tent caterpillar, pine bark aphid, and aphids on crab apples. Also, significant progress has been made in developing IPM programs for stable fly, white peach scale, and aphids on roses. Promising leads were developed for Japanese beetle control.

The ongoing development of monitoring systems and action thresholds were central to this success. Least toxic technologies were also essential for transition to more environmentally compatible strategies, e.g., refuse container redesign and landscaping changes for rat management, refuse and beverage container changes for yellowjacket management, soap and water treatments for azalea lace bug management, insecticides for management of mosquitoes and eastern tent caterpillar, and use of native predators in pine bark aphid management. Progress was also made on developing traps for monitoring and control of yellowjackets, stable flies, filth flies, and traps and the use of the repellent, neem oil, for Japanese beetle management.

A study on the feasibility of importing natural enemies of pine bark aphid was completed; no importation is recommended at this time.

Personnel Training/Public Education

Park personnel were involved in monitoring (yellowjackets, azalea lace bug, stable fly, filth flies, mosquitoes, white peach scale, Japanese beetle, eastern tent caterpillar, and aphids on roses and crab apples) and in use of alternative treatments (all pests). This involvement was restricted to parks in which the pilot implementations occurred. During Year Three, we plan to use IPM Reference Binders (looseleaf manuals) to aid in transfer of these methodologies and technologies to other parks. Development of pest treatment action thresholds is more complex, and will remain dependent on additional training of current personnel, hiring an IPM Field Specialist, or contracting for this.

As field demonstrations succeeded and as personnel became trained through hands-on experience, briefings and formal presentations (a region-wide presentation and two NPS training sessions in which NCR personnel took part), there was a noticeable shift of appreciation for IPM concepts. Crews became aware of

and could identify the presence of natural enemies on pests, and were willing to continue to monitor pest populations being attacked, rather that to apply pesticides on a spray-schedule or see-it spray-it basis. Requests for implementation of IPM programs for rats, yellowjackets, azalea lace bug, stable fly, mosquitoes, and aphids coincided with success of the pilot projects.

An insect reference collection and IPM slide show were developed for use in training and in making public presentations.

Educational activities included distribution of flyers on yellowjacket IPM and sting therapy, and recommended use of a bacterial insecticide, Bacillus thuringiensis for caterpillar control around homes and farms, public briefings to explain development of the IPM program in NCR, use of traps and other visual tools in IPM implementations to increase public awareness of alternatives to pesticides and design of an Urban Wildlife Display.

Systems Analysis

The pest management structure in NCR/NPS was analyzed with regards to policy, decision processes, and adoption of IPM. Recommendations were made for improvement in all aspects of the pest management system.

II. General Recommendations *

The most important pest management objective at present should be to institutionalize IPM programs, concepts, and procedures. This could be done by:

- developing an IPM Field Specialist position, at the GS 9-11 level or above to coordinate IPM activities in NCR. This person would be responsible for helping Park management, advisory groups, resource managers, and designers develop and evaluate IPM plans. He or she should be responsible for monitoring and treatment evaluation in NCR, the maintenance of a record keeping system, pest and natural enemy identification, and training of field personnel.

- changing job descriptions to coincide with emerging IPM responsibilities. Although CIAS is currently responsible for most monitoring and record keeping, there is increasing participation by NCR personnel. Integration of monitoring and record keeping into job descriptions should be a top priority. These records are needed for making treatment decisions, but more importantly, to serve as the "memory" of the system upon which future decisions are based.

- additional training of pest managers re: pest biology, identification of natural enemies, and other key IPM concepts. Current state certification and recertification instruction is inadequate. An in-house capability should be developed by NCR. The transfer of IPM programs already in place (for rats, yellowjackets, azalea lace bug, stable and filth flies, mosquitoes, and caterpillars) to other parks should be a top priority.

- involving pest managers in all phases of park design. This will reduce situations in which pests are planned into the system.

Use of spray schedule or "see-it, spray-it" pest control is neither cost efficient nor environmentally sound. We recommend:

- use of monitoring (and the use of some type of action threshold) to determine if treatments are justified, what treatments to use, where and when to use them, and how to evaluate their success.

- development of a record keeping system for pest management activities.

- use of improved treatments. This should be facilitated by a communication (e.g., newsletter, etc.) that alerts parks to new technologies as they develop.

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* See Section III (Analysis of the Pest Management System) for further elaboration. Specific recommendations for pests are also included under Section IV B (IPM Programs).

III. Analysis of the Pest Management System

Pest management is an aspect of resource management. In the case of ornamental plants, for example, resource management includes plant care (pruning, fertilizing, etc.) and pest management. Plant care may affect pest populations, e.g., overfertilizating with nitrogen may cause aphid problems. Often plant care will affect the plant quite dramatically, leaving pest management as a comparatively minor consideration, e.g., the loss of cherry trees in Central due to drought. In other instances, pest management is the overriding consideration, in cases in which plants are adequately cared for but in which pests are still a problem, e.g., loss of trees due to feeding by the gypsy moth, an exotic pest.

In this section, we will focus on the pest management component of resource management. Plant care will be incorporated only in cases in which incorrect horticultural practices cause or exacerbate pest problems.

The pest management system itself has three interacting subsystems - a biophysical system (including the pest and its environment - weather, habitat, and natural enemies), a management system (including policy makers, park managers, pest control operators, tactics and procedures, etc.), and an information system (scientists, advisors, monitoring, record-keeping, etc.) which provides and processes information needed by managers to adjust the biophysical system and the management system. These systems, and their interaction, are discussed in this section with emphasis on the management and information systems. The biophysical system is treated in detail under IPM Programs; it is discussed here to illustrate management changes.

Since these three systems are dynamic, interdependent, and somewhat meaningless in isolation, we have arranged this section not only along the lines of the information, management, and biophysical systems, but also in an integrated discussion, following changes in the pest management system over time. We begin with a discussion of the pest management system pre-IPM (Part A) and go on to describe the current system and make recommendations for change in the near future (Part B).

PART A

History of Pest Management in NCR Before IPM Implementation

Pest management in NCR before IPM implementation essentially consisted of routine application of pesticides on a spray-schedule basis, usually with little or no determination from year to year as to whether it was effective or not. This strategy is the legacy of the 1950's pesticide revolution and has persisted because of limited knowledge of the harmful effects of pesticides, lack of adequate training programs for crews, lack of viable alternatives, and the availability of inexpensive pesticides. The immediate kill associated with these materials and the simplicity of the approach, directions, and effectiveness is a tremendous instant feedback incentive for perpetuation of the system.

According to records supplied by Dr. James Sherald, Regional Pest Management Coordinator (RPMC), pesticide use in NCR alone in 1979 was 18,222 pounds (active ingredient). Over 50 different materials were used to treat: insects, mites, snails/slugs, nematodes, birds, and diseases of ornamentals and turf; termites and wood borers in structures; weeds in turf and beds; and nuisance or public health pests such as mosquitoes, wasps, stable flies, cockroaches, rodents, ants, spiders, and silverfish.

By the late 1970's, the federal government, increasingly concerned with the harmful threat of pesticides to humans and the environment and conscious of the development of viable options for managing pests in agriculture and urban areas, became more actively involved in promoting IPM as the pest control strategy.

Pest Management Policy Directives

In response to a 1980 Presidential Directive that all federal agencies adopt IPM where practicable, the Assistant Secretary of the Interior issued Directive 517 DM1, Environmental Quality: Pesticide Use Policy, September 23, 1980 (Appendix A). This statement outlined acceptable pesticide use procedures in DOI and banned the use of 2,4,5 T and 2,4,5 TP on DOI lands. Endosulfan and lindane were put on DOI's restricted list. Most importantly, the presidential directive shifted the previous policy focus from that of managing pesticides to managing pests.

