

Volume 4

**U.S. FISH AND WILDLIFE SERVICE
ROCKY MOUNTAIN ARSENAL FIELD OFFICE
FISCAL YEAR 1991 ANNUAL PROGRESS REPORT**

**Prepared in Partial Fulfillment of the
Cooperative Agreement for Conservation and
Management of Fish and Wildlife Resources at
Rocky Mountain Arsenal, U.S. Fish and
Wildlife Service and U.S. Army.**

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by

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The results presented in this report are preliminary and may not be cited or otherwise published without written consent of the authors.

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INTRODUCTION

The Rocky Mountain Arsenal (Arsenal) is located in southwest Adams County, Colorado, just north of Stapleton Airport. The Arsenal was used for the production of chemical weapons and conventional munitions by the U.S. Army (Army) beginning in 1942, and was leased later to private companies for the production of commercial pesticides. All chemical manufacturing and storage at the Arsenal has been terminated and the area is now a Superfund site undergoing cleanup.

The Arsenal is 27 square miles, and is largely undeveloped, open grassland. Because large buffer zones of land surrounded the chemical plants on the Arsenal and these zones have remained relatively undisturbed for 40 years, wildlife populations flourished. This, combined with the fact that the Arsenal is only a fifteen minute drive from downtown Denver, makes the Arsenal a rare island of wildlife habitat in the midst of urbanization.

Arsenal Background

The Arsenal was originally short-grass and sand prairie habitat, dominated by blue gramma grass, western wheatgrass, sand bluestem grass, needle and thread grass, and sand sagebrush (Cooper 1988). Most native vegetation was lost through conversion of the lands to agricultural practices (Ebasco et al. 1989). Before the Arsenal's establishment in 1942, the primary land uses of the area were agricultural and rural residential. Ornamental vegetation on the facility was originally introduced around homesteads (Turner 1975). Lake Ladora and Lower Derby Lake were constructed to store irrigation water in 1919 (Ebasco 1989).

With the advent of World War II, Denver was selected as a location for a chemical munitions factory (Anonymous 1980). Construction of the Arsenal began in June 1942, and production started in December 1943. During its World War II history, the Arsenal produced approximately 87,000 tons of chemical, intermediate, and toxic products as well as 155,000 tons of incendiary munitions.

In 1945, the Arsenal was placed on standby status and portions of it were leased to private industry for the manufacture of commercial pesticides. The Colorado Fuel and Iron Corporation was the first to lease the Arsenal for the production of DDT. The Julius Hyman Company assumed the lease in 1950 and was subsequently bought by the Shell Chemical Company for the continued production of pesticides.

The Arsenal was reactivated during the Korean war to produce incendiary and chemical munitions. From 1959 to 1962, the Arsenal's facilities were used to produce wheat rust (TX), a

biological anti-crop agent. During this period, a hydrazine facility was also constructed for blending rocket fuels used in the Titan and Apollo space projects. From 1965 to 1969, operations at the Arsenal supported warfare in Southeast Asia.

Contamination History

Production of military and commercial chemical products before 1956 resulted in considerable chemical waste by-products (Trautmann 1980). Liquid by-products were sometimes held in settling ponds in the south plants area or placed in Basin A, a natural depression centrally located within the Arsenal (Section 36). Basin B, C, D, and E were utilized to store overflow from Basin A. Solid wastes were either burned or buried in pits in Sections 4, 9, 20, 30, 33, and 36. In 1955, landowners adjoining the Arsenal complained that irrigation ground water was contaminated. In 1956, Basin F was constructed and used to store all subsequent liquid waste disposal. Unlike the other disposal basins that were natural depressions, Basin F was asphalt lined.

In 1962, Basin F reached its storage capacity. As an alternative disposal method, the Army Corps of Engineers drilled a 12,045 foot injection well, and pumped 175 million gallons of liquid wastes into deep earth strata from 1962 to 1966. The well was dismantled after it was identified as the source of seismic disturbances in the Denver area in 1966. Some subsequent liquid disposal was conducted by spray evaporation, carrying aerosol droplets of hazardous liquid waste downwind from the Arsenal.

In 1965, the Shell Chemical Company entered into an agreement with the Army to pay a negotiated rate of 1,000 gallons of waste produced. The Arsenal began accepting waste for disposal from Lowry Air Force Base and Fitzsimmons Army Medical Center in 1966. Solid and slurry waste were often disposed of in the most convenient manner, sometimes without regard or knowledge to its hazardous nature.

In 1968, the U.S. Army Material Command requested recommendations from the National Academy of Science on chemical agent disposal methods. Beginning in 1975, the primary mission of the Arsenal was to demilitarize and dispose of obsolete chemical munitions. In 1980, the mission of the Arsenal was further refined to direct the disposal of chemical agents and hazardous materials, and decontamination and cleanup of the installation (Sheely 1980). In 1988, the Secretary of the Army placed the Arsenal on inactive status and announced that the sole mission of the Arsenal was contamination cleanup. Listed on the national Priorities List, the Arsenal is currently being cleaned up under the Authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

Fish and Wildlife Resource Background

The Arsenal was designed with substantial buffer zones surrounding chemical production facilities. These lands have remained largely undeveloped. Vegetation succession, the removal of livestock, and limited human access since 1942 have resulted in wildlife habitat of extraordinary diversity. Surrounding urbanization and the expansion of agricultural practices have isolated the Arsenal, thereby magnifying its overall importance to local wildlife communities. Construction of the new Denver International Airport, the E-470 beltway, and associated development will continue to isolate wildlife habitat within the Arsenal.

The Arsenal includes habitats that support representative western plains/prairie wildlife communities. Principal species include black-tailed prairie dog, burrowing owl, cottontail rabbit, black-tailed jackrabbit, mule and white-tailed deer, coyote, badger, bald eagle, golden eagle, ferruginous and red-tailed hawks, as well as a host of other native birds and mammals. Pronghorn antelope historically lived on the site, but are no longer present. The Arsenal contains a portion of First Creek, four lakes, a number of ponds, and several prominent canals.

Arsenal wetlands provide a diversity of habitats for ducks, shorebirds, passerines, muskrat, and native fish. Major lakes on the Arsenal support a viable trophy class warm water fishery, represented predominantly by introduced northern pike and largemouth bass.

U.S. Army regulation 420-74, Natural Resources - Land, Forest, and Wildlife Management, establishes policies and procedures for the conservation, management, and restoration of lands and renewable resources on certain Army installations (U.S. Army 1986). Chapter 5 of regulation 420-74 outlines fish and wildlife protection responsibilities, and provides for the coordination and implementation of fish and wildlife management plans with appropriate Federal or State agencies. On March 23, 1989, the Army and the U. S. Fish and Wildlife Service (Service) signed and implemented the Cooperative Agreement, Conservation and Management of Fish and Wildlife Resources at Rocky Mountain Arsenal (Conservation Agreement). Under provisions of the Conservation Agreement, a Service Field Office was established on the Arsenal to provide centralized coordination of wildlife resource management. This Conservation Agreement was revised in the Spring of 1991 to reflect expansion and changes in the Service's role on the Arsenal. The revised cooperative agreement expands the responsibilities of the Service and more accurately defines its role in activities such as managing fish and wildlife resources, conducting the Arsenal's Biota Comprehensive Monitoring Program (BCMP), mitigating fish and wildlife habitat

in response to remedial activities, and conducting remedial activities consistent with provisions of the Federal facilities Agreement (U.S. Government 1991).

The purpose of the Service's Arsenal Field Office is to centrally manage wildlife resources at the Arsenal over the pre-Record of Decision period. Specific responsibilities of the Service Arsenal Office include the development of a 5-year management plan, annual management plans and budgets, annual progress reports, technical review of Arsenal programs and documents, public relations support, and law enforcement assistance (U.S. Government 1989).

This report was prepared to describe accomplishments at the Service Arsenal Field Office during FY91. This report closely follows the reporting format specified in the U.S. Fish and Wildlife Service Refuge Manual (U.S. Fish and Wildlife Service, 1984.)

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PLANNING

Management Plans

During Fiscal Year 1991, the FY91 and FY92 Rocky Mountain Arsenal Fish and Wildlife Management Plans were completed and approved by the Army. The 5 year Fish and Wildlife Management Plan was also reviewed and approved. Annual Progress Reports for FY89 and FY90 were completed and distributed to interested parties, along with the Fish and Wildlife Management Plans.

Public and Agency Participation

During FY91, interested parties and agencies met regularly to discuss natural resource activities in which the Service has been involved.

NRCC Meetings

The Natural Resources Conservation Committee (NRCC) was formed to provide a mechanism for information exchange between the State of Colorado, the Service, and RMA Facilities Maintenance. Five meetings were held during Fiscal Year 1991 on 9 October, 1990, 11 December, 1990, 12 February, 1991, 8 April, 1991, and 9 July, 1991. Mr. Jim Green (RMA) chaired the 9 October and 12 February meetings, Major Fomous (PMRMA) chaired the 11 December meeting, Pete Gober (USFWS) chaired the 8 April meeting, and Larry Malone (USFWS) chaired the 9 July meeting. Mr. Doug Reagan from Woodward-Clyde, recorded notes for each meeting (Appendix A).

Agencies represented at the NRCC meetings were as follows:

- Program Managers Office, RMA
- U.S. Fish and Wildlife Service
- Environmental Science and Engineering, Inc.
- Environmental Protection Agency
- Facilities Maintenance, RMA
- Shell Oil Company
- Ebasco
- MK Environmental Services
- Army Acumenics Division
- Colorado Attorney General's Office
- Colorado Department of Health
- Colorado Division of Wildlife
- Woodward-Clyde
- Geotrans

Topics covered during the meetings included Service wildlife management activities, RMA facilities maintenance activities, the comprehensive monitoring program, and MKE/Shell Oil ongoing programs.

Ad Hoc Committee Meetings

The Ad Hoc committee was originally formed in September 1989. The purpose of this committee is to bring together non-governmental parties interested in the status of wildlife and cleanup programs on the Arsenal, and to allow opportunities for comments on these programs.

During FY91 the NRCC Committee only met one time on 12 February, 1991. Future meetings are planned.

Interested parties attending the Ad Hoc meeting include the following:

- U.S. Fish and Wildlife Service
- Program Managers Office, RMA
- Urban Wildlife Photo Club
- Denver Audubon Society
- Denver Field Ornithologists
- Prairie Dog Rescue
- Loveland Prairie Dog Action
- Federation of Fly Fishers
- Arsenal Anglers
- Colorado Wildlife Federation
- Urban Design Forum
- Colorado Wildlife Society
- Colorado Field Dog Trial Clubs

PERSONNEL

The following is a complete list of all U.S. Fish and Wildlife Service staff employed at the Rocky Mountain Arsenal during Fiscal Year 1991. This includes hire dates, promotions, transfers and terminations.

NAME & TITLE	HIRE DATE	TRANSFER	LAST DAY	TEMPORARY/ PERMANENT	GRADE/ SERIES
BATHA, KATHERINE H Biological Technician	01/22/91			TEMP	GS-404-5
BOSSONG, JEANNETTE L Fish & Wildlife Biologist	07/14/91			TEMP	GS-401-9
COLE, JOHN C Wildlife Biologist	07/14/91			TEMP	GS-486-9
DOUGHERTY, CARRIE D Biological Aid (Intermittent)	05/20/91			TEMP	GS-404-3
DOUGHERTY, JENNA J Biological Aid (Intermittent)	05/29/91			TEMP	GS-404-3
DUFFORD, SHEILA J Wildlife Biologist	11/13/89		06/15/91	TEMP	GS-486-5
ECHELBERGER, SUSAN F Clerk/Typist Office Automation Clerk	07/30/90 04/21/91			TEMP	GS-322-3 GS-326-4
FINK, MICHELLE M Biological Technician	12/03/90		08/08/91	TEMP	GS-404-5
GOBER, DONALD R RMA Coordinator	04/09/89* 05/07/89 04/08/90 09/09/90 04/07/91	*TRANSFER FROM COLO STATE OFF (USFWS)		PERM	GS-401-11 GS-401-11 GS-401-12 GS-401-12/2 GM-401-13
GRIESS, JANE M Park Ranger Wildlife Biologist	07/15/90 02/24/91			TEMP	GS-025-7 GS-486-9
HASTINGS, BRUCE C Wildlife Biologist	02/12/90 03/10/91			TEMP	GS-486-9 GS-486-11

NAME & TITLE	HIRE DATE	TRANSFER	LAST DAY	TEMPORARY/ PERMANENT	GRADE/ SERIES
JAMES, SHERRY L Clerk/Typist Office Automation Clerk	08/13/90 04/21/91			TEMP	GS-322-3 GS-326-4
JAMIEL, DAVID A Park Ranger	02/12/90 05/05/91 06/16/91			TEMP PERM	GS-025-7 GS-025-9 GS-025-9
JOHNSON, LINDA S Office Automation Clerk	04/22/91			TEMP	GS-326-4
KRAMPETZ, FREDERICK J Biological Technician	12/03/90			TEMP	GS-404-5
LANGELIER, LISA Wildlife Biologist Park Ranger Wildlife Biologist	10/30/89 01/14/90 06/17/90 11/04/90 12/02/90	*TRANSFER TO USFWS REFUGES & WILDLIFE	*04/19/91	TEMP PERM	GS-486-9 GS-025-9 GS-486-9 GS-486-9/2 GS-486-11
LANGER, GREGORY J Fishery Biologist Fish & Wildlife Biologist	11/19/89 03/10/91			TEMP	GS-482-9 GS-401-11
LOCKHART, J. MICHAEL Fish & Wildlife Biologist	05/14/90	*TRANSFER TO ALASKA (USFWS)	*09/21/91	PERM	GS-401-12/4
LUNA, EVETTE J YCC Student	06/10/91		08/16/91		YCC
LYON-ROBERTS, INITA L. Clerk/Typist	11/13/89		09/21/91	TEMP	GS-322-4
MAHLIK, DOAK O Biological Aid (Intermittent)	05/28/91			TEMP	GS-404-3
MALONE, LARRY K Deputy Coordinator	05/06/90*	*TRANSFER FROM USFWS REFUGES & WILDLIFE		PERM	GS-401-12/8
MATIATOS, DANIEL J Wildlife Biologist	11/13/89 06/16/91			TEMP	GS-486-5 GS-486-7
McLAURIN, SEDRICK M Biological Aid	06/24/91		08/15/91	TEMP	GS-404-4
McLEAN, CAROLINE C Park Ranger	11/13/89		01/28/91	TEMP	GS-025-7
MIESNER, JOHN F Biological Technician	06/17/90			TEMP	GS-404-5

NAME & TITLE	HIRE DATE	TRANSFER	LAST DAY	TEMPORARY/ PERMANENT	GRADE/ SERIES
MOORHEAD, CAROL ANN Natural Resource Specialist Wildlife Biologist	04/07/91* 08/11/91	*TRANSFER FROM NATIONAL PARK SERVICE RECREATION		PERM	GS-407- 7/9/11 GS-486-9/11
NUNLEY, PELE J Biological Aid (Intermittent)	06/25/90		01/31/91	TEMP	GS-404-2
PATRICK, DARRYL A Biological Technician	04/08/91			TEMP	GS-404-5
PELTIER, SCOTT J Wildlife Biologist	06/02/91* reported 08/06/91	*TRANSFER FROM USFWS REFUGES & WILDLIFE		PERM	GS-486-7
RIECKMANN, DONNA M Wildlife Biologist	12/03/90		06/15/91	TEMP	GS-486-5
RODRIGUEZ, RUBY P Clerk/Typist Office Assistant	10/30/90 02/13/91			TEMP PERM	GS-322-4 GS-303-5
SEERY, DAVID B Wildlife Biologist	03/03/91			TEMP	GS-486-7
STEVENS, PATRICIA D Toxicologist	04/15/90 01/13/91			TEMP PERM	GS-415-9 GS-415-11
TORTOSO, ARLENE C Micro-Biologist	05/19/91* 06/16/91	*TRANSFER FROM BUREAU OF RECLAMATION		PERM	GS-403- 7/9/11 GS-403-9/3
URSINI, ANNETTE M Clerk/Typist Office Assistant Budget Assistant	07/30/89 11/05/89 01/13/91			PERM	GS-322-4 GS-303-5 GS-561-6
WEGRZYN, JOHN G Toxicologist	05/06/90 05/05/91	*DETAILED TO USFWS COLO STATE OFFICE	09/13/91*	PERM	GS-415-11 GS-415-11/2

NAME & TITLE	HIRE DATE	TRANSFER	LAST DAY	TEMPORARY/ PERMANENT	GRADE/ SERIES
ZINK, ERIC C Biological Aid (Intermittent)	07/24/90			TEMP	GS-404-3

YOUTH PROGRAMS

The Arsenal Field Office sponsored a Youth Conservation Corps (YCC) student again during the summer of 1991.

Evette Luna began work June 10 and ended her term with the Service August 16, 1991. Evette's duties included assisting the clerical staff with answering phones, making photo copies, filing, and computer operations. She also assisted at the Visitors Center with visitor information and assistance.

The Field Office was also asked to participate in an nationwide Service EEO program to promote the interest of minorities in fish and wildlife careers. The regional EEO Officer provided guidance and the program ran smoothly.

On June 24 Sedrick McLaurin was hired as a GS-4 Biological aid under this program. His tour of duty ended on August 15, 1991. Sedrick's duties included assisting the Conservation Section with such projects as fence building, trapping and relocating prairie dogs, care and feeding of captive eagles, and vehicle maintenance. Although not a wildlife biology student, Sedrick adapted very well to the work environment and was an asset to the station during the summer.

SAFETY

The Service Field Office took a very active stance on the subject of Health and Safety (H&S) during FY91 and conducted monthly H&S Committee Meetings on the second Thursday of each month. The committee consisted of section heads and other employees closely tied to the H&S program. The H&S Officer led safety discussions at the beginning of each weekly staff meeting. Health and Safety films were shown each month at the end of a weekly staff meeting. Staff members were notified of additional H&S issues in a timely manner. A H&S report was submitted to the Region 6 Safety Officer each month. The Station Safety Plan was revised as necessary to address new issues.