The Director of the National Park Service, Russell Dickenson, complied by issuing Directive N50(496): Update and Clarification of NPS Policy on the Use of Chemical Pesticides on Lands Administered by NPS, April 6, 1981 (Appendix B). This was followed with an update to Regional Directors on development of the Pest Information Management System (Pest Management Program call FY 1981, August 28, 1981, Appendix C). These directives mandated the following pest management policy:

> "Chemical pesticides of any type will be used only where feasible alternatives are not available or acceptable. The Service's use of all pesticides shall be approved by the Director....."

Special departmental approval was required in cases where endangered species were threatened, when applied pesticide would get into aquatic areas, for large area applications (640 acres or more), or for restricted pesticides. The overall intent of these directives is stated in this excerpt from the April 6 Directive:

> "Service policy does not prohibit, as such, the use of chemical pesticides. However, chemical controls are to be allowed only if (a) there is a clear and present danger to the health and safety of man; and/or (b) there is danger of destruction of significant property or resources and a determination has been made that the control methods of no action, mechanical, cultural and/or biological control are non-existent, unavailable, or unacceptable."

Cost and labor were not to be considered in deciding what was "unacceptable".

A Service-wide Pest Management Coordinator (SPMC), working with Regional Pest Management Coordinators (RPMC), was given the responsibility of reviewing pesticide use requests, approving or disapproving them, and recommending that the Park come up with a more "integrated" pest management plan, in some cases one suggested by the SPMC or RPMC. These directives clearly were meant to encourage Park managers to adopt IPM as their pest management strategy.

Policy on Importation of Exotic Natural Enemies of Pests

In addition to habitat modification, importation of natural enemies of the pest (i.e., classical biological control) offers the most long-term, least toxic, and most cost effective strategy for managing many insect and weed pest problems. This is primarily because, in many cases, the pest, in its place of origin, is suppressed by its natural enemies to levels acceptable to human beings. Since most pests are exotic (Sailer, 1978; Elton, 1958) and since they were usually imported without their natural enemies, efforts to import their natural enemies are essentially efforts to restor the natural balance in existence in the pest's place of origin. For a further discussion of these issues, see Debach, 1974; Clausen, 1978; Huffaker and Messenger, 1976.

The NPS Management Policy Handbook (1978) states:

> "In natural zones, non-native plant and animal species may not be introduced except in rare cases where they are the nearest living relatives of extirpated native species, or where they may be used to control established exotic species."
>
> It must also be determined that....."each species proposed for introduction will not become a pest".

This order clearly permits introduction of pest-specific natural enemies onto lands managed by the National Park Service. It also clearly forbids introduction of non-specific natural enemies such as parasites and predators that may attack native plants and animal species.

Initiation of an NCR Pilot IPM Program

In order to determine the applicability of using the IPM approach for managing Park Service pest problems, a Pilot - Model IPM Program was initiated in NCR, to be conducted by personnel of the Center for the Integration of Applied Sciences/John Muir Institute. If successful, this program could serve as a template for development of similar programs in other Park regions and in other government agencies.

PART B

The Current Pest Management System

The following pages present the current pest management hierarchy with descriptions of personnel functions at all levels. Recommendations for changes in personnel, job descriptions, or functions of personnel in this hierarchy are included.

A case study of pest management at NCP-Central* is then provided to demonstrate the level to which IPM translates from policy to operations in an urban park. This analysis includes a discussion of physical, informational, and management systems.

This part concludes with a discussion of overall changes observed in the pest management system within NCR including NCP-Central and other parks, since 1980 when the IPM program was begun.

Pest Management Hierarchy

Figure 1 and the accompanying analysis indicate the current positions and units responsible for pest management in NCR. Those personnel in DOI and NPS whose decisions clearly affect NCR operations are included.

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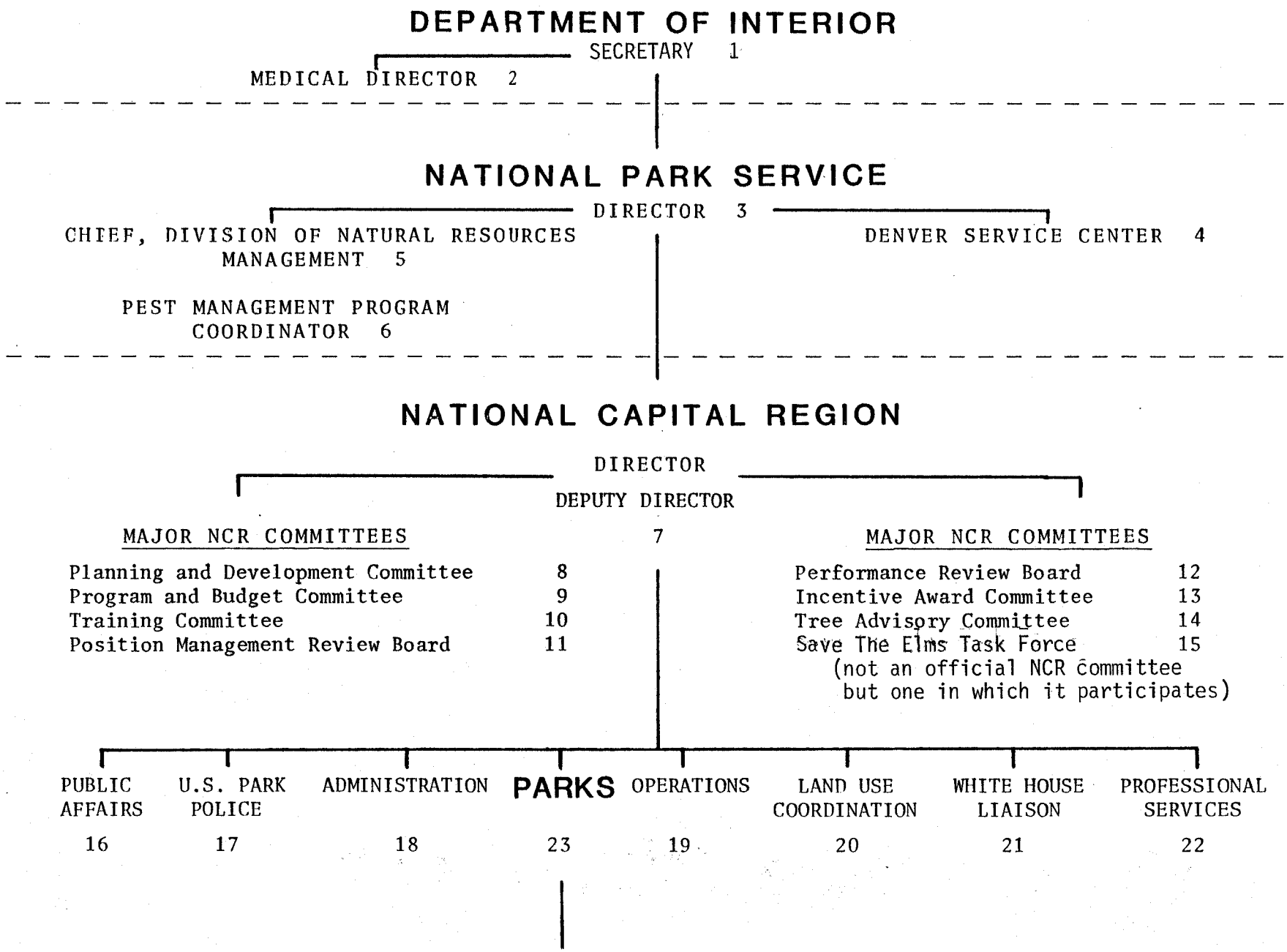
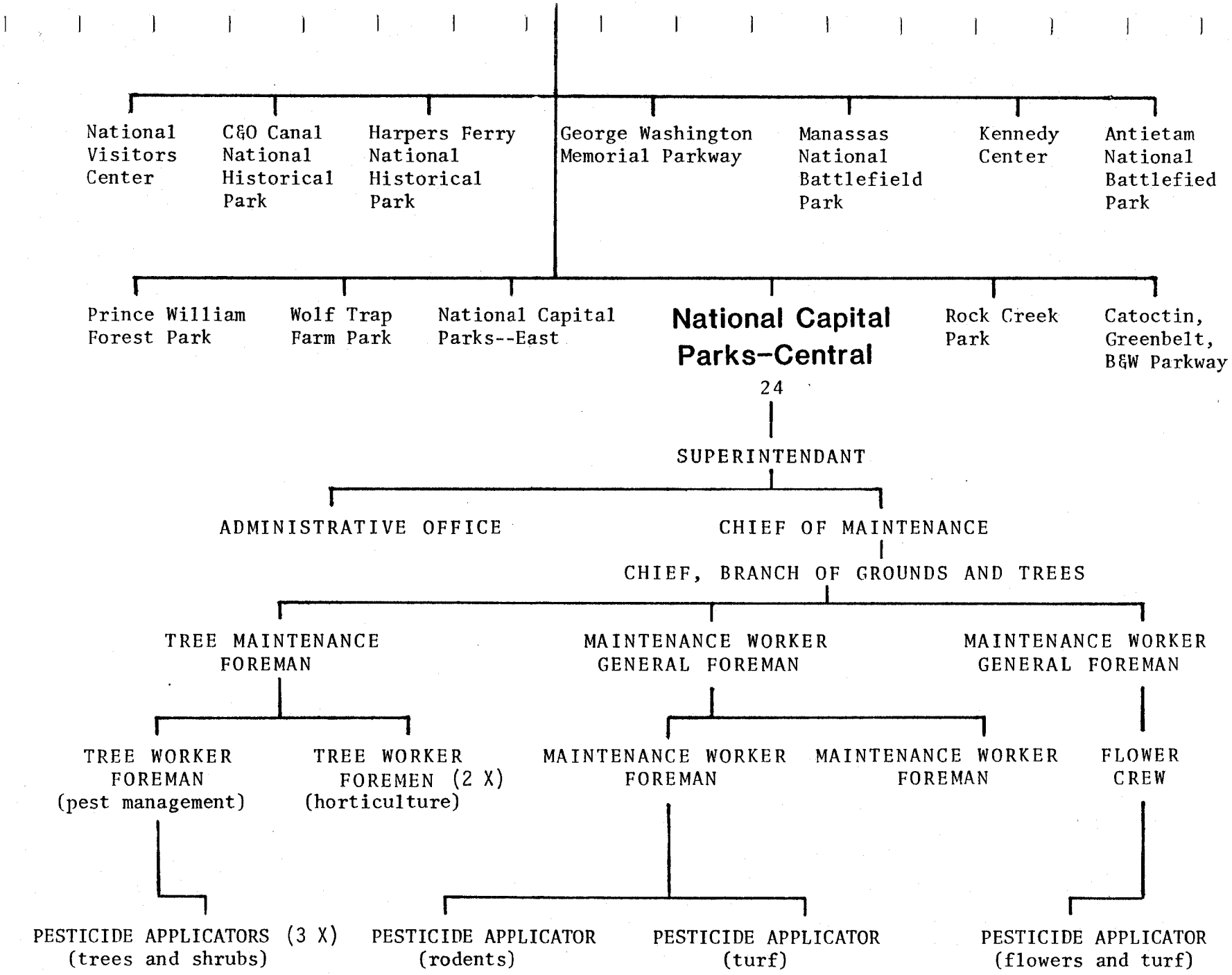
* In this report, National Capital Parks Region is referred to as NCP when indicating a park, e.g., NCP-Central (or just Central). NCR is used as an abbreviation when referring to the Region.