The Service Field Office worked closely with Army H&S officials on additional issues. The Service worked particularly closely with Army's Occupational Health and Safety Officer and Army's Safety Director regarding the Service's Station Safety Plan, the "umbrella" H&S plan for its landscape contractor (Total Terrain), and Total Terrain's site-specific project H&S plans. The Service H&S Officer attended Army's monthly H&S meetings and weekly Contractors' Meeting. The Service Coordinator attended or appointed an alternate to attend Army's quarterly H&S meetings. The Service received several of Army's safety inspections during FY 1991; no significant violations resulted. Army provided courses in First Aid and CPR to all fulltime Service employees and appropriate

volunteers (i.e. those leading tours or helping in the field).

The Service Field Office provided additional training related to health and safety. Each new employee was furnished H&S orientation materials, discussions, and a site tour. All employees, contract researchers, and biological volunteers took Occupational Safety and Health Administration (OSHA) initial or refresher training during FY 1991. The fisheries biologist and several members of the Arsenal Anglers (a fishing club) took a water safety course to prepare themselves for public fishing programs. Most employees took drivers' awareness training. Several personnel also enrolled in courses on aviation safety and the drug-free workplace.

Employees continued to receive medical monitoring during FY 1991. New employees were given thorough physicals within the first month of their arrival. Service field personnel leaving employment at the Field Station were given exit physicals. All other employees received thorough annual physicals. All employees received both pre- and post-season Lyme Disease testing. No contaminant-related health problems or positive tests for Lyme Disease were documented or suspected.

The Service experienced few potentially serious H&S problems during FY 1991. A visitor was hit on the head by a loose overhead handrail in a double decker bus during a tour at the Service's Open House, and an elementary school student fell on a paved parking lot during another organized activity, but neither injury was serious.

The Service initiated an emergency response plan in the event of a chemical spill during cleanup or other emergency situation. An emergency response drill is anticipated during early FY 1992.

Health and Safety responsibilities are rotated on a six month basis. During the first half of FY91, responsibilities for health and safety belonged to the Environmental Quality. In July responsibilities were transferred to the Mitigation Section.

TITLE: Mitigation on Rocky Mountain Arsenal

PERSONNEL: Bruce Hastings, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

Mike Lockhart, Fish and Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

Scott Peltier, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

Michelle Fink, Wildlife Technician, USFWS, Rocky Mountain Arsenal.

INTRODUCTION

The Cooperative Agreement for Conservation and Management of Fish and Wildlife Resources at Rocky Mountain Arsenal (U.S. Government, 1989) defined a variety of Service responsibilities related to land use at the Arsenal. This agreement was revised in March 1991 and stated that U.S. Fish and Wildlife Service (Service) responsibilities included a) "propose habitat mitigation efforts to offset potential adverse effects of remedial activities on fish and wildlife resources, b) coordinate with the Arsenal staff to integrate fish and wildlife resource mitigation plans with other Arsenal activities, and c) incorporate results of fish and wildlife resource mitigation plan implementation into the annual reports" (U.S. Government, 1991, Page 7). The Service strived to meet the obligations of these agreements during FY 1991 while developing a distinct Mitigation Program.

METHODS

The Service intensified efforts to mitigate for impacts on wildlife habitat caused by cleanup activities. One full-time employee was selected to manage the Mitigation Program. Additional employees were loaned to the program from other divisions when possible. Steps were taken to employ three additional mitigation staff during FY 1992.

The Service worked closely with the U.S. Army (Army) to develop a review process capable of taking potential mitigation projects from an initial idea to a conceptual plan, Army review, a technical plan, additional Army review, EPA review, and implementation.

The Service contracted a landscaping firm to conduct a variety of habitat and public use projects. A process for awarding delivery orders to this contractor was established through the use of technical plans, government cost estimates, and cost

negotiations. The Service also continued to work with Army's Facilities Maintenance (FM) and Morrison-Knudson Environmental Services (MK) to conduct additional work.

The Mitigation division worked with Contracting and General Services and Engineering from the Service's Regional Office. Mitigation also worked with other Service divisions at the Arsenal (Conservation, Community Relations, Activities Management, Environmental Quality, and Administration) on a variety of projects to meet mutual objectives.

RESULTS AND DISCUSSION

The Service submitted 24 conceptual mitigation plans to Army for review. A series of meetings resulted in Army's approval of 20 of these plans pending more detailed descriptions within technical plans. Fourteen conceptual plans were converted into technical plans and all were accepted by Army's Deputy Program Manager.

The Service contracted with Merlyn Paulson, Inc. to design a landscape plan (Appendix B, Task 4A, Landscaping and Revegetation of the Eagle Watch: Study and Recommendations Plan) for the Eagle Watch area in Section 5 (Map 1). The results were used to write one landscaping plan that was initiated in FY91 and others to be written and implemented during FY92.

The Service negotiated a 5 year contract with Total Terrain to conduct landscaping and revegetation on the Arsenal. During FY91, Total Terrain was awarded five delivery orders through the Mitigation Program entitled: (1) Health and Safety Planning, Training, and Physicals for Total Terrain (Appendix B), (2) Construction of a Prairie Dog Barrier along the Northwestern and Western Borders of Section 36 (Appendix B, Task 2), (3) Landscaping, Revegetation, and Construction at the Eagle Watch (Appendix B, Task 4B, Phase 1), (4) Enhancement of Wildlife Habitat in Northwestern Corner of Section 2 (mostly fencing) (Appendix B, Task 19), and (5) Auguring of Artificial Prairie Dog Burrows in Section 27 (Appendix B, Task 24). The Mitigation staff assisted the Community Relations division by negotiating a sixth delivery order with Total Terrain for Construction and Installation of Kiosks and Signs along Nature Trails. Negotiations for an additional mitigation project entitled "Enhancement of Wildlife Habitat in Section 34" (for planting and irrigating shrubs) could not be completed due to funding constraints and will be pursued during FY92. Task 24 was completed during FY91. However, Total Terrain initiated work on Tasks 2, 3, and 4 and the quality of their work has been quite satisfactory.

The Service provided oversight for seven projects conducted by MK

(Map 2). Five of these were continuations of the Bald Eagle Management Area (BEMA) Habitat Manipulation projects that were initiated during 1989 to produce sand prairie, tallgrass prairie, two mixed grass prairie sites, and western wheatgrass (Appendix B, Tasks 12 & 14-17). These projects served to diversify wildlife habitat and the raptor prey base, identify the most appropriate methods for establishing prairie communities will promote efficiency during future Arsenal mitigation projects, and offset losses to wildlife habitat caused by leasing portions of the Arsenal to Stapleton International Airport. Prairie dogs and lagomorphs were used to define the raptor prey base. In general, these five projects were much more successful than in previous years, mostly due to MK subcontracting them to a seeding contractor who was familiar with the Arsenal and the type of seeding operations required. (See Appendix C for MK's annual BEMA Habitat Manipulation report.)

MK also conducted projects on vegetative barriers (Appendix , Task 20) and establishment of a source of needle-and-thread hay (Appendix B, Task 22). The vegetative barriers were planted to crested wheatgrass, pubescent wheatgrass, and tetraploid perennial rye during 1990 in the North Boundary Containment System, the Northwest Boundary Containment System, the Irondale Containment System, and the eastern and northern borders of Section 36 (Map 1). These plants were chosen to discourage prairie dogs from burrowing in to underground containment systems and contaminated sites because they grow tall and appear relatively unpalatable. Growth of the wheatgrasses was successful enough to limit work in FY91 to fertilizing and monitoring. Previous efforts with the needle-and-thread hay operation in the southwest corner of Section 5 (Map 2) were also successful enough to limit FY 1991 work to weed control, hay collection and application, and monitoring.

Army's FM conducted another BEMA Habitat Manipulation project for enhancing jackrabbit habitat (Appendix B, Task 13). This project was limited to mowing a mosaic pattern in a portion of Section 5 (Map 2).

FM also worked with an Army contractor (Stearns-Roger) and the Service to construct five wetlands in Sections 7 and 8 in the southwestern portion of the Arsenal (Map 1). The dam for Site 1, the largest wetland, was completed and is capable of meeting state permit requirements if requested. A 3-acre conservation pool was excavated and lined with bentonite within this 24 acre site. Due to funding constraints, only a small portion of Site 2 was excavated.; the remainder will be completed in FY 1992 and will total approximately 12 acres. A farmer's ditch was trenched from a diversion structure in the Highline Canal to Site 2 and another to Sites 3-5 (8, 5, and 7 acres, respectively). All five wetlands received water during late summer of FY 1991. Only enough water to fill the conservation pool reached this wetland

before irrigation water was no longer available from the Highline Canal.

The Service contracted with Dr. David Cooper to investigate wetlands plant ecology on the constructed and other Arsenal wetlands; results will be compiled in an MS thesis. Both Dr. Cooper and the U.S. Geological Survey initiated ground water monitoring during FY91.

The Service implemented the last of the FY91 technical plans (Appendix B, Task 18) by constructing a fence around approximately 23 acres of sand prairie in the southwestern portion (Section 4) of the Arsenal (Map 1). This fence was built to minimize disturbance to the unique plant community.

The Service provided guidance to Army on a variety of other projects such as seeding recommendations for the Barracks area, the Rod and Gun Club area, and Building 111 Complex construction area. The Service also provided literature and initial recommendations for construction of sewage lagoons behind Building 111, recommendations for replacement trees, and a plan for acquiring professional assistance for evaluating and resolving water management issues. The Service also worked closely with Army on approving Total Terrain's overall Health and Safety Plan and several site-specific health and safety plans.

The Conservation and Mitigation divisions worked together on a variety of projects in addition to those mentioned above. The Service established a mitigation and conservation photography program that was conducted mostly by Conservation personnel; detailed record-keeping accompanied the photography. Conservation and Mitigation personnel also collaborated on a raptor electrocution study contracted to Merrick and Company (the results have been presented to Army for correction of unsafe electric lines), protected young cottonwoods from scraping by mule deer bucks in Section 3, and responded to a Commerce City proposal to construct a gas pipeline on the Arsenal.

The Mitigation division worked with the Community Relations division on the Eagle Watch and Visitor Center areas in Sections 5 and 2, respectively (Map 1). Additional facilities to enhance these areas for both wildlife and people are anticipated. The Service proposes to make a number of improvements at the Eagle Watch. Improvements include enhancing esthetics (e.g. painting the blind), improving some access (e.g. adding handicap parking spaces), limiting other access (e.g. fencing), increasing comfort levels (e.g. heating the blind), and revegetating appropriate sites (e.g. seeding disturbed areas beside new path). The Service plans additional work near the Visitor Center to include trails, interpretive signs and kiosks, and revegetation of weedy areas to four types of native prairie.

worked with Denver Museum of Natural History on designing potential studies to evaluate potential impacts on wildlife resulting from perturbations in a variety of habitats.

The Service managed much of the Earth Day 1991 celebration for the Arsenal. The Mitigation division designed and staked a gravel trail between the Visitor Center and Building 111 in Section 2 (Figure 1), directed the construction of that trail, purchased 190 shrubs and trees, helped to oversee the planting by approximately 70 Arsenal employees, and maintained the plants.

The Service worked with Army and Shell to initiate planning of large scale enhancement projects that might mitigate for cleanup activities and dilute soil contamination simultaneously. This planning, along with implementation of the first projects, will be a significant part of the Mitigation Program during FY92.

ACKNOWLEDGEMENTS

The Service appreciates the mitigation assistance provided by numerous people. In particular, Col. Daniel Voss and Deputy Program Manager Kevin Blose were highly supportive of the Mitigation division and provided much insight for establishing a working program. Carl Mackey conducted the MK projects and provided immeasurable help with many additional vegetation projects. The Service would also like to thank Diane Hall, Ernie Husmann, Vera Moritz, Col. Bishop, Steve Molay, John Harper, Jim Green, and Jim Farnham.

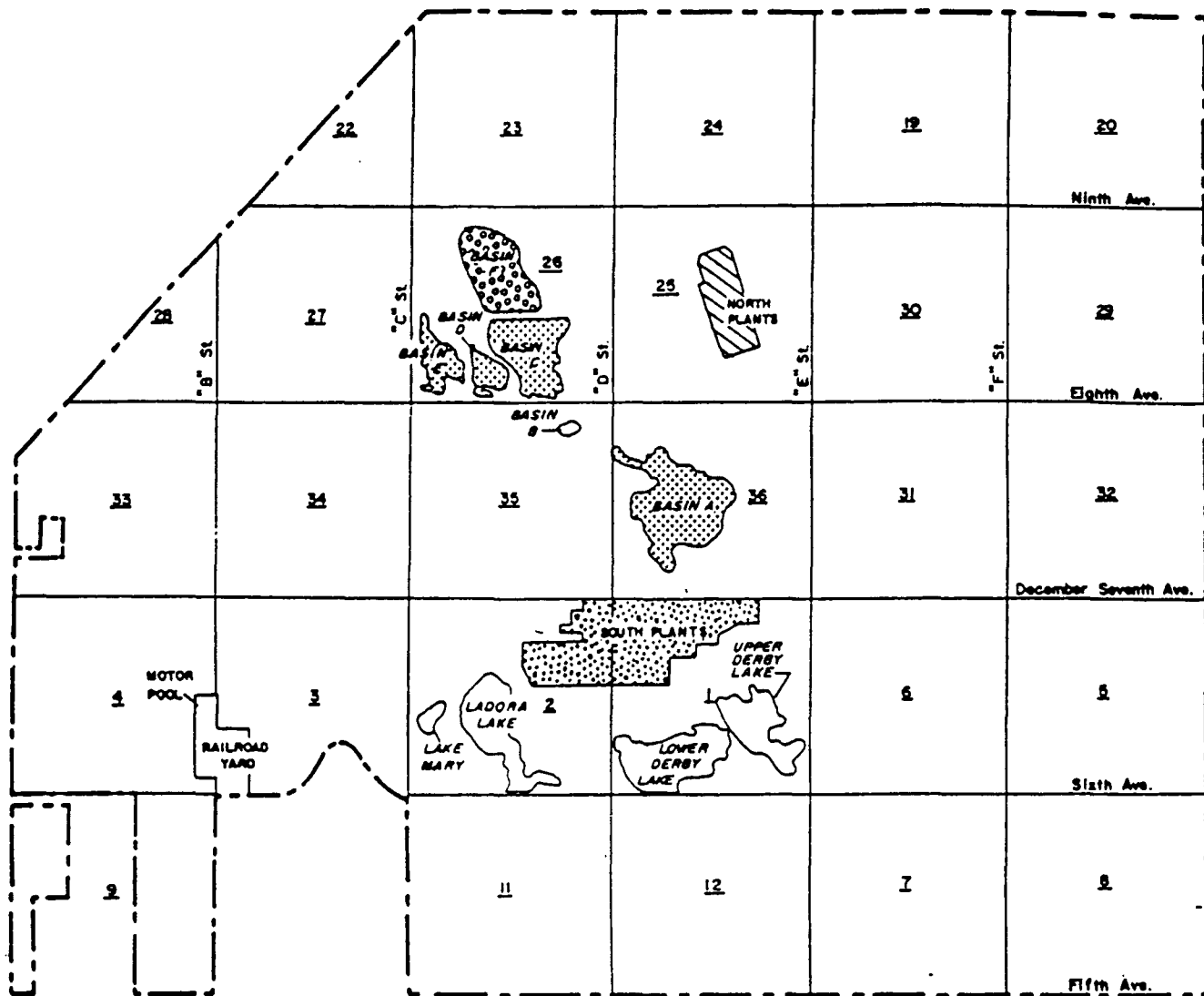
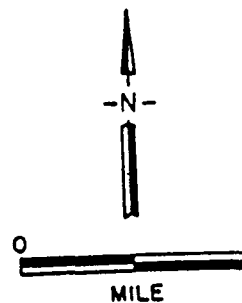


Figure 1. Section locations, Rocky Mountain Arsenal, FY 1991.



C-7

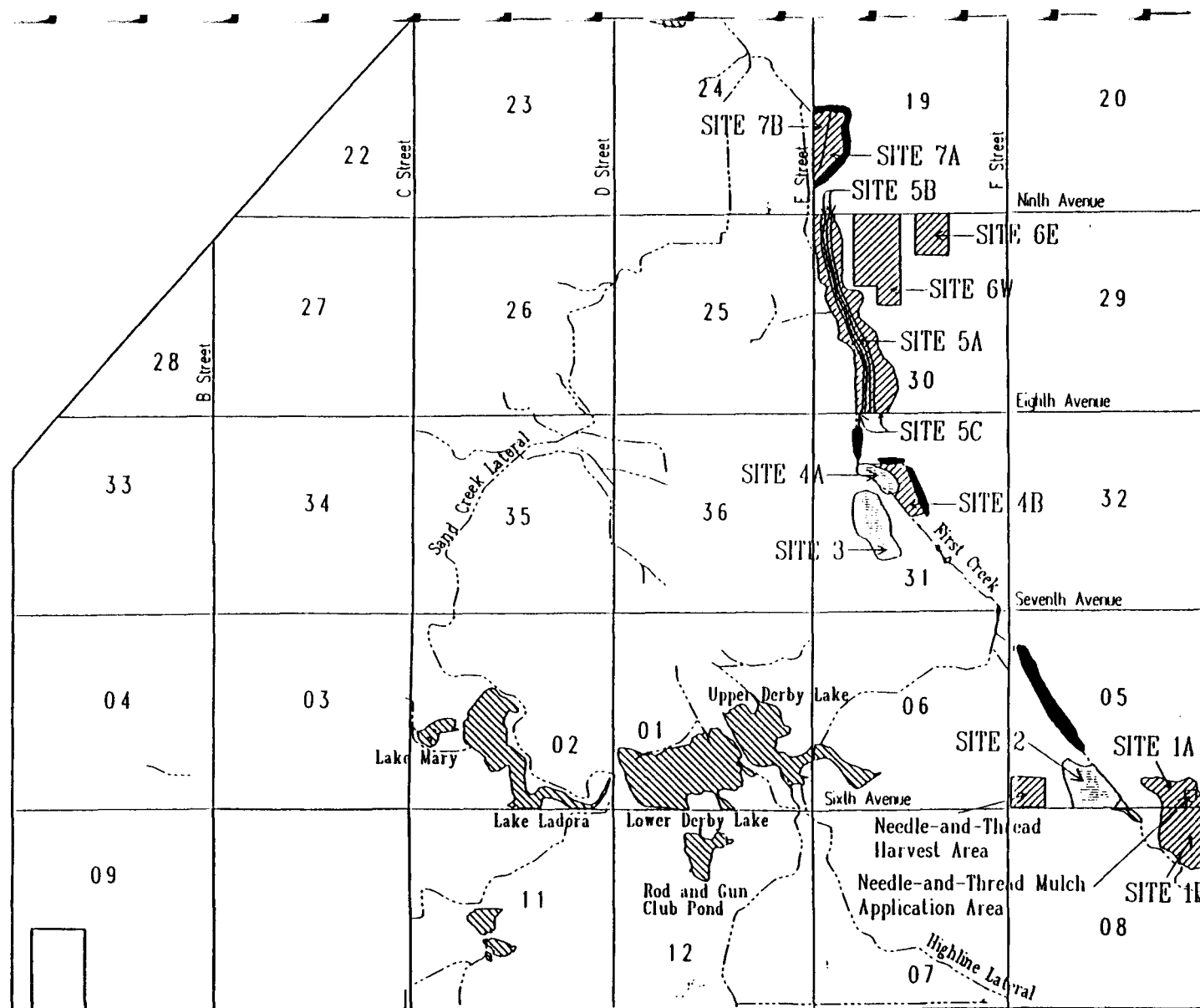


Figure 2. Locations of habitat manipulations conducted by MK personnel, Rocky Mountain Arsenal, FY 1991.