FIGURE 1 PEST MANAGEMENT HIERARCHY





Numbers refer to the following descriptions of position responsibilities (current and proposed).

Numbers in parentheses (e.g., 2 X) indicate the number of people other than 1 that hold this position.

Hierarchy Descriptions, Analysis, and Recommendations for Change

DEPARTMENT OF INTERIOR

1. Secretary, James Watt

   C - The Director of the Department of the Interior holds responsibility for all activities of NPS.

   P - Implementation of IPM procedures and pilot programs should be encouraged as a cost effective approach to changing the existing pest management system throughout DOI.

2. Medical Director, Dr. Mariano Pimentel

   C - Certification of paramedics and emergency medical technicians to administer epinephrine to sting victims in anaphylactic shock. This is currently done at Park request and with Park or Park personnel funding.

   P - The Medical Director should encourage use of DOI resources for training Park personnel to administer medication to shock victims (see IPM for Yellowjackets).

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3. Director, Russell Dickenson

   C - Sets pest management policy including acceptable pesticide use

   C - Prioritizes pest management related activities for review by DOI and funding by Congress, including training programs.

   P - NPS should place high priority on developing an in-house Pest Management Training Program to be attended by all personnel making pest management decisions. This should not only include certification for pesticide use, but also monitoring and other IPM methodology. Development of the IPM Database (including pesticide use and other pest treatment records and recommended methodologies) should continue. Service-wide efforts to implement IPM programs should also be encouraged by establishment of demonstration projects.

4. Denver Service Center

   C - Design of major structural and landscaping projects.

   P - Maintenance of structures and landscaping, re: pest management, should be considered in all future designs. Designs should be selected to minimize the development of pest problems.

C = current function

P = proposed function

5. Chief, Division of Natural Resources Management, Ro Wauer

   C - Overall management of Park resources including training of resource managers. Supervised development of State of the Parks, 1980, a compilation of major threats to the Park. Presently supervising development of Resource Management Plans to deal with these threats.

   P - Integrated Pest Management training should be identified as an important resource management priority. This should include basic ecological concepts and IPM methodology using existing IPM pilot programs as examples.

6. Pest Management Program Coordinator, Michael Ruggiero

   C - Responsible for reviewing pest management alternatives from Regional Pest Management Coordinators and making recommendations to park managers regarding IPM implementation.

   P - Continue to require park managers to justify pesticide use on the basis of their implementation of a total IPM program, particularly including monitoring and treatment evaluation componenets.

   P - Priority, system-wide, should be placed on improved record keeping including records of pest abundance, number of units (e.g., trees) treated, pesticides used, etc.

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7. Director, Manus J. Fish, Jr.
   Deputy Director, Robert Stanton

   C - Responsible for administering NPS pest management policy in NCR. The present study is contracted through this office.

   P - Encourage hiring, training, and job description changes for pest and resource managers which reflect IPM objectives.

   P - Make acquisition of an IPM Field Specialist a top priority.

   P - Continue to encourage development of pest and waste management systems that are compatible with IPM.

8. Planning and Development Committee

   Chairman - Associate Regional Director (ARD), Professional Services, Paul Goeldner

   Members - Land Use Urban Coordinator, Jack Benjamin
   ARD, Operations, Lowell Sturgill
   Regional Planning Coordinator, Michael Donnelly
   Regional Interpretation Planner, Jane Chandler
   Chief, Historic Services

Program and Budget Officer, Hal Miller
Park Superintendents - on a revolving 4 month basis
Chief of Maintenance (James Wolfe), Chief of Resource Management (Edward Drotos), and Chief of Concessions Management (Donald Roush) attend at the request of the Chairman or Regional Planning Coordinator

C - Review and coordinate development of all new projects in NCR, e.g., decide whether to provide more picnic sites in the current golf course area of East Potomac Park.

P - Adopt the Project Presentation Request System proposed by M. Donnelly. Requests to make presentations or to attend meetings would be made via a form sent to all offices in NCR. In this way, greater input regarding pest management and other expertise would be available to the committee and the activities of the committee would be more accessible to park managers.

9. Program and Budget Committee

Chairman - ARD Administration, Carolyn Betts
Acting Chairman - Program and Budget Officer, Hal Miller
Members -
ARD Operations, Lowell Sturgill
Chief Maintenance Division, James Wolfe
Assistant to Hal Miller, Dotty Berks

C - Prioritize all requests for regionally funded projects (e.g., Cyclic Maintenance) from Park Superintendents and fund these projects as the budget permits. Major renovations, including planting changes, are considered by this committee. All other park budget proposals are also prioritized from a regional standpoint; but since Park Superintendents generally have autonomy with respect to their budgets, this prioritization is advisory only.

P - Continue to consider pest management consequences in plant material purchases, e.g., use of insect and disease resistant plant varieties.

10. Training Committee

C - Supervise development of pest management training programs in NCR.

P - Expand training of IPM concepts and methods.

11. Position Management Review Board

C - Write job descriptions; set qualifications for new positions in pest management ; adjust existing job descriptions and performance standards to include pest management.
P - IPM skills and expertise should be considered when hiring personnel who will be directly involved with pest control activities.

12. Performance Review Board

C - Performance evaluation, including pest management personnel.

P - Consider acquisition of IPM skills, e.g., monitoring,knowledge of pest biologies and alternative pest control technologies, in promotion.

13. Incentive Award Committee

C - Special awards for exceptional job performance, usually for highly visible projects.

P - IPM is not highly visible, but, nevertheless, requires a great deal of creativity and initiative. For this reason, we believe awards should be given for developing new IPM systems (e.g., the rodent management system developed for Lafayette Park) or for outstanding performance in using IPM skills (e.g., monitoring - discovery of invading pests such as the gypsy moth).

14. Tree Advisory Committee

Chairman - Regional Horticulturist, James Lindsay
Members -
Chief of the Laboratory (ESL), Richard Hammerschlag
Landscape Architect involved in the project
Representative (Superintendent, Resource Manager, etc.) from park involved

C - Advise park on new plantings, e.g., as to their urban fitness, resistance to pest damage, etc.

P - The committee's scope should be broadened to include all plant purchases, i.e., new and replacement plantings. The committee should be renamed the Plant Management Advisory Committee. Member or designate from the following groups should be added to the committee:

Management Agronomist, Robert Cook (if turf is involved)
Chief Scientist, William Anderson
Chief of Resource Management, Edward Drotos
IPM Specialist (at present, RPMC)

P - Although this committee has official sanction of the Regional Director, it serves on an advisory capacity, at the request of the park, only. The committee should be empowered to veto (subject to Regional Director's approval) planting plans which will create an unreasonable situation with regard to pest management and plant maintenance. For example, parks should not plant trees which will require repeated applications of pesticides.

15. Save The Elms Task Force (not an official NCR committee)

Chairman - National Capital Planning Commission, Martin Rody
Members -
Chief of the Laboratory (ESL), Richard Hammerschlag
Regional Pest Management Coordinator, James Sherald
District of Columbia, Environmental Services, Hans Johannsen
Landscape Architect, Thomas DeHaven

Principal Plant Pathologist (ESL), Horace Wester
Fine Arts Commission, Jeffrey Carson
Other advisors attend as needed

C - Developing a city-wide Dutch elm disease control project.

P - This task force might be expanded to deal with city-wide control projects for gypsy moth, rodents, and other pests for which coordinated efforts would result in better control.

16. Public Affairs

ARD, Sandra Alley

C - This office has functioned in the current program by issuing press releases about the project (e.g., Mosquito Program), announcements of the availability of IPM materials available through NCR (B. t. Flyer), and by arranging for interviews with the media (Washington Post articles).

P - This public outreach should continue.

P - This office could function in refering incoming inquiries regarding pest management to the appropriate resource person (usually the IPM Specialist).

17. U.S. Park Police

Chief, Jerry Wells

C - Protect field equipment, such as Japanese beetle traps. Also, this unit functions as a Park and, therefore, is involved in pest management, e.g., stable flies.

P - As with other parks, Park Police horse stable personnel (particularly grooms) should integrate pest management procedures into daily activities, e.g., monitoring, selective treatments, etc. This may involve special requisitioning of parasites, traps, and other IPM technology and information.

P - A second role which would be very valuable is for park policemen to become more involved in reporting pest problems to park managers. For example, Officer Alex VanVeen's report of a dangerous rat problem at Meridian Hill Park has led to development of an IPM program there.

P - Park policemen would also be an appropriate group for training with regard to administration of drugs to anaphylactic shock victims (see IPM for Yellowjackets).

18. Administration

ARD, Carolyn Betts

Contracting and Purchasing

C - Critical review and purchase of all pest control materials, equipment, and services.

P - All pest management related requests should be reviewed by the RPMC. Representatives from crews which will use this equipment should also be consulted. (This need was very emotionally brought out in a recent NCR Turf Management Roundtable discussion.)

P - Specifications for weatherization work should include cockroach and other pest exclusion actions. This would allow the park to design pests out of structures while dealing with energy issues at the same time.

Computer Operations (CPT System)

C - Plans are being made for this system to load pesticide use information for NCR in 1982.

P - All IPM related data should be stored on this system, including: monitoring, foliage treatment histories, treatment evaluations, etc.

Personnel

C - Responsible for writing job descriptions, classification, hiring, and promotion of pest managers.

P - Current pest management job descriptions need to be changed to reflect IPM needs. Promotions should be linked to attainment of pest management skills, e.g., monitoring ability.

P - Two new positions should be created within NCR:

- o The job description for the person currently functioning as RPMC should be changed to acknowledge this role and should be titled IPM Specialist.
- o An IPM Field Specialist position should be created, at GS 9-11, to assist the IPM Specialist (see 22, ESL).

Training

C - Donald Wadase currently coordinates training in horticulture and resource management, e.g., the 196 hour Gardener Training Program, including classroom and field work. James Sherald (RPMC) addresses the need for pesticide certification done in cooperation with the existing DOI program with recertification being handled at ide the Sherald also supplements pest management training obtained during pesticide certification courses.

P - Crews express dissatisfaction over the information presented at Pesticide Certification courses. Generally these courses cover too many pests, in too little time, with no field demonstrations. IPM is not mandated to be taught. We propose that the Park develop

its own in-house training program for all pest management. This work should be coordinated with training programs developed at the state level and should satisfy state recertification requirements.

19. Land Use Coordination

ARD, John Parsons

C - Responsible for environmental impact assessments, decisions on land use (e.g., whether to maintain an historic battlefield as a meadow or to lease it as a corn farm), and decisions dealing with the Park's relationship to adjacent lands (e.g., whether to reduce gypsy moth populations in Catoctin Park as part of an overall state effort at gypsy moth reduction).

P - Pest management ramifications should be considered in all land use decisions. For instance, decisions to lease land for smallgrains rather than corn farming would reduce the amount of pesticide needed. This should be done as a formal procedure and should involve the Division of Natural Sciences.

20. Operations

ARD, Lowell Sturgill

C - Administers the major division in NCR dealing with pest management.

Maintenance Division Chief, James Wolfe

C - Reviews funding requests including those related to pest management (see also Program and Budget Committee).

Regional Horticulturist, James Lindsay

C - Makes recommendations regarding purchase of plant material. Chairman of Tree Advisory and Seasonal Floral Display Committees.

Regional Agronomist, Robert Cook

C - Role similar to Regional Horticulturist, only specializes in turf management.

see page

Interpretive Services Division Chief, William Failor

C - Interprets Park resources to the public and coordinates the community garden program. The latter involves specifying which pest control options (e.g., pesticides) are acceptable and providing pest control information to gardeners.

P - This division should take an expanded role in informing the public of IPM programs in NCR, e.g., yellowjacket management at Great Falls Park, VA, rodent management at Lafayette Park.

P - Continue to encourage insect resistant, urban tolerant plants to be purchased.

P - Pesticides, other than certain approved ones (e.g., B. t., soap) should not be used in community gardens. This will not only preserve wildlife and eliminate drift of poisons from one garden to another, but will also encourage gardeners to learn more about the ecology of gardening and IPM methodology.