LITERATURE CITED

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TITLE: Service Involvement in Contaminant-Related Activities

PERSONNEL: Patty Stevens, Toxicologist, USFWS, Rocky Mountain Arsenal

Arlene Tortoso, Microbiologist, USFWS, Rocky Mountain Arsenal.

John Meisner, Fishery Biologist, USFWS, Rocky Mountain Arsenal.

John Wegryzn, Toxicologist, USFWS, Rocky Mountain Arsenal.

Michelle Fink, Biological Technician, USFWS, Rocky Mountain Arsenal.

Darryl Patrick, Biological Technician, USFWS, Rocky Mountain Arsenal.

INTRODUCTION

The Service Environmental Quality Section officially began their involvement at the Arsenal when a Toxicologist was hired 26 March 1990. Prior to this time, all Arsenal contaminant issues and activities were coordinated and conducted through the Service Colorado State Field Office, specifically the Environmental Contaminant Specialist. Since March 1990, the Environmental Quality Section has grown to a staff of four. Primary efforts of the Environmental Quality Section during FY91 included the following: provided assistance to the Army regarding the Remedial Investigation/ Endangerment Assessment/Feasibility Studies (RI/EA/FS) processes, Interim Response Actions (IRAs), and Comprehensive Monitoring Programs, assisted in developing and implementing natural resource management programs and provided coordination/guidance to other Service sections working at the Arsenal, designed and implemented specific projects to address wildlife-contaminant issues, and initiated review of Natural Resource Damage Assessment policies and procedures.

METHODS

1. Review and prepare correspondence and comments related to technical documents/issues generated by the RI/EA/FS and IRAs to ensure protection of fish and wildlife resources. Comments include guidance, recommendations, and/or possible solutions to potential or perceived contaminant-wildlife conflicts.
2. Provide guidance and input to the Conservation, Mitigation, Activities Coordination, and Community Relations Sections in

the planning and development of fish and wildlife management strategies that minimize exposure of fish and wildlife resources to contaminants before, during, and after cleanup of the Arsenal.

3. Provide assistance to the Army in the development and implementation of a Biomonitoring Program that will replace the Biota Comprehensive Monitoring Program. This assistance will include the development and implementation of specific programs to answer specific contaminant and/or health related issues as needed to effectively manage fish and wildlife populations at the Arsenal.
4. Conduct a Natural Resource Damage Assessment as authorized by the Comprehensive Environmental Response, Compensation, Liability Act (CERCLA) and amended by the Superfund Amendment and Reauthorization Act (SARA) to recover damages for injury to natural resources.

RESULTS AND DISCUSSION

1. External Assistance - A total of 113 technical documents related to the EA/FS and IRAs were reviewed to ensure protection of Arsenal fish and wildlife resources. Comments were provided as necessary, including guidance, recommendations, and/or possible solutions to potential contaminant/wildlife conflicts. Meetings with the Army and other agencies, organizations, and contractors were attended weekly to discuss issues of technical merit related to the Superfund process. These issues included the planning and implementation of specific remediation projects currently proposed, as well as long term overall cleanup of the Arsenal as proposed in the final Record of Decision.
 - (a) Exposure Assessment - FY91 has been an important year for developing the framework of the input parameters of the food web model for the Ecological Risk Characterization. Parameters developed for inclusion in the model include assimilation fraction, loss rate, bioconcentration factor, bioaccumulation factor, feed rate, dietary fraction, and maximum allowable tissue concentration. These parameters are used to calculate probabilistic biota criteria for soils, sediments, and water. These criteria will be considered in conjunction with human health criteria developed in the human health risk characterization in determining final cleanup criteria for the Arsenal. The Service has been extensively involved in parameter value selection for a variety of species found on the Arsenal. Service involvement has included bimonthly working meetings, review and comment on proposed parameter values, and

recommendations for changes or inclusions in model development and output.

- (b) Feasibility Study - Service involvement in the Feasibility Study process has increased significantly during the past year. Currently, the Army is reviewing existing data on soils, surface and ground water, air, and sediments to determine if additional data needs are required to determine appropriate technologies for cleanup. Service involvement to date has been primarily in the surficial soils program, particularly in the southern portions of the Arsenal where public use and wildlife enhancement activities have been proposed for near future development.
- (c) Interim Response Actions - Service involvement is ongoing related to IRAs at the Arsenal. IRAs of particular concern during FY91 include the South Tank Farm Plume, Lime Settling Basins, and Basin F Liquids.

South Tank Farm Plume - Service personnel, in conjunction with the Environmental Protection Agency, successfully resolved a potential dispute regarding predictions of the ability of the plume to enter the lakes before a final remedy is implemented. Concern was raised because several components of the plume exceed the acute and/or chronic freshwater aquatic life criteria. Resolution was obtained with all parties agreeing that better definition of the relationship between the groundwater and the lakes was necessary. This will be accomplished through the monitoring of groundwater and surface water elevations, including the installation of new wells, and through a quarterly monitoring and assessment program. If results of this program indicate any potential for water to enter the lakes and the process cannot be controlled by managing the lake elevation, then additional measures may need to be taken, including additional analyses of groundwater samples for all constituents proposed by EPA, not just the five constituents identified by Army and Shell.

Lime Settling Basins - Water from the Lime Settling Basins in Section 36 and surface water runoff from the South Plants have resulted in surface water ponding in the Basin A area. This water has been analyzed at the request of the Service and does contain a variety of potentially harmful levels of contaminants. Service and Army personnel are working closely to successfully resolve this issue. Resolution will likely involve routing of the surface water to Basin B where infiltration can occur more rapidly. Fencing/netting

efforts may become necessary if the ponding cannot be reduced significantly.

Basin F Liquids - Environmental Quality personnel have reviewed and commented on an Ecological Risk Assessment associated with the proposed Basin F Incinerator. The implementation of this IRA is essential for the destruction and removal of contaminated liquid currently stored in tanks near the incinerator site. Service concerns include the deposition of ash on surrounding habitats and potential effects to fish and wildlife resources. Additional involvement has included ongoing coordination with the contractor responsible for maintaining the wildlife deterrent devices at Pond A and recommendations for wildlife barriers and control around the Basin F wastepile.

2. Internal Assistance - Guidance and input was provided to the Conservation/ Mitigation, Community Relation, and Administration sections for the planning and development of fish and wildlife management strategies, public education programs, and administration/management issues to minimize potential contaminant exposure to fish and wildlife, to Service staff, and to the general public.
3. Biomonitoring (BM) and Comprehensive Monitoring Programs (CMP) - The Environmental Quality section assumed responsibility for the CMP from the Army during FY91. Service personnel provided oversight of the completion of the pre-existing CMP program. This program will be completed with the issuance of the 1990 Annual Report. In the future, the CMP will be called the Biomonitoring Program and will be developed and implemented by the Environmental Quality Section. Currently, a scope of work and associated tasks are being developed to address a variety of contaminant/fish and wildlife resource issues. Proposed tasks include:
 - (a) monitoring of fish and wildlife exposure to contaminants through tissue residue analyses,
 - (b) monitoring of fish and wildlife health through physical and histopathological examination,
 - (c) surface water quality monitoring through water and sediment bioassays using a variety of freshwater organisms,
 - (d) wildlife land use surveys, with emphasis on wildlife use in or near known contaminated areas, to assess potential for wildlife exposure to contaminants,
 - (e) fortuitous specimen collection and determination of cause of death,

- (f) coordination and oversight of a field study on water quality monitoring and successional changes in the macroinvertebrate community over time in the newly developed wetlands, and
- (g) coordination and oversight of a field study on the changes in distribution and abundance of small rodents in various habitat types affected by remedial disturbance.

CMP and BM activities already initiated include: (1) the transfer of a mobile home from U.S. Bureau of Reclamation in Montana to U.S. Fish and Wildlife Service at the Arsenal for use as a water quality laboratory, (2) the purchase and acquisition of all equipment and associated materials necessary to operate this laboratory, (3) a deer herd health study has been completed except for a final report which is due in early FY92, (4) weekly wildlife land use surveys of contaminated areas, and (5) the determination of cause of death for a variety of fish and wildlife species found on the Arsenal.

All suspected causes of death related to contaminant exposure to date have been attributed to other causes (e.g. distemper, viral infections, nutrient deficiency) after a thorough examination.

- 4. Natural Resource Damage Assessment - A preliminary damage assessment was conducted and has provided valuable information regarding the necessity for the collection of additional data. This information included the collection of Army, Shell, and Service historical records of wildlife die-offs and injuries related to past Arsenal activities. Additional data should be accomplished through the Biomonitoring and Comprehensive Monitoring Programs.

TITLE: Deer Herd Health Study

PERSONNEL: John Wegrzyn, Toxicologist, USFWS, Rocky Mountain Arsenal.

Mike Lockhart, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

Don Whittaker, Graduate Student, Colorado State University.

Patty Stevens, Toxicologist, USFWS, Rocky Mountain Arsenal.

Dr. Terry Spraker, Veterinary Pathologist, Colorado State Veterinary Diagnostic Laboratory.

INTRODUCTION

The Service initiated a deer herd health study in 1991. The objectives of this study were:

1. To assess the physical and physiological condition of mule and white-tailed deer in relation to the condition of their range on Rocky Mountain Arsenal.
2. To prevent or restrict the incidence and cycling of infectious diseases to prevent large die-offs.
3. To develop management strategies that limit exposure of Arsenal deer to environmental contaminants.

Information resulting from this study will be used to develop mitigation strategies for loss of habitat as a result of remedial activities and serve as baseline information for potential future herd health studies if warranted.

METHODS

Ten white-tailed deer (Odocoileus virginianus) and 13 mule deer (Odocoileus hemionus) were collected by gun shot, dislocating the cervical vertebrae with a small caliber, high-speed bullet. A thorough gross postmortem examination was immediately conducted in the field by Dr. Terry Spraker. Two sets of tissues from each deer were collected, one for histopathological examination and the other for potential chemical analyses. Tissues collected included liver, kidney, brain, spleen, heart, lung, bone, skeletal muscle, and hair. Selected tissues (liver, kidney, and hair/integument) were analyzed for selected vitamins and minerals. Blood samples were also taken and analyzed for CBC, Pack Cell Volume, hematocrit, hemoglobin, and differential cell

counts. Leukocytes and spleen were cultured to detect Bovine Viral Diarrhea (BVD). Blood serum was analyzed for various viruses, bacteria, and vitamins and minerals. A tonsil tissue culture was analyzed for Pasteurella spp. A culture of the small intestine was taken to characterize normal flora. A fecal sample was collected to determine parasite burdens.

All histopathological examinations were conducted at the Colorado State University Veterinary Diagnostic Laboratory.

RESULTS

Laboratory and histopathological examinations are ongoing. A final report will be issued in FY92.

TITLE: Kestrel Nestbox Monitoring Program

PERSONNEL: Darryl Patrick, Biological
Technician, USFWS, Rocky Mountain
Arsenal.

Michelle Fink, Biological Technician, USFWS, Rocky
Mountain Arsenal.

Patty Stevens, Toxicologist, USFWS, Rocky Mountain
Arsenal.

Brett Petersen, Research Associate, Colorado State
University.

INTRODUCTION

In 1982-83, the Service conducted a study to assess potential effects of contaminants on American Kestrel (Falco sparverius) reproduction at the Arsenal. In 1986, the kestrel study was continued as part of the Biota Remedial Investigation. From 1988-90, the kestrel reproductive study was conducted as part of the Biota Comprehensive Monitoring Program. During all phases, the Service coordinated and/or participated in the program.

METHODS

Forty-six nest boxes are located throughout the Arsenal (Figure 1) while 19 nest boxes are located at off-post control sites (Figures 2). All boxes were cleaned out and new wood chips were added from March 25 to March 28. During the nesting season, nest boxes were monitored approximately every two weeks. Nest box monitoring consisted of plugging the nest box hole with a telescoping pole and climbing a ladder to reach the box. The side of the box was opened and kestrels were captured by hand and removed to obtain sex and age class and to band each bird if not previously done. Juveniles were weighed, aged, sexed and banded.

No contaminant analyses of tissues were conducted during 1991.

RESULTS AND DISCUSSION

All results presented are preliminary; a final report will be issued during FY92.

At the Arsenal, nest boxes were monitored on the following dates: May 2, 16-17, 30, June 13-14, 18, 24, 27, July 9, 11 and 25. Nest boxes at the off-post control sites were monitored on: May 7-9, 29, June 12, 26, July 9, and 25. A total of 27 of 46 Arsenal nest boxes (59%) were used by kestrels, whereas 12 of 19 off-post nest boxes (63%) were used by kestrels.

Of the 27 Arsenal nest boxes, 26 contained nests and one box was utilized as a feeding and/or roost site as it contained castings (Table 1). Twenty-one nests were successful in producing young; two clutches did not hatch, two nests were lost probably to predation and one nest box fell and all eggs destroyed. Of the 26 nests documented a total of 130 eggs, 93 young and 86 fledglings, for an average of five eggs, 3.58 young and 3.31 fledglings per nest were produced.

At the off-post control sites, only eleven nests were monitored for eggs, although twelve nest boxes were utilized (Table 2). One nest box already had young in it when first monitored. Of the eleven nests, a total of 54 eggs were present, for an average of 4.91 eggs per nest. Of all 12 nests, 47 young and 43 fledglings were produced for an average of 3.92 young and 3.58 fledglings per nest.

Productivity of kestrels at the Arsenal was similar to productivity for off-post kestrels (Table 3). The mean number of young fledged/nest attempt on RMA was 3.31; the mean number off-post was 3.58. These are both above the mean number of 2.88 considered necessary to maintain the population (Henny, 1972).

A total of 168 kestrels were banded this past year during the course of the study. On the Arsenal, a total of 113 birds were banded; 27 adults and 86 young. Off-post, 55 birds were banded; 9 adults and 46 young.

LITERATURE CITED

Henny, C.J. 1972. An analysis of the population dynamics of selected avian species. U.S. Fish and Wildlife Service Res. Rep. No. 1, Washington, D.C.

Table 1. Production by American Kestrels in Nestboxes at Rocky Mountain Arsenal, 1991.

<u>Box Number</u>	<u>No. Eggs</u>	<u>No. Young</u>	<u>No. Fledged</u>	<u>No. Banded</u>
3	6	0	0	0
4	5	4	4	4
10	5	0	0	0
11	5	5	5	5
107	5	4	4	4
109	5	4	1	1
112	5	4	4	4
114	5	5	5	5
117	5	2	2	2
118	5	3	3	3
119	5	4	4	4
122	5	5	5	5
123	5	5	5	5
128	5	3	3	3
133	5	2	0	0
134	5	0	0	0
135	5	5	5	5
137	5	5	4	4
138	5	4	4	4
*139	0	0	0	0
140	4	0	0	0
141	5	5	4	4
142	5	5	5	5
143	5	5	5	5
146	5	5	5	5
148	5	4	4	4
150	5	5	5	5
Total	30	93	86	86
N	26	26	26	26
**Average	5.00	3.58	3.31	3.31

* Nest box was used as feeding/roost site only.

** Number/Nesting Attempt

Table 2. Productivity by American Kestrels in Nestboxes at Off-Post Controls, 1991

Site	Box Number	Eggs(#)	Young(#)	Fledged(#)	Banded(#)
*Barr Lake	63	*	4	4	4
McIntosh Farm	80	5	5	5	4
	81	6	6	6	6
	82	4	4	4	4
	84	4	3	3	3
Metro Sewage	95	5	3	0	3
	97	5	3	3	3
Riverside	101	5	4	4	4
	102	5	5	5	5
	102A	5	2	2	2
	103	5	5	4	5
	104	5	3	3	3
Total		54	47	43	46
N		11	12	12	12
** Average		4.91	3.92	3.58	3.83

* Young were present at first monitoring.

** Number/Nesting Attempt

Table 3. Nesting Productivity by American Kestrels at Rocky Mountain Arsenal and at Off-Post Control Sites, 1991.

<u>Reproductive Parameters</u>	<u>Arsenal</u>	<u>Control</u>
Nest Attempts	26	12
Clutch Size	5.0	4.91
% Nests Hatched *	85	100
Hatchlings/Nest	3.58	3.92
% Nests Fledged *	81	92
No. Fledged/Successful Nest	3.90	3.90
No. Fledged/Nest Attempt	3.31	3.58

* Hatched nest: ≥ 1 egg hatched
 Fledged nest: ≥ 1 young fledged

TITLE: Fortuitous Specimen Program

PERSONNEL: Patty Stevens, Toxicologist, U.S. Fish and Wildlife Service, Rocky Mountain Arsenal.