Resource Management and Visitor Protection Division Chief, Edward Drotos

C - Responsible for developing resource management projects in NCR, including supervision of the development of State of the Parks (Threats) and Resource Management Plans. These plans when fully developed will hopefully lead to specific maintenance standards for each geographically separate park area. New standards are desparately needed to coincide with the fiscal, energy, and environmental realities of the 1980's.

P - IPM skills need to be identified as a resource management need. More ecologists should be recruited as resource managers.

Concessions Management Division, Donald Roush

C - Manages contracts with concessions, including specifications of pesticides which are allowed in pest control at some concessions (e.g., golf courses).

P - IPM specifications should be written into all concession contracts. Concessions should be required to have their pest control subcontractors provide records of pest control treatments as well as measurements of pest populations before and after treatments so evaluations of effectiveness can be made.

Public Health Officer, Robert Hayward

C - Responsible for health enforcement for No. Atlantic and National Capital Regions.

Youth Activities Program, Joseph Murray

C - Youth programs (YCC and YACC) perform about $2.3 million worth of work yearly in NCR. Some of this includes control

John Hoke

C - Designs and tests environmental technology, e.g., a sea turtle hatchling anticipation device.

P - Should be part of the process of writing specifications for pest control.

of exotic vegetation by weeding. This reduces the need for herbicides.

P - This program should continue, and should expand into other areas of pest management, e.g., trap construction and monitoring.

P - Members of this group should be included in IPM training sessions.

P - His expertise might also be used in developing pest management technology, e.g., pest proof waste management systems.

21. White House Liaison

ARD, Elmer Atkins

C - The White House grounds area essentially functions as a park (although somewhat autonomously for security reasons).

P - Due to contiguity of the parks, White House and President's Park should unify rodent and squirrel management programs.

22. Professional Services

Acting ARD, Paul Goeldner

C - Administers design, historic resources, and scientific work in NCR; Chairman of Planning and Development Committee.

Design Services Division, Chief Architect, Vernon Smith

C - Design structures and landscapes, and by so doing, has a great influence in future pest management practices in these areas.

P - All designs and redesigns should have the formal input of the IPM Specialist and/or other pest management personnel.

Natural Sciences Division, Chief Scientist, William Anderson

C - Coordinates NCR Science Program; Principal liaison between research/extension at ESL and other groups within the Regional Headquarters, Park Superintendnents, other Regional Chief Scientists, the public, and other cooperative agencies (e.g., District of Columbia). Also involved om critical review of State of the Parks and Resource Management Plans.

P - The Chief Scientist should be a formal member of the Planning and Development Committee and should attend all meetings of the Program and Budget Committee which involve pest management issues.

Ecological Services Laboratory

C - This group functions at present as "the IPM Specialist", especially the RPMC. Pest management and research projects evolve as a function of requests from Park Management, priorities of the Chief Scientist and Chief of the Laboratory, and the interests of the scientists. Until this year, there were almost no requests from the parks for assistance in regular monitoring, although requests for scientists to make site visits for pest identification were common. There have been very few requests for advice on setting injury levels.

P - ESL should initiate long term studies aimed at developing injury levels for key pests. Initially this could be an extension of the Pilot Program.

P - The IPM Specialist and IPM Field Specialist should work out of this laboratory. This will ensure major contact with resource scientists.

P - The IPM Specialist Position, to include the duties of the RPMC, should not require more than 50% time on IPM work activities; the other 50% should be research. Promotion should be based on both research and IPM work activities. In order to complement research specialities already at ESL, the IPM Field Specialist should be an entomologist or horticulturist.

Chief of the Laboratory, Richard Hammerschlag

C - Takes an active role in developing the research projects of the other scientists; Water Resources Coordinator which includes water analysis and development of strategies region-wide to improve water resources. A member of the Tree Advisory Committee.

Plant Pathologist and Regional Pest Management Coordinator (RPMC), James Sherald

C - Research on plant disease and stress, e.g., scorch disease, Dutch elm disease.

Principal Plant Pathologist, Emeritus, Horace Wester

C - Research and extension over a broad range of urban ecological topics, including horticulture, insect and disease control,

As RPMC, he determines whether park pesticide use requests are acceptable from a policy standpoint and he is responsible for personnel training re: pest management. At present, he is requiring those applying for pesticide use clearance to demonstrate that a pest is present in damaging or potentially damaging levels and that safer options are not available.

P - This position should be redefined as the IPM Specialist. An IPM Field Specialist, GS 9-11, should be hired to assist the IPM Specialist in data collection and analysis, implementation research (e.g., soap spray for aphid control), and record keeping.

and aquatic wetlands studies. Authored Tree Preservation Bulletin No. 6 (1968). This bulletin is used by crews as a major source of pest control information.

Research Agronomist, James Patterson and Laboratory Technician, John Short

C - Research and extension on urban soil characterization and improvement

Plant Ecologist, L. Kay Thomas

C - General assistance to NCR regarding plant monitoring procedures and weed management. Authored a major study of the effect of 3 exotic weeds on the ecology of Theodore Roosevelt Island.

Wildlife Biologist, David Manski

C - General assistance to NCR on management of vertebrates, e.g., squirrels, pigeons, rats, raccoons, owls, beavers, and ground hogs.

P - This position should be made permanent.

Eugene Wood (University of Maryland)

C - On Schedule A contract to give NCR advise on structural pest control.

P - This contract should continue .

Laboratory Technician, Stephen Syphax

C - Assists in water quality work, plant pathology, etc.; Responsible for technical analyses and maintenance of major ESL laboratory areas.

Greenhouse/Hursery, Mark Uhl

C - Maintenance of system for propagation and testing

Administrative Technician, Deborah Carroll

C - Acts as clerk/typist and assists with bookkeeping

P - An administrative officer might also be a useful addition to this group. This would encourage scientists to pursue research and would facilitate extension work.

23. Parks within NCR:

Park	Administrator
National Visitor Center	temporarily closed
C & O Canal National Historical Park	Richard Stanton, Superintendent
Harpers Ferry National Historical Park	Donald Campbell, Superintendent
George Washington Memorial Parkway	John Byrne, Superintendent
Manassas National Battlefield Park	Roland Swain, Superintendent
Kennedy Center	E. O Larson, General Manager
Antietam National Battlefield Site	Virgil Leimer, Superintendent
Prince William Forest Park	Robert Harney, Superintendent
Wolf Trap Farm Park	Claire St. Jacques, Director
National Capital Parks - East	Burnice Kearney, Superintendent
National Capital Parks - Central	William Ruback, Superintendent
Rock Creek Park	James Redmond, Superintendent
Catoctin, Greenbelt, and Baltimore and Washington Parkway	Thomas McFadden, Superintendent

24. National Capital Parks - Central

Superintendent, William Ruback

Administrative Officer, William Saylor

C - Purchases pesticides and other pest control and horticultural equipment.

P - Improved communication with maintenance personnel would help ensure purchase of appropriately designed equipment.

Chief of Maintenance, James Rubin

C - Makes sure trees, shrubs, turf, etc. are pruned and sprayed as needed.

Chief, Branch of Grounds and Trees, Melvin Odle

C - Determines which pest management strategy will be used. All personnel below, and including this employee, are responsible for determining whether a pest problem exists; however, major responsibility for this work is done by field crews and their foreman.

Tree Maintenance Foreman,
Donald Mace

C - Supervises all operations on trees and shrubs including pest control, pruning, etc.

Tree Worker Foreman,
Thomas West; and
Spray Crew Members

C - Responsible for all pesticide applications to trees and shrubs. Identify problems, make recommendations, treat, evaluate.

Two (2) Tree Foreman

C - All tree maintenance other than pest control.

Maintenance Worker General
Foreman, Milton Boston

C -Turf management in "uptown" areas.

Flower Crew

C -All flower bed pest management in Central, e.g., use of methyl bromide fumigants.