Dr. Terry Spraker, Veterinary Pathologist,
Colorado State University Veterinary Diagnostic Laboratory, Fort Collins, CO.

INTRODUCTION

In 1990, the Service initiated a Fortuitous Specimen Program to investigate the cause of death for selected animals found dead or dying at the Arsenal.

METHODS

Candidates for inclusion in the program were all animals found dead or dying at the Arsenal. Animals were selected based on: (1) suspected contaminant-related poisoning, (2) protected under federal laws, or (3) opportunistic finding (e.g. badger). Service personnel were notified of dead or sick/injured animals by Army personnel, contractors, or other Service personnel. The animal was collected and a determination was made whether to send the animal to Colorado State Veterinary Diagnostic Laboratory (CSVDL). Dr. Terry Spraker was then notified and the animal was immediately transported to CSVDL. The animal was either placed on ice or transported alive, if possible. Once at CSVDL, an examination and necropsy were conducted. In some instances, tissues were saved for potential contaminant analyses.

RESULTS

Thirteen partial or full post-mortem examinations have been performed since July, 1990. All but #1 were examined by CSVDL.

- (1) An injured mule deer fawn (Odocoileus hemionus) was reported alive near Building 111. Upon observation of the animal, a pendulous mass was observed hanging down from the abdomen. The fawn was weak and depressed. After euthanization, a field post mortem evaluation was conducted. Numerous small contusions and puncture wounds were present and hemorrhaging was apparent. Evidence indicated an attack by a canine species, probably a coyote.
- (2) An incapacitated red-tailed hawk (Buteo jamaicensis) was reported alive near Upper Derby Lake. The bird was captured and brought to the Service field station. Upon receipt, the bird was placed in a kennel for observation. The hawk was in a state of tetany and was unable to move its wings, legs or talons. The talons were clenched in a closed position. A slight amount of fluid discharge was present in the oral

cavity. Breathing was rapid and shallow. The keel was not prominent. The hawk died. A post-mortem examination revealed lesions in the brain stem, spinal cord, and brachial plexus. The lesions may have been associated with acute neurotoxins or some type of metabolic disturbance. Moderate autolytic change was apparent in the spleen and was likely indicative of immune/inflammatory stimulation. Tissues were saved for potential chemical analyses.

- (3) A Service captive red-tailed hawk was found dead in its enclosure at Rocky Mountain Arsenal. The primary cause of death in this bird was a severe multifocal necrosis of the heart, liver, kidney, lung, and spleen, associated with uric acid deposition. The exact cause of this uric acid deposition was not determined, but could be associated with either too high a protein diet or some type of chronic problem that would lead to renal failure, such as chronic blood poisoning or high levels of other heavy metals. Levels of lead and mercury were insignificant in both liver and kidney tissue.
- (4) A red-tailed hawk was found dead near the corner of Sixth Avenue and F Street. The bird had been dead approximately 2-3 days. Upon post-mortem examination of this bird, it was found to be in excellent condition. The crop and ventriculus were filled with tissues from a ground squirrel or young prairie dog. No significant lesions were found. The cause of death was not determined. Tissues were saved for potential chemical analyses.
- (5) Buck deer remains were found near the intersection of First Creek and Buckley Road; the skull plate, edible parts and the skin were missing. The heart and lungs were analyzed for identification of species. Lesions in the lung were indicative of gun shot. The deer was a mule deer.
- (6) A white-tailed deer fawn (Odocoileus virginianus) was found in a clover trap unable to stand and in a weakened state. The fawn was taken into captivity and held for several days, but did not improve. It was euthanized. Upon post-mortem examination, the only lesions observed were on some white streaks on the muscles of the front legs. A complete necropsy was not performed. The lesions in the legs were indicative of capture myopathy. The degree of mineralization in the muscles suggested a vitamin E/selenium deficiency.
- (7) A young male coyote (Canis latrans) was observed extremely sick near the Visitor Center. Service personnel were unable to capture it. It died several hours. The coyote was extremely thin and in poor body condition. A post-mortem examination revealed a severe penetrating ulcer in the

duodenum which led to severe diffuse peritonitis. The cause of the ulcer may have been associated with severe chronic stress due to high coyote population at the Arsenal and competition for food.

- (8) An adult female cottontail rabbit (Sylvilagus floridanus) was observed by contractor personnel at the Basin F Wastepile with blood around the anal area. The rabbit was captured; examined alive then euthanized. A post-mortem examination revealed a moderate to severe degree of hemorrhage in the small intestines. Fecal pellets were firm. The primary cause of illness was determined to be severe acute necrotizing enteritis that is compatible with Clostridium perfringens. Numerous clostridia and streptococci were isolated from the intestinal tract and liver.
- (9) An immature red-tailed hawk was found dead underneath an electrical line in the South Plants. The hawk was emaciated and the carcass was extremely autolyzed. Several large cactus thorns were present in the pads of both feet. No internal lesions or broken bones were found. No evidence of electrocution was found. The cause of death in this bird was not determined. It is assumed that if this had been a healthy bird, the bird would have broken off the thorns resulting in small granulomas in the feet. Radiographs showed no evidence of gunshot.
- (10) An adult bald eagle (Haliaeetus leucocephalus) was found dead in First Creek under the roost area. The eagle had been dead a long time and had undergone advanced autolysis. Radiographs showed no evidence of gunshot or broken bones. The eagle had a leg band on its right foot (#629-33205). The cause of death could not be determined.
- (11) A great blue heron (Ardea herodias) was observed flying over Basin F Wastepile by contractor personnel. The bird suddenly lost its ability to fly and fell to the ground. It was alive after it hit the ground, but died shortly thereafter. A post-mortem examination revealed a structure within the cerebellum suggestive of a larval stage tapeworm. Severe parasitism, tapeworms and flukes were present in the small intestine. The possibility exists that the migration of the tapeworm in the brain caused the bird to abruptly lose its ability to fly.
- (12) An immature American Robin (Turdus migratorius) was observed extremely sick on a picnic table at the USGS trailers near Seventh Avenue and C Street. The bird was captured. A post-mortem examination revealed that both eyes were protruding from the sockets and a moderate amount of red-black friable material was observed behind both eyes. This

material was suggestive of blood clots. The anterior portion of the brain was hemorrhagic and swollen. Tapeworms and protozoan parasites were apparent in the small intestines. The primary cause of death was a severe infection of vessels of the brain with a protozoan parasite.

- (13) A badger (Taxidea taxus) was observed extremely sick at the Basin F Wastepile. It was captured. The badger was in poor body condition. It was examined alive then euthanized. A post-mortem examination revealed several parasites and tapeworms in the intestines. No lesions were found in the brain. The badger tested positive for distemper.

TITLE: Wildlife Land Use Survey

PERSONNEL: Michelle Fink, Biological
Technician, USFWS, Rocky Mountain
Arsenal.

Dan Matiatos, Wildlife Biologist, USFWS,
Rocky Mountain Arsenal.

Darryl Patrick, Biological Technician, USFWS,
Rocky Mountain Arsenal.

INTRODUCTION

The wildlife land use survey was begun in April 1990 to document the numbers and species of wildlife utilizing known contaminated areas within the Arsenal. This information is useful in developing management and mitigation plans for species before and during remediation efforts. Originally, Basin A, Ponds A and B, and the North Bob were surveyed for all terrestrial vertebrates except passerines. In April 1991, the survey was expanded to include Basin C, Basin F wastepile, spillover pond, and storage tanks, and the Toxic Storage Yard and adjacent ponds along First Creek (Figure 1). Passerines were included in the expanded survey.

As a result of the inclusion of additional sites, not all sites were observed for the same frequency, nor were sites prior to April 1991 surveyed for passerines. Data summarized in this report encompasses the period April 1990 to July 1991.

METHODS

The survey was performed weekly during morning hours. Because of entry restrictions into contaminated areas, all surveys were conducted roadside with the aid of binoculars and spotting scopes. Numbers of individuals of each species observed at each site were noted and recorded. The location of animals in Basin A were further delineated by quarter-quarter sections in which they were observed. The data were summarized in two ways. The frequency was calculated using the number of survey days for each site, not the total number of survey days for the duration of the study.

Species were grouped into Mammals, Raptors, Waterfowl, and Other Birds, (e.g passerines, galliformes, etc.). The "Other Bird" category was not included for Basin A because the high number of passerines observed after April 1991 distorts the graphic representation of the other categories. The category "Other Birds" was included in the other original survey sites (Ponds A and B and the North Bog) to show the fluctuation from the time they were recorded only; not throughout the entire survey period

for each site because they were not recorded prior to April 1991.

RESULTS AND DISCUSSION

Table 1 lists the average number of species and the percent frequency of occurrence of each species at each site.

Figures 2-11 show a basic seasonal trend in the number of animals, however, long-term monitoring is necessary to determine long-term use and seasonality.

Some interesting observations were apparent. The average number of mammals in Basin A in May-July, 1990 was forty, whereas in May-July, 1991, the average number was only eighteen (Figure 4). This decline in mammals, specifically prairie dogs, may be due to the planned control of prairie dogs in the NWNW and SESE corners of Section 36 (Figure 1). Another interesting observation is the sudden increase in waterfowl in Basin C in June-July, 1991 (Figure 5). The increase corresponds to a period of heavy rains that left substantial amounts of standing water in the basin. The peak of waterfowl at Pond A in August-September, 1990 consists mainly of large flocks of lesser yellow-legs that utilized the pond during fall migration.

Since the initiation of this survey in April 1990, many management practices have been implemented to prevent or eliminate wildlife use in contaminated areas. Some of these practices include physical and vegetative barriers to deter burrowing animals such as prairie dogs and ground squirrels; noisemakers such as tweeters and zon guns to frighten wildlife away from contaminated areas, and removal of perch sites such as trees and shrubs. While these practices have not proven fool proof, they have decreased wildlife use of some contaminated areas considerably.

Table 1. Average Number and Percent Frequency of Mammals Observed in Contaminated Areas, 3 April 1990 to 9 July 1991.

Species	Basin A	Basin C	North Bog	Toxic Storage Yard	TSY Ponds	Pond A	Pond B	Spill Over	Basin F Tanks	Waste Pile
(Survey Days)	49	14	32	8	8	45	45	11	15	11
Mule Deer	9 30.6%	4 14.3%	---	---	3 37.5%	---	---	---	---	---
White-tailed Deer	---	---	---	---	1 12.5%	---	---	---	---	---
Cottontail	2 38.8%	---	---	1 25%	---	1 11.1%	1 <10%	2 27.3%	2 13.3%	1 18.2%
Prairie Dog	19 75.5%	---	---	---	---	---	---	---	---	---
Muskrat	---	---	1 15.6%	---	---	---	---	---	---	---

Table 2. Average Number and Percent Frequency of Raptors Observed in Contaminated Areas, 3 April 1990 to 9 July 1991.

Species	Basin A	Basin C	North Bog	Toxic Storage Yard	TSY Ponds	Pond A	Pond B	Spill Over	Basin F Tanks	Waste Pile
(Survey Days)	49	14	32	8	8	45	45	11	15	11
Red-Tailed Hawk	1 20.4%	1 <10%	1 <10%	2 25%	---	---	---	---	---	---
Swainson's Hawk	2 18.4%	2 14.3%	---	1 12.5%	---	---	---	---	---	---
Northern Harrier	---	---	---	---	1 12.5%	---	---	---	---	---
Kestrel	1 14.3%	1 35.7%	---	1 37.5%	1 12.5%	---	---	---	---	1 18.2%

Table 3. Average Number and Percent Frequency of Waterfowl in Contaminated Areas, 3 April 1990 to 9 July 1991.

Species	Basin A	Basin C	North Bog	Toxic Storage Yard	TSY Ponds	Pond A	Pond B	Spill Over	Basin F Tanks	Waste Pile
(Survey Days)	49	14	32	8	8	45	45	11	15	11
Lesser Yellowlegs	10 <10%	---	2 <10%	---	---	56 11.1%	---	---	---	---
Gadwall	2 <10%	---	2 12.5%	2 12.5%	2 25%	2 <10%	---	---	---	---
Blue-winged Teal	1 <10%	---	2 12.5%	---	---	---	---	---	---	---
Mallard	4 <10%	5 21.4%	2 37.5%	5 25%	6 75%	3 26.7%	2 <10%	2 <10%	---	---
Pintail	---	2 <10%	---	2 25%	1 17.8%	---	---	---	---	---
Redhead	---	---	---	2 12.5%	4 50%	---	---	---	---	---
Cinnamon Teal	---	---	2 <10%	---	1 37.5%	2 <10%	---	---	---	---
Coot	---	---	---	3 25%	1 100%	---	---	---	---	---
Great Blue Heron	1 >10%	1 34.4%	1 12.5%	1 62.5%	---	---	---	---	---	---
Black Crowned Nightheron	---	1 <10%	2 12.5%	---	2 62.5%	1 <10%	---	---	---	---
Pied-Billed Grebe	---	---	---	---	2 50%	---	---	---	---	---
Double- Crested Cormorant	---	---	6 <10%	2 12.5%	2 12.5%	---	---	---	---	---

Table 4. Average Number and Percent Frequency of Other Birds in Contaminated Areas, 3 April 1990 to 9 July 1991.

Species	Basin A	Basin C	North Bog	Toxic Storage Yard	TSY Ponds	Pond A	Pond B	Spill Over	Basin F Tanks	Waste Pile
(Survey Days)	49	14	32	8	8	45	45	11	15	11
Killdeer	2 10.2%	---	3 25%	---	---	2 <10%	3 <10%	---	---	---
Meadowlark	6 20.4%	1 14.3%	1 <10%	5 100%	---	4 <10%	1 <10%	1 <10%	3 26.7%	2 27.3%
Mourning Dove	2 12.2%	4 21.4%	1 <10%	1 75%	---	7 <10%	---	---	1 20%	1 <10%
Magpie	4 24.5%	1 <10%	---	4 62.5%	5 12.5%	---	---	---	---	2 <10%
Starling	52 22.4%	2 <10%	---	7 62.5%	---	---	---	---	2 20%	---
Sparrow	2 <10%	---	5 <10%	9 37.5%	---	---	4 <10%	1 <10%	1 <10%	---
Kingbird	2 <10%	---	---	2 37.5%	---	---	1 <10%	---	---	---
Red-winged Blackbird	---	---	11 37.5%	5 75%	12 100%	---	---	---	---	---
Rock Dove	---	---	---	2 75%	---	1 <10%	---	---	---	---
Grackle	---	---	---	1 12.5%	---	---	---	---	---	---
Northern Oriole	---	---	---	2 37.5%	2 12.5%	---	---	---	---	---
Flicker	---	---	1 12.5%	---	---	---	---	---	---	---
Swallow	---	---	1 <10%	---	2 12.5%	---	---	---	---	---
Robin	1 <10%	---	1 <10%	1 25%	---	---	---	---	---	---

Species	Basin A	Basin C	North Bog	Toxic Storage Yard	TSY Ponds	Pond A	Pond B	Spill Over	Basin F Tanks	Waste Pile
(Survey Days)	49	14	32	8	8	45	45	11	15	11
Ring-Necked Pheasant	---	---	---	---	1 12.5%	---	---	---	---	---

Figure 1. Locations of Wildlife Landuse Survey sites, Rocky Mountain Arsenal.

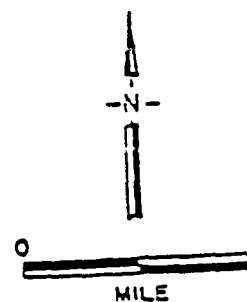
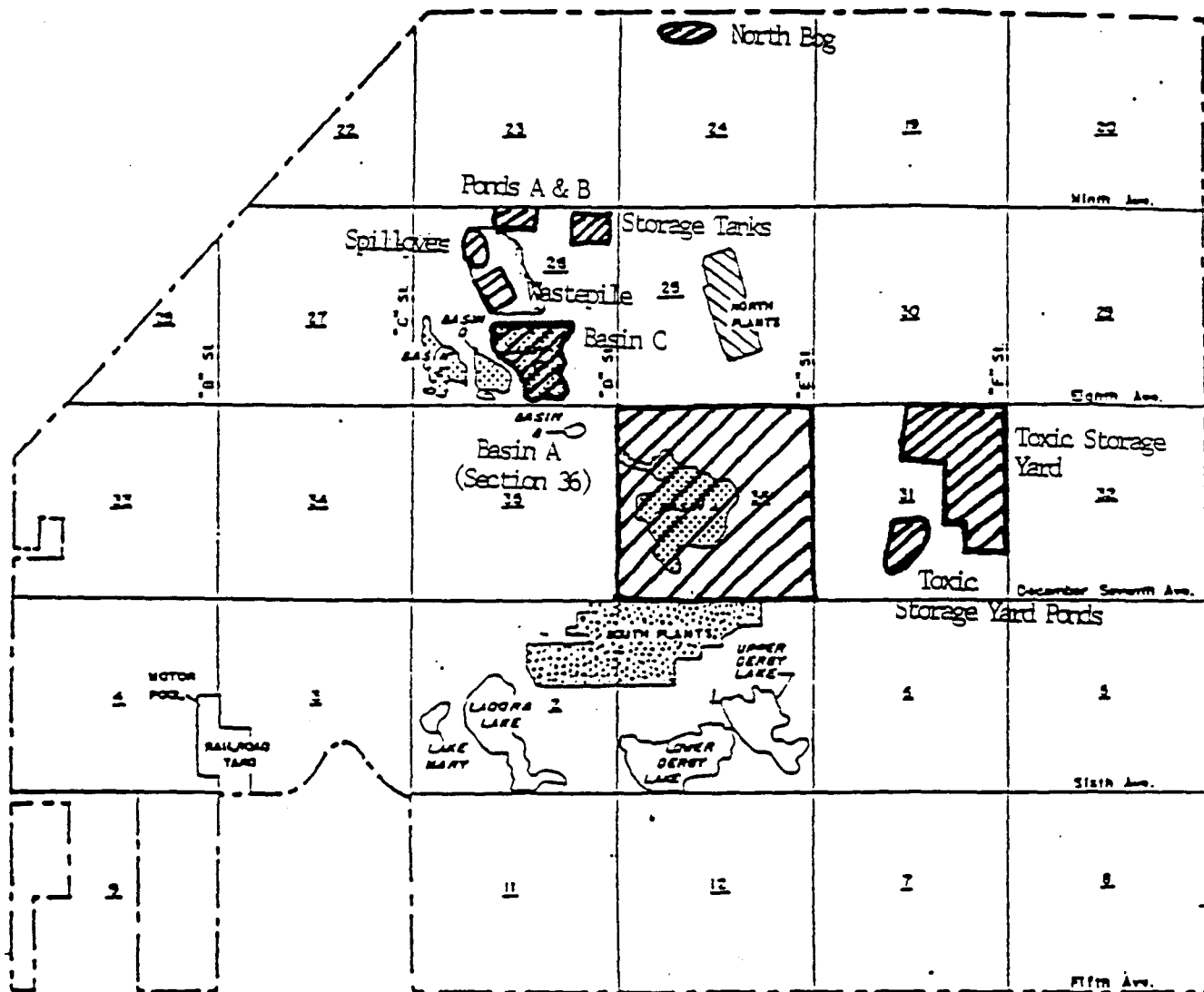


Figure 2.