Maintenance Worker General
Foreman, Lewis Whalen

C - Turf management in West Potomac PArk; all rodent control in Central. Developed the current form for recording pesticide use on rodents.

Maintenance Worker Foreman,
Arthur Mangum

Rodent Control Specialist,
Melvin Washington

C - All rodent control in Central. He is sometimes contracted to other parks (e.g., President's Park) for rodent control. Identifies problems, makes recommendations, treats, evaluates.

Maintenance Worker
Foreman, Anthony
Migliaccio

C - Turf maintenance including pesticide applications. Identifies problems, makes recommendations, treats, and evaluates.

A Case Study - National Capital Parks - Central

Central is a collection of urban parks in downtown Washington, D.C. Its larger land areas include the Mall (between the Capitol and Washington Monument), Constitution Gardens, and East and West Potomac Parks. Central was chosen for special study because it is the most intensively managed park in NCR, approximately 8,800 pounds of pesticides, about 60% of all pesticide use in NCR, was applied in Central in 1980.

The Biophysical System

Pests

A strict ordering of pest management priorities is not possible due to differences in criteria for prioritization. The following list summarizes our observations of Central's prioritization of their pest problems, based on amount of manpower and pesticide used in control, and nuisance/health/aesthetic damage produced:

weeds in turf and ornamental beds
scale insects, mostly on cherry and oak trees
elm bark beetle (Dutch elm disease vector) on American elms
rats, mostly in landscaped areas
stable flies, wasps, and bees in picnic areas
eastern tent caterpillar and Japanese beetle on cherry and other trees
cockroaches in concessions
aphids on pine, roses, etc.
black leaf spot and leaf miners on holly
azalea lace bug on azalea
mites and mildew on various ornamentals

Biologies of these pests and natural enemies we have studied are in the Year One Annual Report and in Section IV of this report.

Pest Environment

Downtown Washington receives about 54" of rainfall per year, primarily in the spring and fall. Temperatures range from about 0°F minimum to 103°F maximum. Most of Central is located in a former marsh (dredgefill and landfill). Soils are mostly of the nonstratified, loamy-clay type. High visitor use causes severe compaction in some areas especially the Mall. Air pollution is a frequent problem during summer, particularly in the Tidal Basin and Mall areas.

Plant material is mostly bluegrass turf, with holly, boxwood, yew, privet, and azalea bushes surrounding buildings. Groups of trees and several flower beds dot the area. There is a great variety of tree species, with cherry trees, elms, oaks, and dogwoods predominating. Flower beds contain pansies, tulips, daffodils, and many other species. Flowers are changed often to ensure a continuous display.

Aquatic environments include the Potomac River Park. Many pools are under Central management, as is a skating rink.

Algae have been a problem in several of these pools. Central's responsibility also includes the Tidal Basin.

There are several federal buildings on Central's land including food concessions which contract for their own pest control. A Park Police horse stable is managed by Central; this is a source of stable and other flies.

The Information System

Other than recertification courses, major sources of pest control information are (not necessarily in order of importance):

1. Tree Preservation Bulletin No. 6. Wester, 1968.
2. Pesticide labels
3. Diseases and Pests of Ornamental Plants, 4th Ed., P. Pirone, 1960.
4. Insects That Feed on Trees and Shrubs, W. Johnson and H. Lyon, 1976.
5. Regional Pest Management Coordinator, other ESL scientists, regional pest management specialists, and committees (e.g., Dutch Elm Disease Task Force, Advisory Committee) (and CIAS/JMI for duration of contract).
6. **Outside specialists** - University, Federal, State, County
7. Treatment records - records of pesticide use on ornamental, turf, and rodent control are kept. (See **III.B.2.d.(1.)** for discussion.)
8. Monitoring (site visits and records). (**See III.B.2.d.(1.) for discussion.**)
9. Rarely professional journals, e.g., Grounds Maintenance.

The Management System

Jurisdiction

Central performs its own pest management except that done by concessionaires on its property. Central also sometimes does pest control for other parks in NCR on a contract basis, e.g., rodent control at President's Park.

Personnel

According to M. Odle (Chief, Branch of Grounds and Trees), Central has approximately 130 employees, 10 of which are engaged directly in application of pesticides (ave. 70% time). Counting other activities that indirectly affect pest management (e.g., pruning, turf renovation, choice of landscaping plants, etc.) would make the total pest management figure much higher.

Educational levels range from 7th grade to two years of college (ave. 11th grade). Experience in pest management ranges from 2 to 29 years. One employee has taken two years of basic college level courses in horticulture, entomology, etc. All pesticide applicators and supervisors attend pest management seminars

(usually Pesticide Certification/Recertification Symposia).

Salaries

As of February 17, 1982, Grounds and Trees personnel salaries range from WG7 to WG9 ($8.24 to $9.22/hour, Step 1) for applicators to WG12 ($13.26/hour, Step 1) for Chief. At present there are no economic incentives for obtaining IPM skills. However, increased education and training, as well as work performance, will eventually lead to promotion.

Hazardous Duty Pay

Spray crews also receive about $.36 per hour (4%) for hazardous duty (pesticide application) for every hour in the day after they start a pesticide application (M. Odle, pers. comm.). This probably adds no more than $170 per year to anyone's salary. This is small compensation for use of hazardous materials (tree climbers get 25%) yet may serve as a slight incentive for increased pesticide use.

Equipment

Central has aquired the following pesticide application equipment:

1 - 5 oz. insecticidal fogger

3 - 2.5 to 5.0 gal. hand sprayers

3 - 20 to 100 gal. power sprayers

3 - conventional 200 to 500 gal. hydraulic sprayers

3 - 300 gal. roto mist sprayers

2 - trucks for hauling application equipment

Central also recently purchased some hand lenses for monitoring.

The roto misters alone are adequate for treating all elms in Central for Dutch elm disease in one week. The equipment cost (by Central's estimates) is approximately $150,000 and requires about 400 man-hours maintenance per year.

Maintenance of healthy turf minimizes weed problems, reducing the need for herbicides. We, therefore, consider the following turf maintenance equipment part of the pest management system:

2 - aerators

2 - Jacobsen F-10 mowers

2 - water trucks

1 - Nelson water cannon

This equipment costs approximately $122,000 and requires about 210 man-hours maintenance per year.

Plant Inventory

Many trees, particularly cherry trees along Ohio Drive, are numbered. Many

beds are also numbered and can be referred to on maps located in the park office.

Decision Process

Most decisions to initiate pest control come from crews, public complaints of damaged ornamentals, sightings of rats, etc. The public is more apt to complain of pesticide drift onto themselves or their cars.

The Chief, Branch of Grounds and Trees, is essentially responsible for determining which pest management strategies and tactics are acceptable from a policy and budgetary viewpoint. Foremen and spray crews are largely responsible for identifying pest problems, assessing the need for treatment, and making evaluations after treatment.

In keeping with current NPS policy, pesticide use and pest management strategy is approved by the RPMC on a case by case basis.

The Pest Management System in Transition

Central is in transition from spray schedule applications of hazardous pesticides to a more integrated pest management system, utilizing monitoring, record keeping, injury levels, action thresholds, selective treatments, and treatment evaluation. Highlights of this transition are reflected in reduction of pesticide use and in positive changes in the attitudes of crews toward IPM.

In the following section, we have used IPM components as a conceptual framework for portraying the transition to IPM in Central. Examples of changes in the pest management strategies of NCR parks other than Central are included in cases in which they are particularly or uniquely illustrative of changing trends.

IPM Components

Monitoring

Site visits for determining whether pests are present, and their potential for injury greatly increased during 1981. For example:

- A site visit to observe an aphid infestation on crab apples revealed that the aphids had migrated from the crab apples and no longer posed a problem. In previous years, all crab apple trees were routinely treated.
- A planned treatment of hawthorn trees for leaf miner was halted when monitoring revealed that the leaf miners were no longer in a stage susceptible to pesticide treatment.
- Requests for use of insecticides for azalea lace bug control were denied by the RPMC when site visits revealed that damage was already complete and that lace bugs were no longer present.