Change in Number of Animals over Time

Toxic Storage Yard Ponds

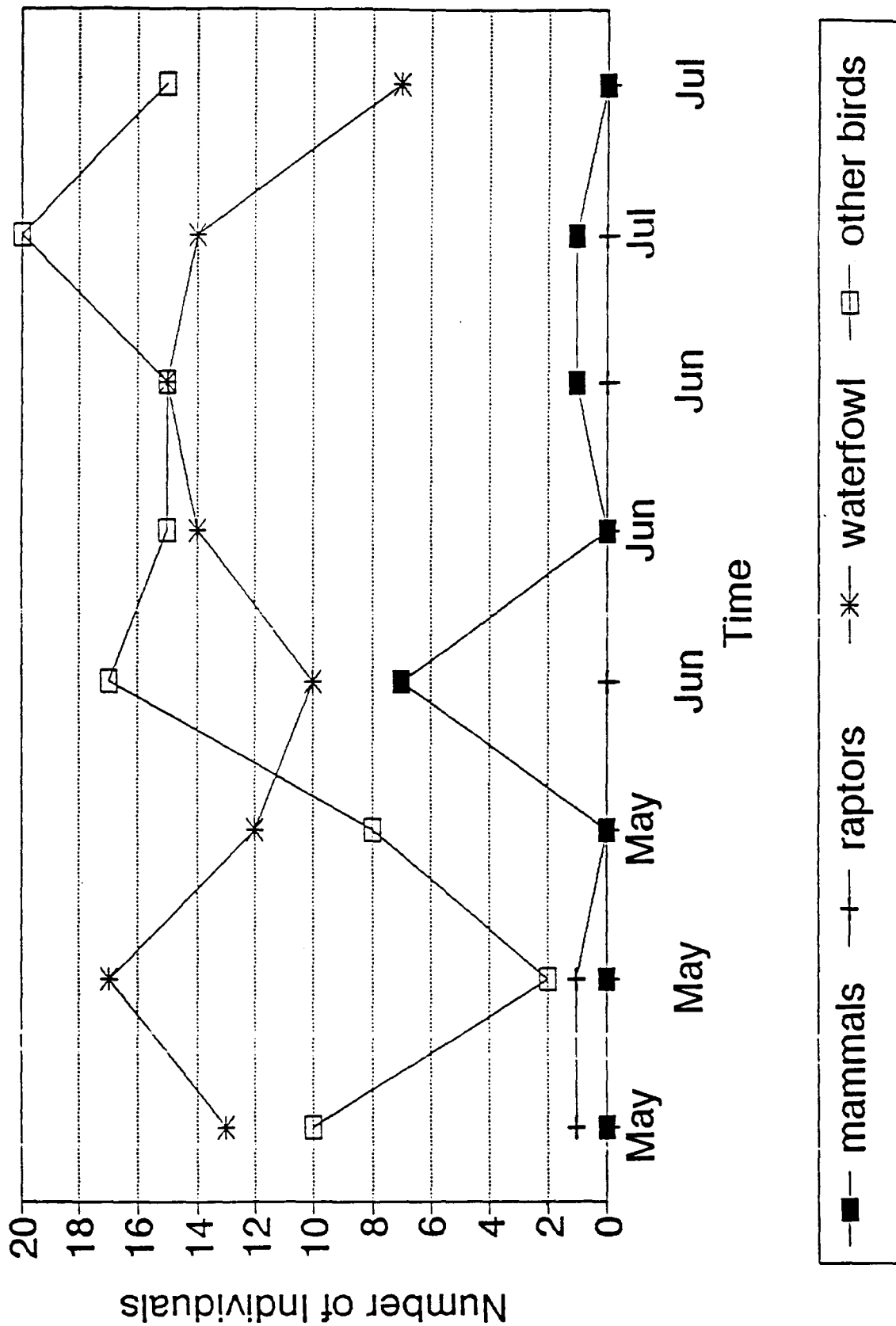


Figure 3.

Change in Number of Animals over Time

Toxic Storage Yard

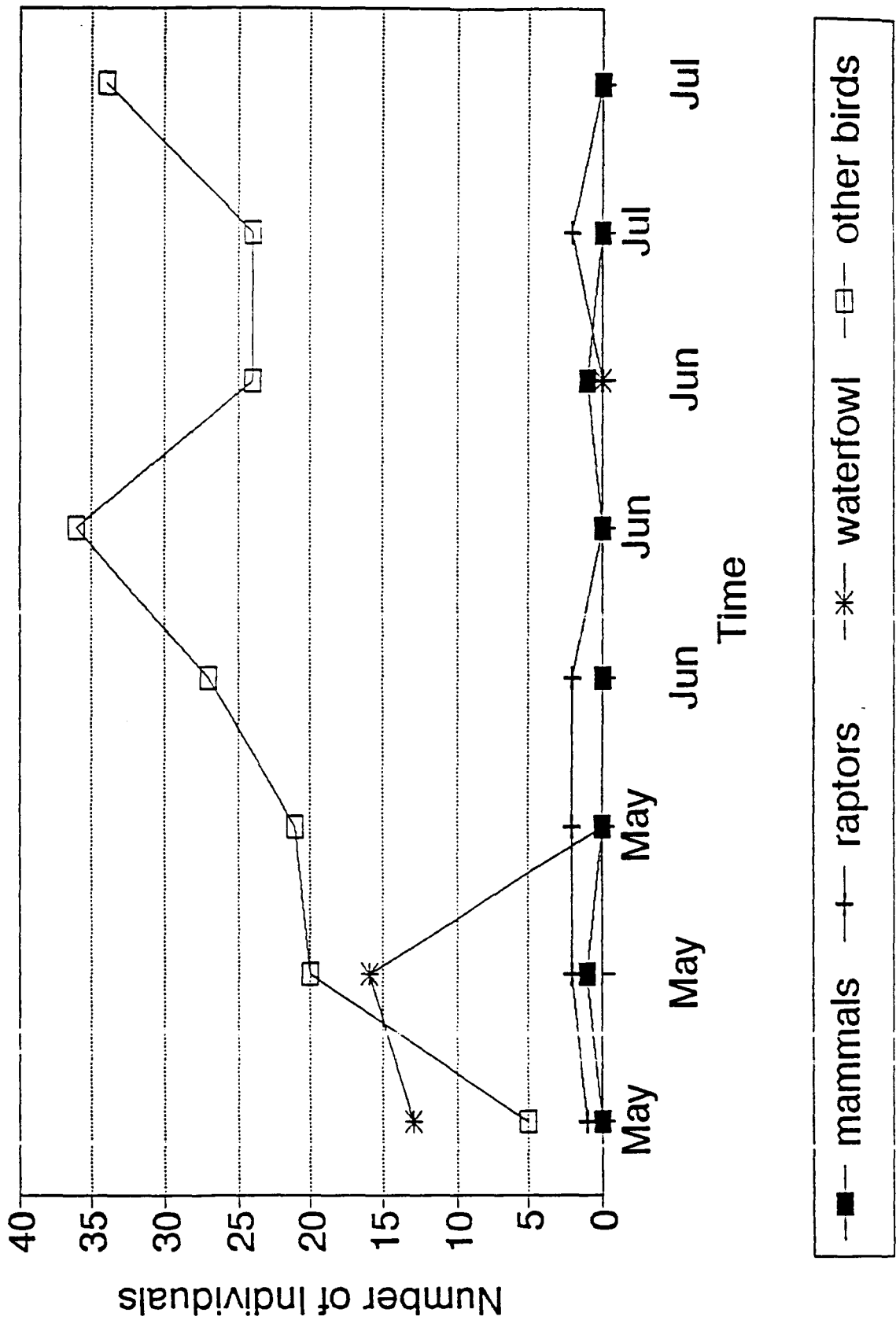


Figure 4.

Change in Number of Animals over Time

Basin A

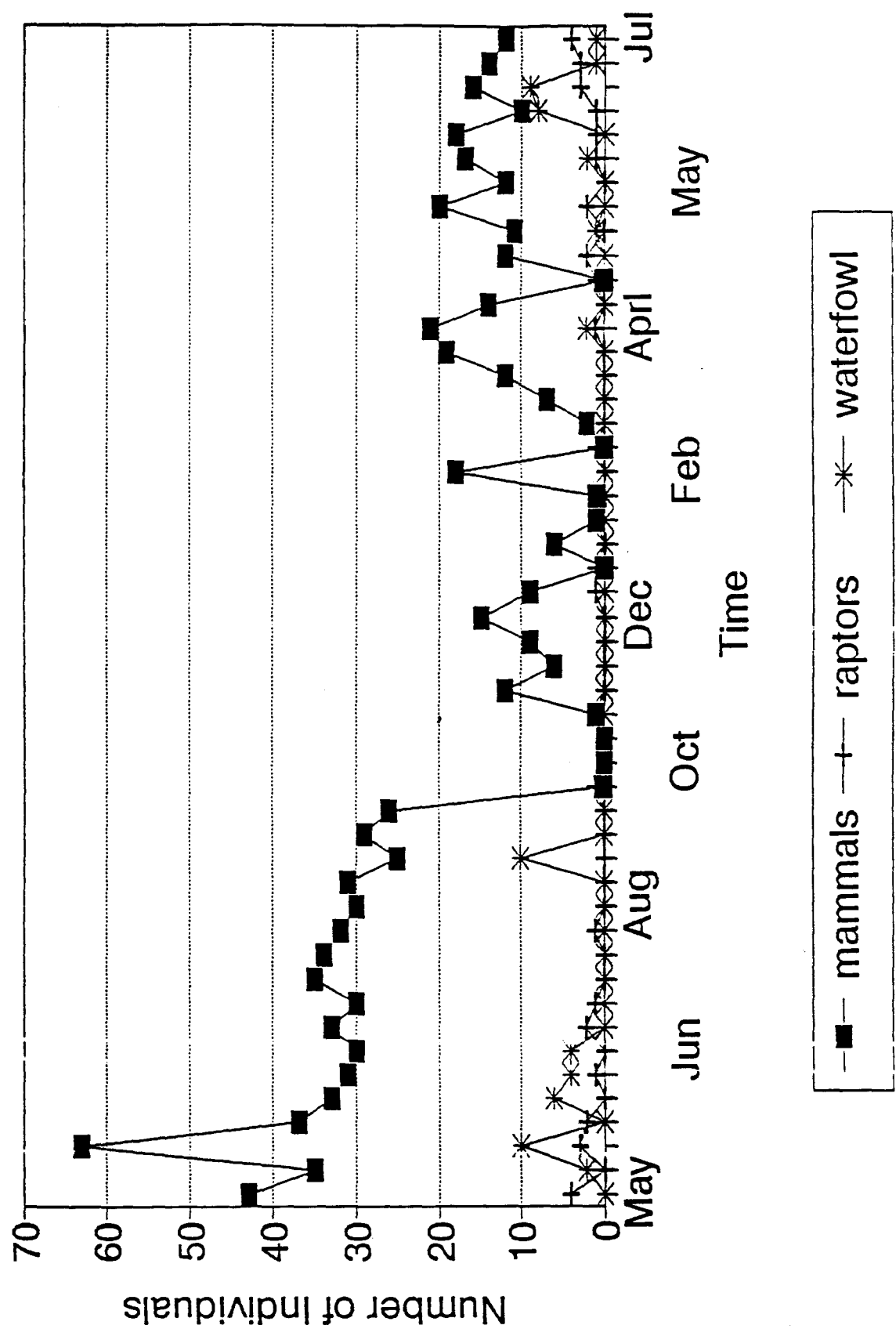


Figure 5.

Change in Number of Animals over Time

Basin C

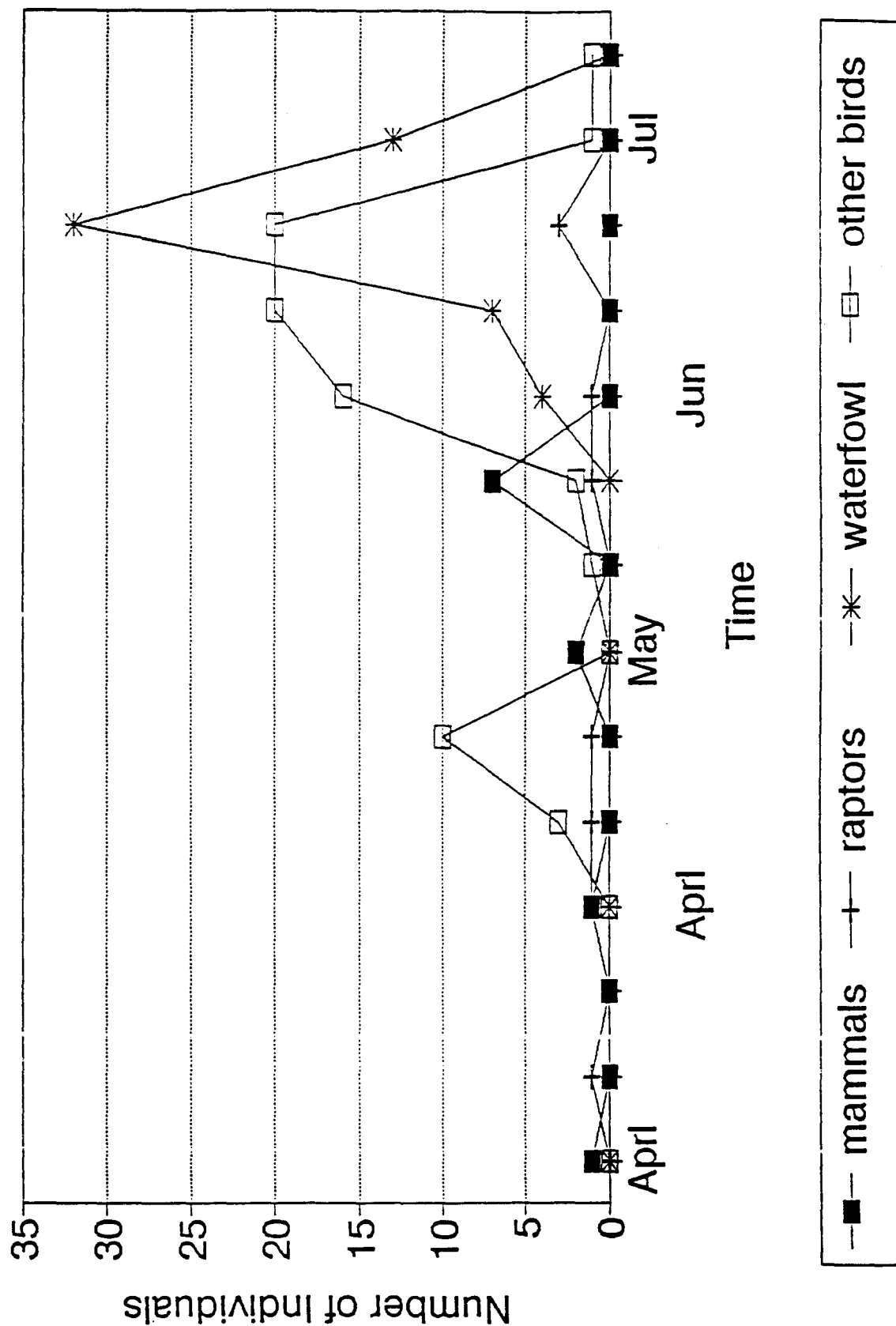
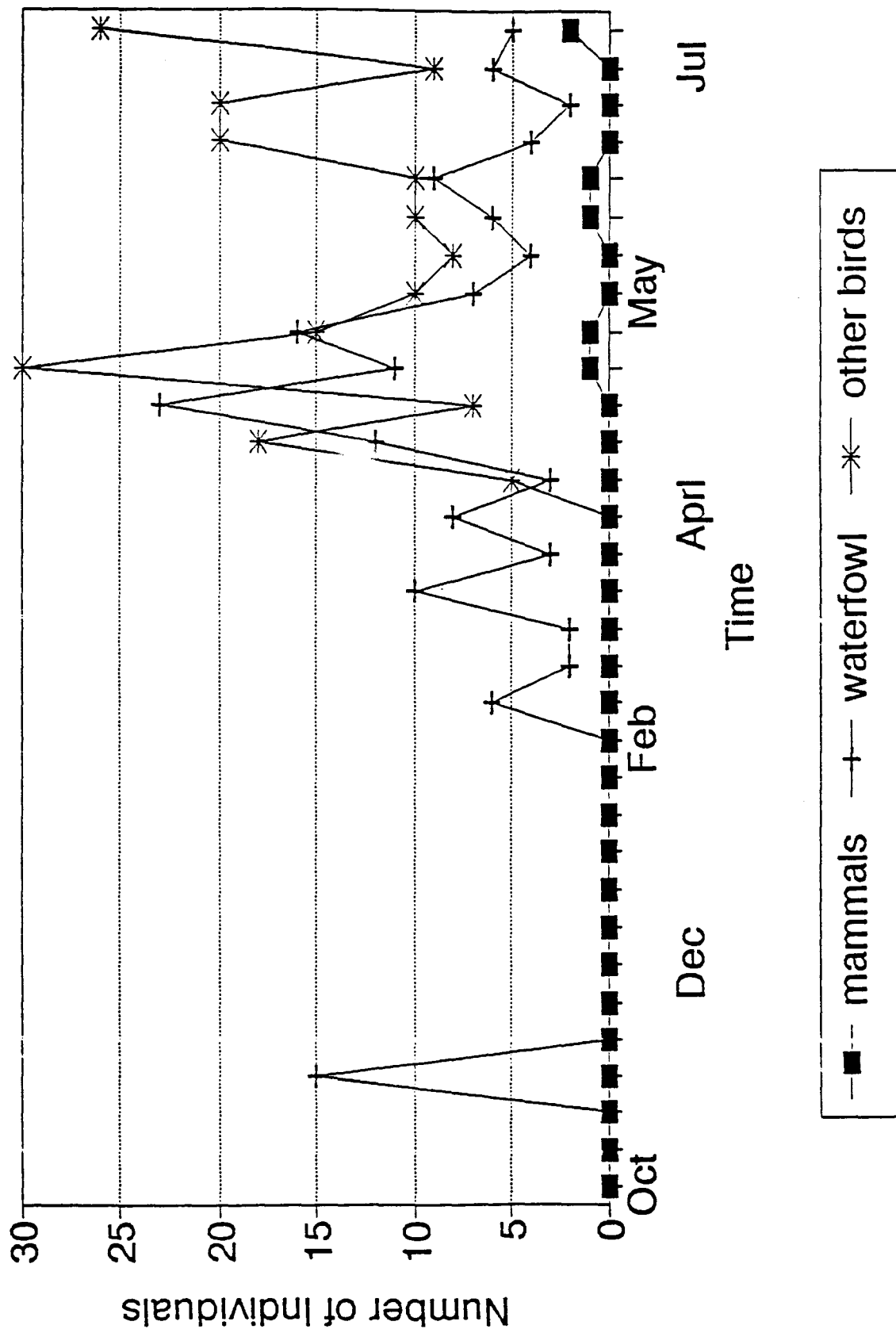


Figure 6.