From these examples and other observations, we conclude that the following changes are essential for continued implementation of IPM.

THE INFORMATION SYSTEM

- Current information for prediction of when pests are present is sparse. Due to variations in weather, publications can only give very rough estimates of insect hatch; we, therefore, recommend that a regular monitoring system be implemented for all major pests. This will enable pest managers to determine if and when pests are present and will eventually provide information for prediction of action thresholds. Also, monitoring and record keeping facilitate treatment evaluation and, therefore, assist the pest manager in making decisions with regard to treatment strategies.

- Information on the pest environment is also insufficient. This information base should be improved by developing a mapping system for all plant material, to be stored as drawings or electronically. Monitoring records should refer to the particular trees, turf areas, or ornamental beds monitored. Information on soil analyses could be superimposed on plant inventories in order to more effectively plan appropriate landscapes.

- The Tree Worker Foreman, Thomas West, took the initiative to order hand lenses for use in monitoring. Prior to acquisition of the lenses, crews had no way to tell whether tiny insect pests were present, whether they were alive or dead, or whether parasites were present. The distribution of hand lenses to all field workers should be encouraged. This will improve the identification capabilities of field crews.

- Crews which originally did not know what an "insect parasite" was had, by the end of 1981, incorporated the terms "parasite", "predator", "disease", and "natural enemy" into their vocabularies. They were also willing to "wait and see" whether these natural biological agents would suppress the pest. Crews expressed the need for additional IPM training and reference material indicating the current level of information was inadequate. IPM Reference Binders (looseleaf manuals), to be developed in 1982, were a direct outgrowth of crew requests for up to date, easy to use, and more ammenable IPM manuals.

We recommend that:

- the IPM Specialist (presently RPMC) or IPM Field Specialist (see Section III B) be responsible for training crews in monitoring techniques.

- NCR strive to develop a comprehensive IPM Binder series.

THE MANAGEMENT SYSTEM

- Mastery of IPM skills should be rewarded with promotion or other incentives. Able personnel can, by monitoring, reduce the number of applications of pesticide needed, thus reducing manpower,

equipment, and material costs. This savings might be partially programmed into more monitoring, training, or plant care; the rest could be allocated in some way as incentives.

- Greater accountability should be built into the monitoring system by using monitoring forms as work records. This will not only improve decision making capability (as described under Monitoring Records), but will also protect the worker from supervisors who might conclude that no work was being performed (due to lack of visibly sprayed trees, and pesticide use) and will ensure quality control by the supervisor over the work being done. Decisions to treat can then be made by supervisors, in consultation with field crews, with the monitoring records as the major evidence of pest presence, numbers, and damage. In this way decisions to treat are based on conditions, with responsibility placed on crews and supervisors rather than distanced expertise or reference works.

Monitoring Records

Record keeping is currently inadequate for full implementation of IPM. In most cases, no monitoring records are being kept. When they are kept they usually do not record all the necessary information. This may be a result of lack of motivation for record keeping, whether because the pest manager does not understand the importance of keeping records or because supervisors fail to encourage record keeping.

We have observed that necessary information is also often not recorded because the recorder does not have adequate knowledge of the pest being managed. By analysis of records kept, the supervisor can help identify training needs, or devise ways to improve the monitoring form. The following contains observations of record forms now in use:

- One of the most common mistakes was either lack of identification or misidentification of the pest to be controlled. If the crew member does not know what pest is present, treatment will likely be wasted. Training is needed in pest life cycles and in identification of pests and natural enemies. If the crew member knows the pest, but different crew members use different names to describe the same pest, the records lose value in transfering information to those using them. In this case, training and an improved record form (perhaps one in which the treated pest can be circled) is needed.
- Treatment locations need to be standardized, perhaps by mapping park vegetation. Beds or trees within parks can be noted on the maps or referred to by numbers. Marking treated trees with different colored paints at their bases is also a very useful record since it is somewhat permanent and allows direct observation of the trees to evaluate the success of treatments used on it. In cases in which it is necessary to record the treated plant, this should also be standardized to the level of identification needed. For example, cherry trees should be identified by variety when treating white peach scale. This will allow later evaluation as to the susceptibility of different cherry varieties to the scale.

- Number of units (e.g., trees) treated is often a more important record than amount of spray material used, particularly when judging the success of spot treatments. We recommend that hand counters be purchased for this purpose. Since one counter can be used for each tree species, data on cherry trees, oaks, pines, etc. in mixed plantings can be kept separate. Even if the total amount of pesticide used covers the mixed group of trees, the number of tree species treated will be kept separate.

- Substances used are sometimes misspelled. This can be confusing when the spelling of two different substances is very similar, for example: kelthane and karathane. A reference list of names would help in this case.

- The form should also leave enough room that the amount of each pesticide used can be associated with the correct chemical. In cases in which a mixture of chemicals is sprayed, it is often difficult to determine which amount (e.g., 3 pts.) refers to which chemical (e.g., malathion or adjuvant) sprayed. List one substance per line for clarity.

- In cases in which pesticides such as malathion have more than one formulation, e.g., different amount (%) of active ingredient, this should be specified. Otherwise, calculations of active ingredient used cannot be made from records of the total amount of formulation used.

- At present, treatment record forms are really pesticide use forms. As the transition to IPM becomes more complete, it will be necessary to keep records of traps, waste management changes, and other treatment strategies. A computerized system of data storage would be useful in this effort. However final records are stored, the treatment form should be expanded to include space for recording these other treatments.

Injury Levels and Action Thresholds

THE INFORMATION SYSTEM

The greatest need is to determine injury levels and action thresholds. Spray-schedule pest control strategies largely ignore these components, resulting in wasteful and hazardous pesticide use. IPM utilizes these components in order to determine if treatment is necessary, and at what level of pest population or plant damage treatment should be applied. The following examples from 1981 work illustrate the current state of development of these componenets within NCR:

Scale Insects and Aphids

Observations of cherry trees reveal that white peach scale is abundantly present on a few limbs of some trees and almost entirely absent from other trees. Its association with tree injury is less clear, however, and it is generally regarded by the Park as an aesthetic pest, i.e., one in which the white scales are visually displeasing. The spotty distribution of the scale

has led us to postulate an action threshold of two moderately infested or one heavily infested limb per tree. Analysis of trees along Ohio Drive in East Potomac Park indicates that only 1/6 of these trees satisfy this requirement. Most have no scale. In 1982, only those trees reaching the action threshold (as indicated by a paint mark at the base of the tree) will be treated with dormant oil. Since dormant oil for scale control is one of the major uses of pesticides, this will mean a significant reduction in pesticide use. Furthermore, the appropriateness of the action threshold can be easily evaluated by looking at paint marked trees to determine if scale populations are acceptably suppressed there.

We have also observed that many oaks treated with dormant oil for obscure scale do not have any scales on them. This is easy to determine visually (with or without a hand lens) on small trees. Infestations are more difficult to see on large trees. Initial efforts at establishing an injury level may merely be that of leaving half of the trees marked and untreated. Evaluation of damage/scale on these trees in subsequent years will help the pest manager to assess how often treatment is needed.

Pine bark aphid, also suppressed by dormant oil, was shown in 1981 to be spottily distributed. In some trees which were not treated in 1980-81, the aphid population collapsed, probably due to presence of natural enemies such as predators. This illustrates the importance of considering the presence of natural enemies in deciding whether to treat.

Another example of the importance of considering natural enemies is the case of aphids on crab apple. Although aphid populations on some crab apple trees were quite high early in the season, predator (hover fly larvae) populations were also high and eventually helped reduce the aphid population to a harmless level. Pesticide treatment would undoubtedly have stressed the tree more. Willingness of crews to continue to observe whether these predators would bring the aphids under control eliminated pesticide application in this case.

Aphids on roses, which can probably be controlled by use of soap sprays, have at present an undetermined action threshold. For this problem, as well as for others we have not studied, the process of determining an injury level should begin with regular monitoring of aphid numbers and plant damage (in this case the sooty mold fungus which grows on aphid excrement and blackens rose leaves).

Biting and Stinging Insects

Establishing injury levels/action thresholds for mosquitoes, yellowjackets, and stable flies is largely undeveloped at present. Researchers have probably avoided this area of study because of the difficulty in relating numbers of these pests to "acceptable annoyance". Often citizen complaints of bites translate into pesticide action against adult insects. This is unfortunate since the action, in cases of mosquitoes or stable flies, should have taken place against the immature stages. Yet the population size of immature populations is very difficult to correlate with the subsequent adult population size, particularly with very motile insects.

In 1981, we began to make progress in this area, in some cases by reasoning backwards. For example, trials of use of B. t. i. to control heavy populations of mosquito larvae indicated that larvae could be reduced to about 3 larvae per dip. We therefore set 3 larvae per dip as the action threshold. In areas where this action threshold was used, there were no complaints. Therefore, we reason that 3 larvae per dip is a good starting place for establishing an action threshold.

With stable flies, waste management to reduce immature populations and other treatments correlated with positive feedback from horse grooms and mounted police that stable flies were adequately controlled. This evaluation can be refined in the future by using a more complete recording of stable fly catches and bites. Trap catches and weather data may eventually be used to predict stable fly population peaks, thus timing treatment to avoid population build ups.

Since most population suppression of yellowjackets is done on the adult stage, essentially detering them from visiting human eating places, evaluation can be done by recording the drop in stings or visits of yellowjackets to refuse containers. However, what level of yellowjacket stings is acceptable? One sting can result in the death of a hypersensitive individual. Yet, we cannot seriously consider trying to control all yellowjackets, and would not want to do so because of their beneficial role (i.e., they are predators and scavengers). After consultation with park managers, it was determined that action was justified in park picnic areas, where the vast majority of stings were occuring. Since action in this case is the use of wasp tight lids on refuse containers, and since this is fairly inexpensive, this operation is now being carried out by several parks in NCR. At Great Falls Park, Virginia, this action resulted in a decrease in yellowjacket stings by 96.5% in 1981. The action was evaluated by park managers as justified and adequate. In the case of yellowjacket management, therefore, the concepts of injury and action thresholds, although somewhat intuitively defined, were used to very dramatically reduce yellowjacket stings and visitor annoyance.

Rodents

For public health reasons, the action threshold set by the park for rat control in urban areas is currently 1 rat. Consideration in this case is not whether to treat the rats, but how to eliminate them at lowest cost. Action is therefore related to how cost effective it is. In Lafayette Park, waste management, landscaping changes, improved monitoring and poisoning have eliminated the rats in most areas, therefore meeting the injury level of zero rats, at a cost savings of 36% (see Rodent discussion).

Insects Attacking Foliage

In general, a great deal of injury to tree foliage is acceptable from aesthetic or economic standpoints. Injury in the case of Japanese beetles, elm leaf beetle , and fall webworm is late in the season, after most photosynthesis has taken place, and therefore particularly high action thresholds can be used for these pests. Tent caterpillars, by virtue of the visibility of their tents, are usually controlled if present, i.e., action level of one tent per tree. We suspect that one tent per tree might be acceptable in picnic type areas. In fact, these insects are native and are also of interest to

children who watch and explore the tents. They should, to some extent, be considered "wildlife".

In 1981, spot treatments of Japanese beetle infested trees were based on subjective estimates of defoliation. In 1982, we will attempt to devise a more objective action threshold index (such as 50% of foliage loss). It may be possible to correlate numbers of trapped beetles with injury levels and thus fine tune the action threshold. However, this will take several years.

Determining injury levels/action thresholds for azalea lace bug is much further developed. Since a great deal of foliage damage (we suspect at least 25% stippling) is tolerable from an aesthestic standpoint, the action threshold was set at this level. Number of lace bugs per leaf was then correlated with damage, and an action threshold combining both damage and lace bug numbers was constructed (see Fig. 6 , p. 62). By recording plant damage and lace bug numbers, this estimate can gradually be improved over the years.

Insects Vectoring Disease

In NCR, death of American elms from Dutch elm disease(vectored by elm bark beetles) is currently being held below 3-5% tree loss/year. 1% loss is probably possible. Efforts to save elms are highly dependent on budget (for sanitation mostly) and cooperation among neighboring jurisdictions. The high value of elms, both in terms of aesthetics, energy conservation (temperature moderations), and the high cost of removing mature elms ($1200) has resulted in a program aimed at saving as many elms as possible.

To date there has been no correlation between numbers of flying beetles with need to spray trees with insecticides. Each tree to be saved is sprayed on a spray-schedule basis. All diseased wood is removed as quickly as possible, optimally within two weeks. However, the frequency of monitoring, to discover diseased wood and the speed of wood removal are highly dependent on funding. The cost of action, therefore, bears a complex relation to the "acceptable injury" level and action thresholds. This issue is presently being studied by the Save The Elms Task Force. (CIAS has not worked directly on this problem in NCR.)

THE MANAGEMENT SYSTEM

- Field crews, if encouraged, are capable of devising injury levels and action thresholds. This capability is largely responsible for the increase in spot treatments of white peach scale, Japanese beetle, etc. Records of these tentative levels should be kept for evaluation. In some cases, injury levels may have to be set by a higher authority so field crews can feel comfortable in abiding by them.
- The IPM Specialist (and IPM Field Specialist) should become more involved in assisting park managers in establishing injury levels and action thresholds. Since these levels are somewhat site dependent (e.g., damage to roses in highly visible areas is less tolerable than when in low profile areas), park managers will have to adapt them to their own needs. However, it is generally true that an action threshold for azalea lace bug in one area in NCR will be about the same as in any other

area. The IPM Specialist should place priority, therefore, on setting these levels for the principal pests and in disseminating information gleaned from the experiments with these or other levels.

Treatments

THE INFORMATION SYSTEM

Although hazardous and costly, pesticides have become, by virtue of simplicity of use and immediacy of kill, the accepted means of controlling pests. Treatment information most readily available to pest management crews is on pesticides. Directives from the President and others have somewhat abruptly changed this course toward one of IPM.

We have noted the following treatment information gaps:

- Parks need more explicit information on which pesticides they will be permitted to use. For economic reasons, pesticides tend to be purchased in bulk. Current changes in pest management policy, such as discouraging the use of some pesticides (e.g., 2,4-D) while encouraging substitution with pesticides previously not used by Central (e.g., soap, B. t.), have caused confusion and in some cases has resulted in purchases of materials in small units and at high prices. This also results in stockpiling of materials that cannot be used.

- Alternatives to hazardous pesticides are not always known by crews. In some cases alternatives do not exist; in most cases, knowledge of alternatives is not communicated. The communication problem is starting to be addressed by the RPMC and SPMC who are taking responsibility for compiling and disseminating alternative treatment strategies. In cases in which adequate alternatives do not exist, studies are being initiated, e.g., by CIAS, the Dutch Elm Disease Task Force, ESL, etc. Particularly promising alternatives for future research and testing are: habitat design and redesign (e.g., waste related pests); improved plant care for control of weeds in turf; use of insect resistant plant varieties (e.g., Dutch elm disease); physical control (pruning fall webworm and tent caterpillar tents; trapping of Japanese beetles); biological control (of aphids, lace bugs, leaf miners, etc.); and use of less hazardous chemical treatments (particularly soap for aphids, lace bugs, and weeds; B. t. for caterpillars; neem oil for repelling Japanese beetles and other pests).

The following discussion includes:

- a general discussion of how pest managers have integrated various treatment options and

- an alphabetized pest list of recommended management strategies.