Change in Number of Animals over Time

North Bog



Change in Number of Animals over Time

Number of Individuals

Time

May Jun Sept Nov Jan April May Jun

Time	Species (+)	Species (*)	Species (x)
May	10	0	0
Jun	10	0	0
Sept	60	10	0
Nov	60	0	0
Jan	60	0	0
April	60	10	0
May	75	0	10
Jun	60	0	10



Figure 8.

Change in Number of Animals over Time

Pond B

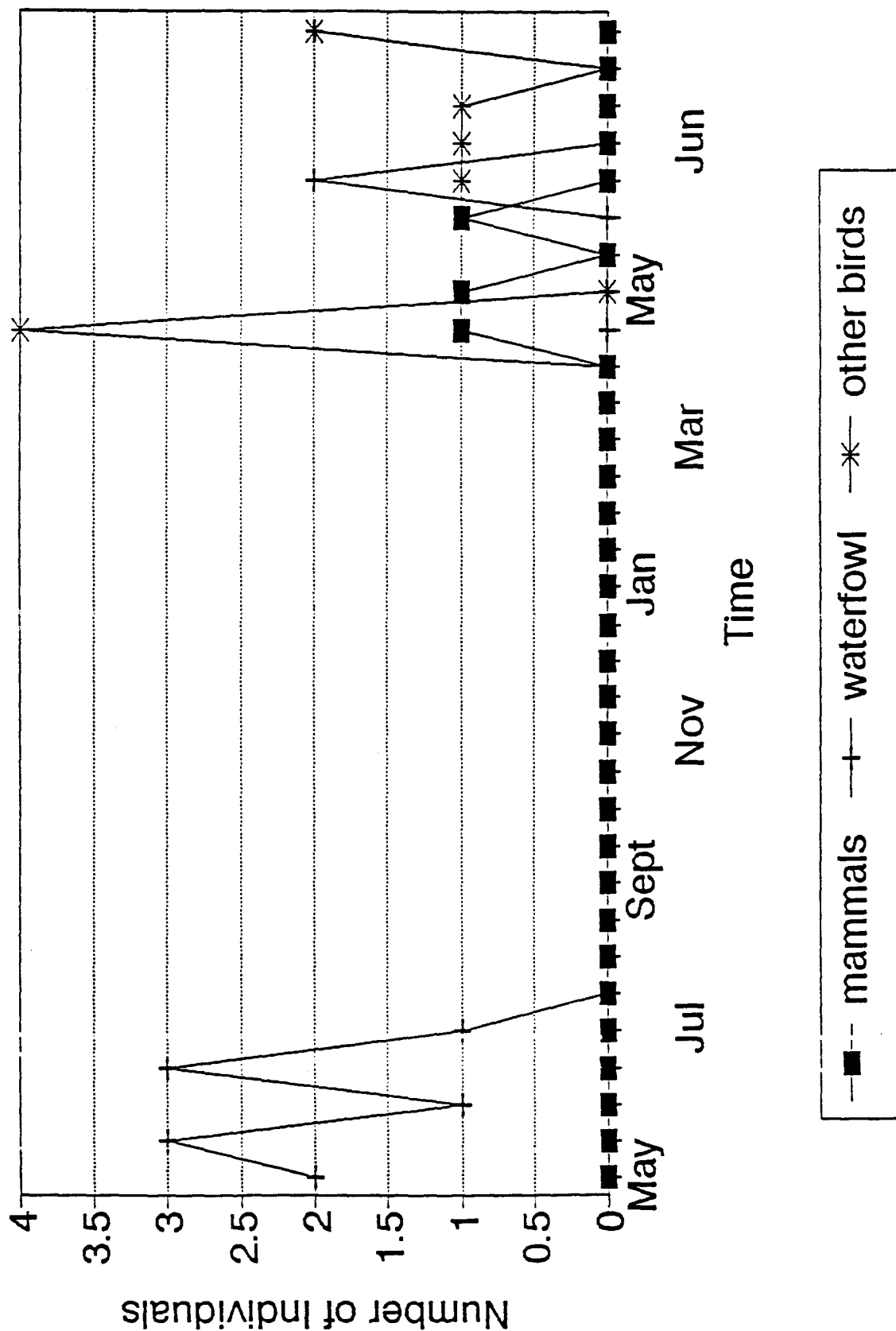


Figure 9.

Change in Number of Animals over Time

Basin F Spillover Pond

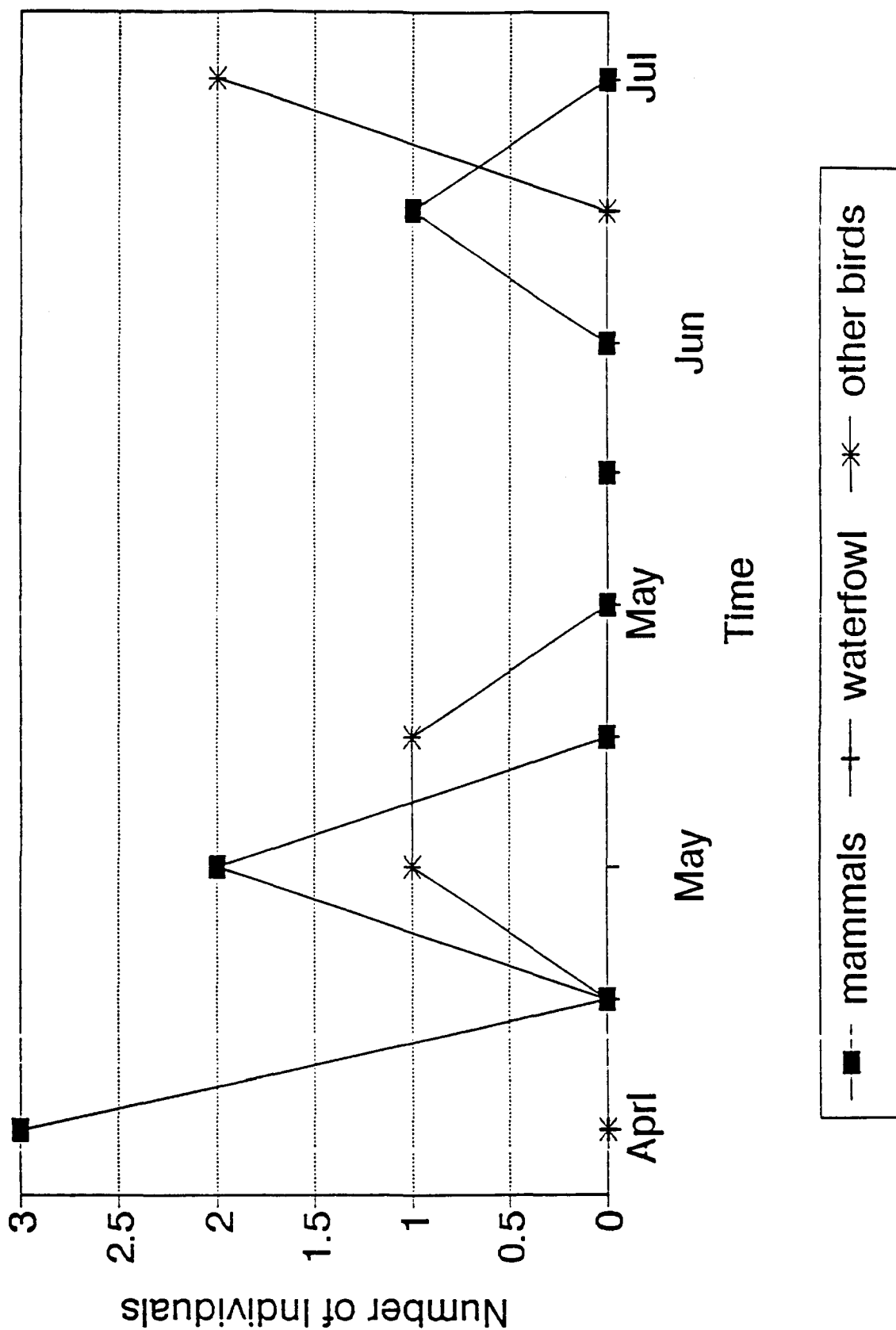


Figure 10.

Change in Number of Animals over Time

Basin F Storage Tanks

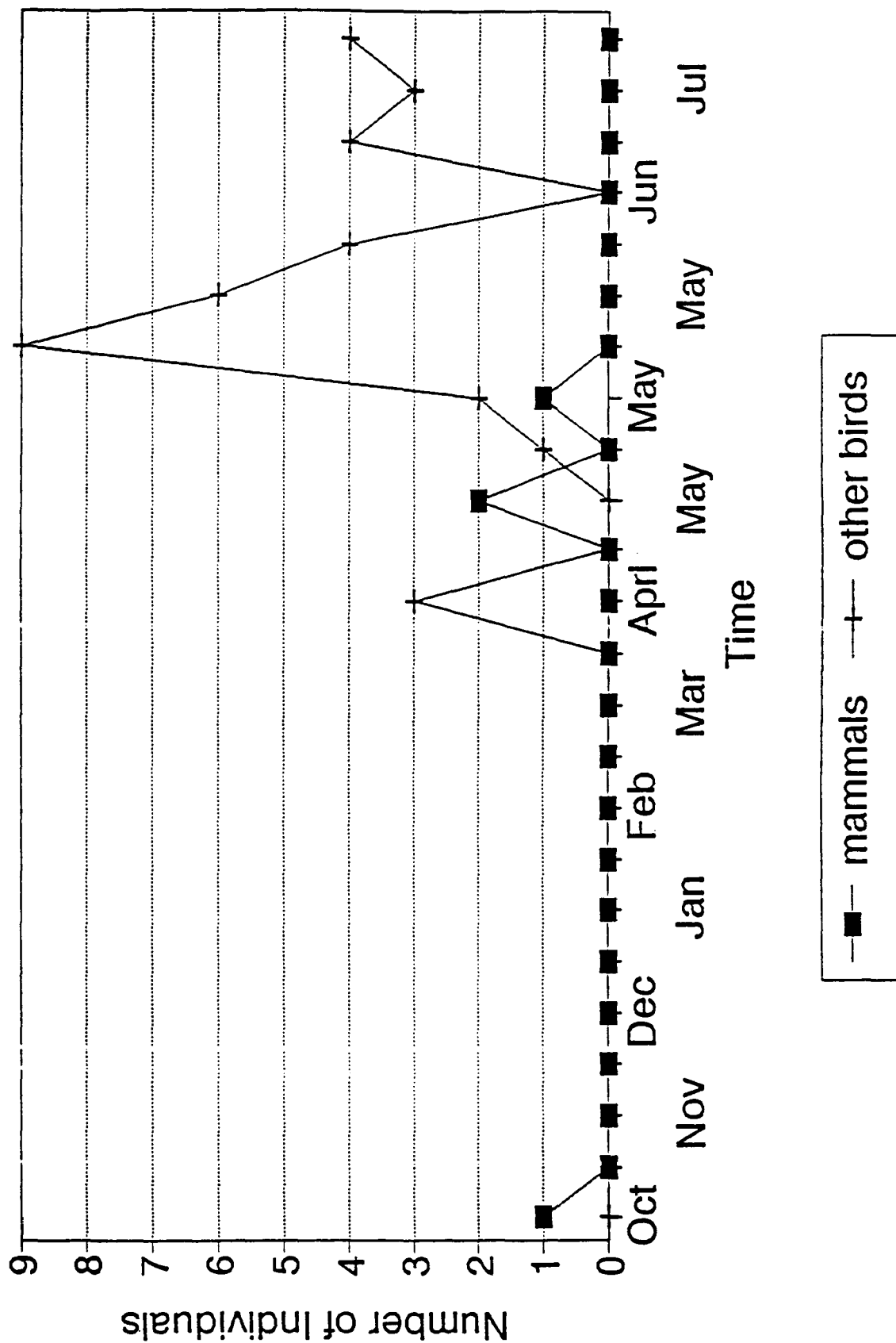
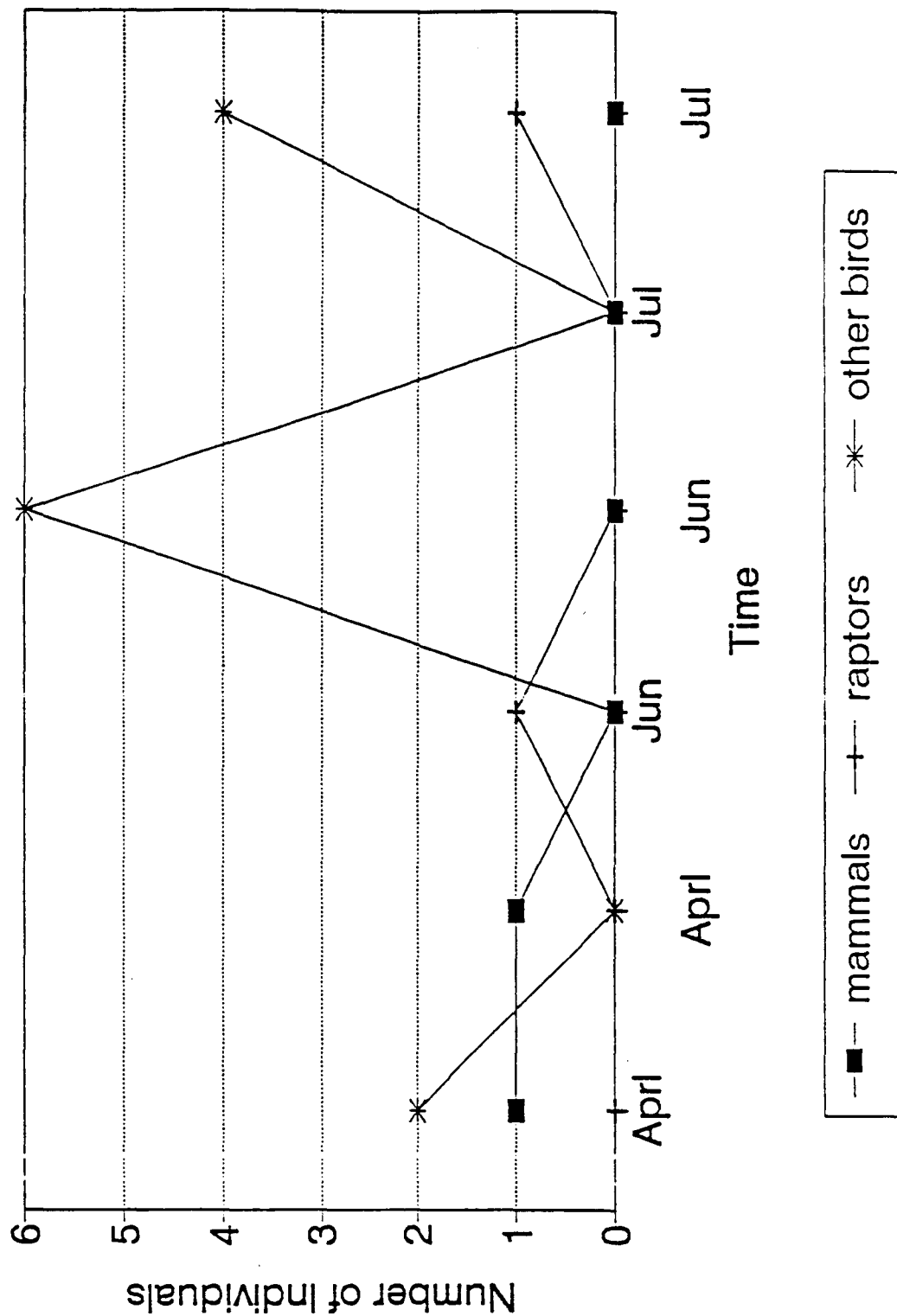


Figure 11.

Change in Number of Animals over Time Basin F Wastepile



TITLE: Community Relations Program at the Rocky Mountain Arsenal

PERSONNEL: Kathy Batha, Wildlife Biologist, USFWS, Rocky Mountain Arsenal (Promotional Outreach Coordinator)

Jeanette Lynn Bossong, Fish and Wildlife Biologist, USFWS, Rocky Mountain Arsenal (Environmental Education Specialist)

Carrie Dougherty, Biological Aid, USFWS, Rocky Mountain Arsenal

Jenna Dougherty, Biological Aid, USFWS, Rocky Mountain Arsenal

Jane Griess, Park Ranger, USFWS, Rocky Mountain Arsenal

David Jamiel, Park Ranger, USFWS, Rocky Mountain Arsenal (Volunteer Coordinator)

Lisa Langelier, Wildlife Biologist, USFWS, Rocky Mountain Arsenal (Supervisor)

Caroline Maclean, Park Ranger, USFWS, Rocky Mountain Arsenal (Environmental Education Specialist)

Carol Ann Moorhead, Wildlife Biologist, USFWS, Rocky Mountain Arsenal (Supervisor/Acting Supervisor)

INTRODUCTION

The Service established the Community Relations Section at the Arsenal in October, 1989 with the hiring of a Community Relations supervisor. In FY90, three staff members were hired to assist the supervisor. During FY91, there was some attrition of the original Community Relations staff; however with new hires, the section maintained an average of four fulltime employees throughout the year.

During FY90, the activities of the Community Relations Section consisted primarily of: wildlife bus tours; outreach presentations to school and civic groups; open house events, eagle viewing at the Eagle Watch blind; issuance of fishing permits, volunteer training; field dog trials; and wildlife calendar, poster and brochure development.

In FY91, the staff continued the programs that were initiated during FY90. In addition, new programs, plans and activities were developed in FY91, such as a hands-on environmental education program, fishing fun days for scouts and physically-challenged individuals, weekend nature walks, and a cooperative effort with Colorado Wildlife Federation on school outreach.

The goals of the Community Relations Section are to:

1. To educate the public about wildlife and natural resource issues.
2. To educate the urban public about their role in wildlife and environmental conservation.
3. To educate the public about the history of the Arsenal.
4. To publicize the efforts of the U.S. Fish and Wildlife Service at the Arsenal.

METHODS

1. Volunteer Program

The Community Relations Section is supported by an active group of volunteers who lead bus tours, nature walks, environmental education programs; staff the Visitor Center, Eagle Watch, and the Service office building (infrequently); and prepare for and assist during open house events. Currently, only one volunteer makes presentations to classroom and civic groups. Occasionally there are opportunities for community relations volunteers to assist biologists with field work.

At the end of FY90, there were approximately 30 active volunteers assisting the Community Relations Section. Recruiting and training volunteers are the primary jobs of the Volunteer Coordinator. In FY91 recruiting took place on an as-needed basis. Interviews were conducted with all volunteers and, each new volunteer was required to sign a Service volunteer agreement, and a U.S. Army release form, which releases the federal government from any liability for potential injuries or health problems associated with the Arsenal. All volunteers received either formal or on-the-job training.

2. Wildlife bus tours

Both the staff and seasoned volunteers conduct school and public tours. Tour buses were provided by the U.S. Army and almost all tours are given on double decker buses.

a. Schools

Bus tours are given to school children (grades 1-12) during the school week any time between 8:00 a.m. and 4:00 p.m., with the majority scheduled to begin between 8:30 a.m. and 12:30 p.m.. Length of the tours varies from one to two hours depending on the students' ages and attention spans. During the tour, the guide interprets the Arsenal's natural and cultural history, as well as the Army's clean-up operation. The tour also includes a stop at the Arsenal Visitor Center where the tour guide gives an overview of the Arsenal using site maps and displays in the exhibit room. Students view an 8-minute video that reinforces points made by the tour guide and elaborates on the Arsenal's history and wildlife issues.

b. Public

Bus tours are offered to the general public on Saturdays and Sundays. Tours for the general public are approximately two hours long, and include a stop at the Visitor Center. Tour schedules vary with the season and day length. Saturday tours are generally in the morning, except during the summer when they are scheduled in the evening to avoid mid-day heat. Sunday tours are generally offered in the early afternoon. During July and August of 1991, public tours were not offered. Morning nature walks were offered instead (see Section 6, Nature Walks).

c. Special Groups

The Community Relations Section also provides tours upon request, for senior citizen homes and organizations, civic groups and university classes.

3. Environmental Education Program

In August and September of FY91, plans were made for a two and one-half hour, hands-on environmental education program for metro-area schools, grades K-8. Due to limited space in the Visitor Center and to a small staff, the programs were scheduled for only Tuesday and Thursday mornings. The first program was offered on September 17, 1991. The theme of the environmental education program is "The Importance of Habitat". For children in grades 4-8, Service staff and volunteers emphasize the effects of urbanization on wildlife habitat, as well as the need for creative urban planning for wildlife. The program generally included a nature walk, wildlife lessons and Project Wild Games. Pre-visit and post-visit materials were developed specifically for the environmental education program.

In mid-August, "Take a Walk on the Wild Side" flyers, which advertised the program, were mailed to target area schools and schools that had already visited the Arsenal on bus tours. In the same mailing, Colorado Wildlife Federation (CWF) flyers were mailed. They advertised CWF's new Arsenal outreach program. (See Section 11, Cooperative Efforts, Colorado Wildlife Federation.)

The public relations objective of the environmental education program is to provide the area schools with an alternative to wildlife bus tours, which have been the only on-site school program at the Arsenal since October, 1989. Although the program objectives have not been formally identified, generally they are to increase students' awareness of wildlife; to increase students' appreciation for the importance of habitat to wildlife survival; to increase student's appreciation for creative planning for wildlife in cities; and to provide urban children with a positive outdoor experience.

4. Eagle Watch

Construction of the concrete Eagle Watch was completed by the U.S. Army in time for Bald Eagle Day on December 8, 1991. This observation blind overlooks a bald eagle communal roost site along First Creek, one of the most active winter roosts for bald eagles in eastern Colorado. Three spotting scopes and one pair of handicapped-accessible binoculars provide reasonable viewing of the eagles from a distance of 3/4 of a mile.

In September, 1991, plans to install a video camera near the primary roost tree were initiated. The camera will be operated from the Eagle Watch blind where two close-circuit television monitors will provide live, close-up viewing of eagles in their trees. The system will also have an audio component. The goal is to have the system fully operable by January 11, 1992, the date of Bald Eagle Day.

5. Outreach Presentations

In FY91 outreach presentations were offered to school and civic groups. The presentations consist primarily of an informal slide show about the Arsenal during which questions from the audience are encouraged. After the slide presentation, Service staff members pass around and discuss animal skulls and pelts, as well as bird nests found on the Arsenal. Most outreach presentations are made by Community Relations staff members.

In August and September of FY91, the Service and the Colorado Wildlife Federation combined efforts to expand outreach efforts about the Arsenal (see Section 11, Cooperative Efforts, Colorado Wildlife Federation).

6. Nature Walks

As an alternative to public bus tours, nature walks were offered during July, August and early September of 1991. These provided members of the public a chance to experience the Arsenal's resources directly. The nature walk experience began at approximately 7:45 when participants boarded the van at the West Gate. It included a stop at the Visitor Center where they viewed an 8-minute video about the Arsenal, an introduction to the Arsenal's history by their guide, and a two hour walk around the "quad", an area to the south of 6th St, between C and D streets.

7. Open House Events

The Community Relations staff organizes at least two open house events per year. They are jointly sponsored by the Service and the U.S. Army, with additional funding from Shell Oil Company. Open house events are designed to promote the Arsenal as a community resource for environmental/historical education and wildlife recreation. In FY91, two open houses were held: Bald Eagle Day and Prairie Dog Day.

8. Fishing Program

a. Issuing Fishing Licenses

Five hundred fishing permits are issued to the general public each March on a first come, first serve basis. All Arsenal permit holders must also hold a Colorado fishing license. Public permits cost \$20 and may be used by all members of the permit holder's immediate family. Additional permits are issued to active or retired military and/or Arsenal personnel at \$5 each, and to senior citizens and physically-challenged individuals at \$2 each. The Arsenal's lakes support an exceptional warm water fishery, but due to residual contaminants in lake sediments, only catch and release fishing is permitted.

b. Arsenal Anglers

Approximately twenty-five permit holders are members of the Arsenal Anglers, a club of avid anglers who occasionally assist the Service's fishery biologist in managing the Arsenal fishery. The club members also assist the Service's Community Relations staff by educating children about fishing and in sponsoring fishing events for the local community.

c. Fishing Fun Days

Between June and September, the U.S. Fish and Wildlife Service and the Arsenal Anglers jointly sponsored six fishing events, three for local scout troops and three for physically-challenged individuals. In preparation for the fishing events, all participating Arsenal Anglers took first aid and water safety courses. The ratio of adults to children for all events was approximately 1:2.

9. Field Dog Trials

Since the 1950s, the Colorado Hunting Dog Association has held field dog trials at the Arsenal. Typically, the trials are held in Sections 33, 34, 3 (east of the railroad tracks), and 9 (eastern side).

The Community Relations Section is responsible for scheduling the trials and meeting with representatives from the dog clubs prior to the event to inform them of safety regulations. In addition, the Community Relations staff periodically checks in during the event to ensure compliance with the regulations.

10. Promotional Materials and Publications

a. Wildlife Calendars

The objectives of the Arsenal wildlife calendar are to capture the public's attention, facilitate public interest in the Arsenal, and to educate the public about the Arsenal's wildlife and natural history. A secondary objective of the calendars is to inform the public about the history of contamination at the Arsenal and the current clean-up operation. The calendars are offered free of charge to the public.

b. Brochures

Brochures serve as promotional and educational materials for the general public. They are provided free of charge and are offered to the general public and school children at the Visitor Center, on tours, and through the mail if requested. In FY91, the

Service provided editorial assistance on new brochures and ran re-prints of old brochures.

11. Cooperative Efforts

The goal of cooperative efforts is to create partnerships and good working relationships with other agencies and organizations. Other reasons for collaborating with outside entities are to expand the educational efforts of the Arsenal, to increase the Service's ability to meet the demands of the public, to ensure the best quality of publications, and to ensure access to the most informed and talented professionals.

The Community Relations Section was involved in numerous formal and informal cooperative efforts in FY91. In FY91, the Service initiated informal cooperative efforts with Colorado Wildlife Federation and the Denver Audubon Society for work related to community relations. The Service, working with the Community Relations staff, initiated work with the Denver Museum of Natural History under a formal cooperative agreement and continued work with the Colorado Division of Wildlife, also under a formal cooperative agreement.

12. Media

Attention on the Service's Arsenal efforts boomed during FY91. Several programs or segments were either produced or aired during the year. Increased media attention from local, regional and national media is attributed in part to Congressional bills drafted by Representatives Patricia Schroeder and Wayne Allard in which they propose transferring the Arsenal property from the U.S. Army to the Department of the Interior for the establishment of a National Wildlife Refuge. Other reasons for increased media attention are the large open house events and the growing educational and recreational opportunities. The growing clean-up operation attracts media attention to the Army's and Shell Oil Company's efforts, and only indirectly to the Service's.

13. Visitor Center

The Arsenal Visitor Center is a multi-purpose facility used by the Service and the U.S. Army for in-house and public meetings, environmental education programs, open house events, and exhibit, video and slide viewing. The Service staffs the center with a Visitor Center manager, who is in

charge of scheduling meetings and programs in the Visitor Center, as well as all public and school programs for the Service.

RESULTS AND DISCUSSION

1. Volunteer Program

Four one-day/eight-hour training sessions were offered in FY91, during which 24 volunteers were recruited. Each training session covered techniques and logistics of the one of the primary Community Relations activities: guiding bus tours, leading nature walks, staffing the Eagle Watch, and staffing the Visitor Center.

Volunteers contributed 3,442 hours of service in FY91, the equivalent of one and a half FTE's. The Community Relations staff hosted a volunteer appreciation program and potluck dinner on April 18, 1991 at the Visitor Center. Awards were given to especially active volunteers.

Volunteer recruitment and training in FY91 were conducted on an as-needed basis. Plans were begun for an October/November docent (trained volunteer) training program. A formal docent training program is advisable for the future because it ensures that volunteers are provided all the information that the Service deems valuable, that each volunteer is receiving the same information, and that each volunteer is acquiring enough material to help them feel comfortable giving tours, etc. In addition, having a set time for training, docents assists the scheduling of work in the Community Relations Section.

2. Wildlife Bus Tours

In FY91, 14,000 school children and 7,000 members of the general public toured the Arsenal. Most tours stopped at the Visitor Center to view a video, the exhibits, and to pick up literature.

3. Environmental Education Program

Due to limited space in the Visitor Center and to a small staff, the Environmental Education programs were offered only on Tuesday and Thursday mornings. The first program was offered on September 17, 1991. During this time, 194 children and 20 adults participated in the program. By early October (FY92), all Tuesday and Thursday morning

openings for the environmental education program were booked through January of 1992.

4. Eagle Watch

Over 3,000 members of the general public visited the Eagle Watch in FY91 to view the eagles. This figure, does not count the nearly 5,000 people who visited the facility on the opening day, Bald Eagle Day (See Section 7, Open House Events)

5. Outreach Presentations

Community Relations staff members reached 3,000 students and citizens during FY91 by making presentations at schools and civic club meetings.

6. Nature Walks

During the summer, nature walks were met with varied success. Exact figures are not available because numbers of participants were unfortunately compiled with public bus tours. Participation varied between four and fourteen, with an average of about seven. Nature walks are likely to increase in popularity in the future as news of the walks spreads and with more publicity in the local press. It is advised that the Community Relations Section invites local journalists on a public nature walk.

7. Open House Events

In FY91, the Community Relations staff organized two open houses which were jointly sponsored by the Service and the U.S. Army, with additional funding provided by Shell Oil Company.

a. Bald Eagle Day

This event was held on December 8, 1990 to bring attention to the Arsenal's large wintering colony of bald eagles and to celebrate the opening of the Eagle Watch observation blind. Activities included a breakfast for dignitaries, an opening ceremony presided over by U.S. Representatives Patricia Schroeder and Wayne Allard, wildlife bus tours, eagle viewing, distribution of the 1991 Arsenal calendar, and games for children. Approximately 5,000 people attended the event.

b. Prairie Dog Day

This event was held on May 11, 1991 to celebrate the prairie dog's role in the grassland ecosystem and to draw attention to the continued and growing summertime opportunities at the Arsenal. The day's activities consisted of wildlife bus tours, nature walks, slide presentations by wildlife biologists, children's environmental education games, puppet shows, face painting, and a children's art contest for grades K-8. Prairie Dog Day attracted 2,000 people to the Arsenal.

8. Fishing Program

a. Issuing Fishing Licenses

On March 23rd, 503 fishing permits were issued to the general public. Considering that the public permits are family permits, and the average family size is four, the Service estimates that as many as 2012 people may have been fishing the Arsenal's lakes in FY91. In addition to the public permits, 143 permits were issued to military and Rocky Mountain Arsenal personnel, senior citizens and physically-challenged individuals.

b. Arsenal Anglers

The Arsenal Anglers held monthly meetings in FY91, all of which were attended by a Community Relations staff member and a Service fishery biologist. Late in the year the club members decided to have guest speakers at their monthly meetings. In addition, they voted to incorporate in order to gain tax-free status. Club members are active volunteers in the Fishing Fun Days and often purchase prizes for the winning participants. (See Fishing Fun Days below.)

c. Fishing Fun Days

During the summer months, three fishing days were held for local scout troops. A total of 42 boy and girl scouts participated in these events. In celebration of National Fishing Week, the Arsenal Anglers offered fishing lessons on June 8th to 15 Commerce City Boy Scouts, who fished Lake Mary. Another children's fishing fun day was held on July 13th when 16 Montbello Girl Scouts participated in fishing lessons and a fishing contest offered by Arsenal Anglers. Prizes, such as a rod and reel, fanny pack and lunch box cooler were purchased and awarded by the Arsenal Anglers. On September 28, 11 Green Valley Ranch Boy Scouts took fishing lessons from the Arsenal Anglers to earn their fishing badge. Because the badge requirements are lengthy, additional training was held indoors at the Visitor Center on September 25.

Three fishing events were also held for physically-challenged individuals from Craig Hospital. The Arsenal Anglers played an active role in the organization of these events. Thirteen physically-challenged people and approximately 30 hospital and family assistants enjoyed Fishing Fun Days in FY91. On July 29th, five Craig patients, accompanied by two hospital staff members and eight family members, fished Lake Mary from 4 p.m. to 8 p.m. Three of the patients were paraplegic and two were quadraplegic. One of the fishermen used a new fishing apparatus which allowed him to cast his line by blowing and to reel the line in by sucking. Five more physically-challenged patients from Craig Hospital enjoyed fishing on August 19th. They were accompanied by two staff members and 12 family members. On September 16, three wheelchair-bound individuals from Craig Hospital fished Lake Ladora.

9. Field Dog Trials

In FY91 field dog trials were held in March, April, May, September and October. Twelve events were held during the year and approximately 890 participants, 320 horses, and 600 dogs participated. The following dog clubs held trials: Skyline Brittany Club, Mile High Weimaraner Club, German Shorthaired Pointer Club, Colorado Pointing Dog Association, Rocky Mountain Pointing Dog Association, Irish Setter Club of Colorado, and the Northern Colorado Brittany Club.

10. Promotional Materials and Publications

a. Wildlife Calendars

Work on the 1991 wildlife calendar began in FY90 and was completed in FY91. It was available for distribution to the public on Bald Eagle Day, December 8, 1990. Cooperating sponsors included Shell Oil Company, National Fish and Wildlife Foundation, Denver Audubon Society, and U.S. Fish and Wildlife Service. Bob Rozinski and Wendy Shattil were the wildlife photographers and Wendy Shattil was contracted to ensure the design and production of the calendar. Initially, 25,000 calendars were printed. In March, 1991, an additional 10,000 were printed due to continued demand.

Planning for production of the 1992 wildlife calendar began in June FY91. The cooperating sponsors were the same as for last year's calendar. Representatives of each sponsor met regularly during the summer and fall

of FY91. They determined that the theme of the 1992 calendar would be the biology and natural history of various wildlife species at the Arsenal, with discussion of the studies that biologists have conducted or are conducting at the Arsenal. The Service calendar representative set up meetings/informational interviews with all Service, university (graduate students), and Denver Museum of Natural History biologists. The Community Relations Section provided consultation and editorial support.

b. Brochures

In September, 1991, the Service ran reprints on two Army publications that are popular with children, the Arsenal Coloring Book and "The Arsenal Story". During September, the Service also reprinted the "Bald Eagles at Rocky Mountain Arsenal" brochure. The Government Printing Office in Lakewood ran 10,000 of each publication.

In addition, during the summer of 1991 the Community Relations staff provided editorial support for the "An Eye on Progress" brochure jointly sponsored by U.S. Army, Shell Oil Company, and the Service.

11. Cooperative Efforts

a. Colorado Wildlife Federation (CWF)

In July of 1991, Shell Oil Company provided CWF with grant monies to hire an Arsenal outreach coordinator. Carrie Warren-Gulley was hired to produce a slide show about Arsenal wildlife and natural history for elementary school children. She has worked closely with the Service staff in co-developing and scheduling a "packaged" Arsenal program. The package includes a visit by Carrie to the elementary school classroom, distribution of her post-visit and our pre-visit materials, a tour of the Arsenal within two weeks of her outreach program, and the Service's post-visit materials.

b. Denver Museum of Natural History (DMNH)

The Community Relations staff served as primary contact on three projects funded by the U.S. Army and sponsored by the Service. Collaboration will continue for another two to three years, depending on the duration of each project. The projects are a video-documentary for use with the general public and school children; a comprehensive teacher's packet about the Arsenal's natural and cultural history for use in grades K-12; and a book about Eagles, as part of the DMNH's Wonder

series of natural history books for children (Appendix F). The Service wrote task plans for each project.

David Baysinger, Head of the DMNH audio-visual department, serves as the DMNH contact on the video-documentary; Carol Kampert, DMNH education specialist, serves as the writer and contact on the teacher's guide; and Betsy Armstrong, Head of DMNH Publications, serves as the lead on the eagle book.

c. Colorado Division of Wildlife (CDOW)

In 1989, the Service entered into a cooperative agreement with CDOW for their development of a series of reports on the potential for "watchable wildlife" interpretation, education and recreation at the Arsenal.

Rich Larson, Environmental Education Specialist for the CDOW's metro region office, was given the lead on the project. He formed a task force of approximately forty professional interpreters and planners from the Front Range to provide ideas, insight, consultation and professional review of the written reports. Four of the forty task force members are paid as authors of the reports. Service representatives were included on the task force. In FY91, task force members visited the Arsenal several times and gathered information pertinent to the four reports:

1. Final Report I (User Preferences for Wildlife Viewing at the Rocky Mountain Arsenal, Denver, Colorado.)
2. Final Report II (Interpretive Framework)
3. Final Report III (Educational Framework)
4. Final Report IV (Watchable Wildlife brochure)

d. Denver Audubon Society

In August of 1991, preliminary plans were made to collaborate with DAS on the production of Arsenal bird and mammal species lists for the general public with records of sightings, including the season of occurrence.

12. Media

The Arsenal received extensive coverage from both print and broadcast media during FY91. The following list constitutes the year's media highlights:

Coverage of Bald Eagle Day -- Denver Post, Rocky Mountain News, local radio and television stations 2, 7 and 9.

CNN "Toxic Earth" three-part series -- aired twice during week of May 5, 1991
Coverage of Prairie Dog Day -- Denver Post, Rocky Mountain News, KOA radio, television stations 2, 7 and 9.
Coverage of Fishing Fun Day for physically-challenged individuals on September 16, 1991 -- Rocky Mountain News
Buzzworm: The Environmental Journal -- volunteer recruitment notice and photograph of mule deer and south plants
Numerous articles in the Rocky Mountain News and Denver Post, as well as the Fort Collins Coloradoan about Schroeder's and Allard's wildlife refuge bills and the September 9th Congressional hearing in Denver.
Western Outdoors July/August 1991 issue -- article about the Arsenal

13. Visitor Center

Several changes and additions to the Visitor Center had a positive influence on the Community Relations program at the Arsenal.

- a. The Denver Audubon Society (DAS)
DAS contributed \$4,280 worth of equipment and materials to the Visitor Center, including reference books, binoculars, spotting scopes, and a desktop computer and printer.
- b. Exhibits
The eagle display case, produced by Creative Productions, was completed, with the installation of three eagle mounts produced by the Denver Museum of Natural History and addition of snow to the display floor.
- c. Data management system for public programs
In September, 1991, a new data management system was programmed on the Visitor Center computer. Ed Hendrickx, one of our most active community relations volunteers and owner of a office management consulting firm, devised and entered the system. The system summarizes all tour and program information by date, school or group name and school district. In addition, it provides the staff with a monthly breakdown of adult and child visitors to the Eagle Watch, on school and public tours, on environmental education programs, and at presentations to school and civic groups.

TITLE: Activities Management the Arsenal

PERSONNEL: Gregory J. Langer, Fish and Wildlife Biologist,
U.S. Fish and Wildlife Service, Rocky Mountain
Arsenal.

J. Chris Cole, Fish and Wildlife Biologist, U.S.
Fish and Wildlife Service, Rocky Mountain Arsenal.

Scott Peltier, Wildlife Biologist, U.S. Fish and
Wildlife Service, Rocky Mountain Arsenal.

INTRODUCTION

During March of 1991, an Activities Management Program was established at the Arsenal. The program's purpose is to minimize conflicts between, and help ensure safety of, all Arsenal employees, contractors, and other entities, and minimize cleanup impacts to Arsenal fish and wildlife resources. This program is described in detail in "Activities Policy and Procedures for Rocky Mountain Arsenal" (See Appendix D). The Service was given responsibility to implement activities management at the Arsenal. Implementation involved development of a mapping system to coordinate all Arsenal activities on a weekly basis. A standardized reporting format was also developed for Arsenal entities to disclose proposed activities. The U.S. Army compliance office approves each weekly schedule, provides activity conflict resolution, and assists in the preparation and distribution of weekly schedules. Activities management was conducted on a weekly basis from March through September, 1991.

METHODS

A flexible mapping system was developed utilizing the Services of Tentime Mapping, Inc. located in Denver, Colorado, to plot all contractor activities on a weekly basis. Each week the map is modified to reflect current status of activities for the preceding week, reviewed to ensure minimum conflicts exist, and distributed at the weekly Arsenal Contractor meeting. A standardized format for describing activities was developed. All Arsenal contractors and entities planning to conduct field investigations on the Arsenal are required to return a completed form one week prior to the onset of field work. The one week notice period allows Activities Management personnel adequate time to review proposed field work for compliance conflicts.

Activities occurring within the Bald Eagle Management Area (BEMA) are regulated by Activities Management personnel. Between October 15, 1991 and April 15, 1992, access to lands within the BEMA is minimized to reduce impacts to the wintering bald eagle population on the Arsenal. BEMA access is coordinated on a daily basis with

Activities Management personnel. Magnetic cones that are attached to vehicle hoods are distributed to Arsenal contractors to who have coordinated their activities with Activities Management personnel.

RESULTS AND DISCUSSION

During the week of March 11, 1991, the first activities coordination map was produced for the Arsenal. The map system has gradually evolved into its current "stand-alone" status. However, more detailed descriptions of specific Arsenal activities can be found in the daily schedules which are attached to each map.

Activities Management responsibilities have been shared with the Army Compliance Office. Throughout most of 1991, one Army personnel and one Service personnel operated and maintained the Activities Management system. The U.S. Army has incorporated Activities Management into the Arsenal Emergency Contingency Plan.

In general, Arsenal contractors have accepted the new process and compliance with activities management (sufficient notification) is acceptable. All contractors are required to attend the weekly contractors meeting in which anticipated field activities are discussed for the upcoming week.

Activities Coordination will continue in the future, and will help ensure that coordination needs are met as both remediation and wildlife management activities increase.

TITLE: Water Resources and Sport Fishery Management on the Arsenal.

PERSONNEL: Gregory J. Langer, Fish and Wildlife Biologist, USFWS, Rocky Mountain Arsenal

Bruce D. Rosenlund, Project Leader, Colorado Fish and Wildlife Assistance Office

John Miesner, Fishery Biologist, USFWS, Rocky Mountain Arsenal

Eric Zink, Biological Technician, USFWS, Rocky Mountain Arsenal

INTRODUCTION

Although Arsenal Lakes and aquatic resources are identified individually in Service management elements, this report will address 1991 aquatic management collectively.

The management objective for the Arsenal sport fisheries is to support the fishing pressure of 650 permitted anglers per season. Anglers should catch an average of 0.5 to 1.0 fish per hour of effort, from a fishery that is primarily supported by natural reproduction of warmwater fishes.

Management objectives for the four south lakes include the maintenance of a high quality sport fishery, through the monitoring of fish population characteristics in relation to angler use and success. Management will include minimizing water level fluctuations, managing human activity to allow the most public use while minimizing wildlife and fishery habitat destruction around the lakes. Management efforts will functionally and aesthetically enhance Lake Mary, Lake Ladora and Lower Derby Lake areas to maximize the fishery and promote wildlife viewing opportunities. Upper Derby Lake will be managed to minimize wildlife use of the area, and provide maximum flood protection by keeping the lake dry as called for in the Arsenal Water Management plan.

General objectives for water resources on the Arsenal are to monitor the quantity and quality of existing water resources on the Arsenal. Additionally, propose additional wetland development sites, and protective management strategies for existing wetlands and aquatic resources on an ongoing basis.

Due to the presence of contaminants in Arsenal fish populations, all legal consumptive harvest of Arsenal fish ended by the late 1970's. The management of the Arsenal as a quality urban catch-and-release fisheries has resulted in waters that are dominated by larger than average predator fish species.

Lake Mary. Lake Mary was dredged in 1975, and the lake stocked with cutthroat trout (Salmo clarki) to provide a catch-and-kill fisheries. Unfortunately, trout were found to readily absorb high levels of dieldrin and the stocking of catchable trout was deleted by the direction of the Service Regional Director in 1977. Bass introduced here by anglers grew slowly from 1979 to 1985, and have remained relatively small through 1991 (Rosenlund 1991).

Ladora. In 1970, Ladora was dominated by small bass and bluegill (Lepomis macrochirus), with black bullhead (Ictalurus melas) numbers expanding during the 1970's. To control bullheads and increase sport fishing opportunities, northern pike (Esox lucius) were introduced by the early 1970's. Under catch-and-release regulations, the populations of pike and largemouth bass (Micropterus salmoides) in Ladora expanded and reached their maximum average size in 1982. After 1982, the number of forage fish species declined along with the average size of bass and pike (Rosenlund, 1991). Although the average length of bass and pike (as measured by standard gill net sets) has declined since 1982, quality and trophy sized bass and pike caught in Ladora maintains the quality fishing reputation of the Arsenal.

Lower Derby. Common Carp (Cyprinus carpio) dominated Lower Derby in 1979, but aquatic vegetation was common and the water clarity was acceptable most of the year. Catch-and-release regulations (and the introduction of pike) resulted in an expansion of pike and a reduction of carp by 1982. However, in 1982, the water level of Lower Derby was reduced to a minimum pool to allow repairs to the dam. Reducing the water level of Lower Derby to a minimum pool reduced the aquatic plant population, and combined with the presence of carp, resulted in the reservoir being turbid since 1982 (Rosenlund 1991). The water level of Lower Derby was severely reduced again in 1990 for dam repairs, and resulted in additional impacts to the vegetation and fish populations. Lower Derby Lake re-opened to catch-and-release fishing during 1991, following the completion of the dam renovation project starting in 1990.

METHODS

PERMIT SALES

As in previous years, anglers were issued permits on a first come first served basis, beginning on March 23, 1991. However, this year applicants were allowed to wait in line in their cars at the south gate, rather than standing in line outside. Children under the age of 14 were allowed to fish with a parent or guardian. The cost of a permit increased from \$15.00 to \$20.00 in 1991, and up to two adults from one family were allowed to fish on one paid permit. Arsenal anglers are required to have a valid State of Colorado Fishing License in addition to their Arsenal angler permit.

ANGLER SURVEY

The roving clerk creel survey method (Malvestuto 1983) was used to estimate angler hours, and the distribution of angler use on lakes Mary, Ladora and Lower Derby.

ANGLER SUCCESS

Angler success includes fish catch rates, percent of the catch, and size and species of fish caught. The modified Colorado Fish and Wildlife Assistance Office creel survey form was used during 1991.

ANGLER SATISFACTION AND EXPERTISE

Angler satisfaction and expertise was evaluated during creel survey by asking the completed-day anglers' if they are "satisfied" with the number and length of fish caught, and if they are satisfied with their overall fishing experience at the Arsenal. The anglers are also asked if they consider themselves as, inexperienced, experienced or expert anglers.

FISH POPULATION ASSESSMENT

Gillnet

Experimental mesh, monofilament and multifiliment gill nets were set in standardized locations within lakes Mary, Ladora and Lower Derby. Gill net population assessment was used to compare 1991 trends to previous years at standard gill net sampling sites. Sites established in 1977 through 1990 were utilized during 1991. In order to minimize fish mortality, standardized gill net sets were shortened from overnight to 3 to 4 hour long night sets.

Electrofishing

Electrofishing population assessment was completed in 1991 using equipment purchased in 1990. Night electrofishing was conducted using a boat mounted Coffelt Mark X electrofisher and 5,000 watt generator with a single boom and 12" sphere anode. Two standardized 15-minute electrofishing stations were established in Lakes Mary, Ladora, and Lower Derby.

Small Seine

Small seine sampling was conducted on 2 October 1991 in Lakes Mary, Ladora, and Lower Derby. Two passes were made through lake Mary and Lower Derby with a 15' X 6' X 0.25 inch ace seine. Lake Ladora required 6 passes to achieve a representative sample. Standardized sites were established in 1991, and will be repeated in future years.

FISH POPULATION STUDIES

Ladora Northern Pike Study

To determine the total number of pike in lake Ladora and the number of times per year each pike is caught, pike were caught in trapnets (fyke-nets) and tagged with white Floy "cinch-up" tags during March of 1990, and again in 1991. Tags were individually numbered and labelled "Please Release". Anglers were asked to report floy tag numbers when a tagged fish was caught. Tag return data were analyzed both from trapnet recaptures and angler tag reports.

Because of the poor angler tag report success experienced in 1990, and algae growth problems, Floy "Cinch-Up" tags were replaced with "Pit" tags. During 1991, all electrofished pike and bass larger than 250 mm were implanted with a PIT tags on the left side of the abdomen just behind the pelvic fin.

Fisheries Graduate Research Project

The Structural Diversity Indices Graduate Research project is ongoing. A brief summary can be found in the Results section, and the 1991 Annual Report is attached (Appendix).

MOUTH CONDITION OF ARSENAL FISH

The 1990 pike and bass mouth condition study was continued in 1991. Mouth condition was evaluated prior to the 1991 fishing season. Pike and bass were caught in trapnets during March of 1991. Mouth Condition was based on a scale of 0 to 3 (0 - no hook marks, 1 = 1 mark, 2 - multiple hook marks, 3 - torn mouth parts and/or secondary infection).

FISH STOCKING

To provide additional angling opportunities during the spring of the year, Snake River cutthroat trout from the Leadville National Fish Hatchery were stocked in Lake Mary in March 1991. Tiger muskies reared at the Gavins Point National Fish Hatchery were introduced in Lower Derby to control carp and provide an additional sport species. To provide biological control of aquatic vegetation, diploid grass carp were purchased from a commercial hatchery and stocked into Lake Mary during 1991.

AQUATIC VEGETATION

Aquatic Vegetation Management

During 1991, vegetation was controlled by physical and biological means. Since many of the Arsenal anglers complained about the vegetation and the vegetation conflicted with children and handicapped fishing programs, areas near the fishing docks were cleared with weed cutters pulled by a boat.

For biological control of aquatic vegetation, 105 grass carp eight to 11 inches in length were stocked into Lake Mary on 26 September 1991.

Aquatic Vegetation Monitoring

Standardized vegetation transacts were completed on 18 July 1991. Transacts were run using a boat mounted Lawrence X-1 chart-recorder to monitor current aquatic vegetation levels. These charts will be compared to those completed in the mid-80's.

AQUATIC RESOURCES SAMPLING PROGRAM

In order to determine the quantity and quality of existing Arsenal water resources several new aquatic areas were sampled in 1991. Standardized sites and methodology was developed to facilitate future sampling of these sites.

First Creek

Five sites along First Creek (Figure 1) were sampled starting upstream of where First Creek enters the east side of the Arsenal to where it leaves the Arsenal on the north. Sample sites that were not well defined by existing land marks were marked with USFWS Carsonite stakes. First Creek sampling was conducted using the Fisheries Operational Planning System (FOPS) methodology developed by the Colorado Cooperative Fishery Research Unit at Colorado State University (Bergersen and McConnell 1978). Fish populations were sampled using dip nets and overnight sets of unbaited minnow traps. Fish habitat was also evaluated using FOPS methodology.

Storage Yard Pond

An overnight experimental mesh gill net set in the washed-out Storage Yard Pond was sampled on 30 September 1991. A single pass of an experimental mesh gillnet was seined through the storage yard pond. Additionally, two 20 foot passes with a small ace seine (15' X 6' X 0.25") were completed in the pond.

Havana Street Pond

Havana Street pond was sampled on 1 October 1991, using a single experimental mesh gillnet set overnight.

AQUATIC HABITAT MANAGEMENT

Lower Derby Lake

Due to excessive turbidity levels, Twenty tons of hay were purchased to be spread in Lower Derby lake. Lower Derby dam construction has increased the amount of habitat in the lake.

RESULTS AND DISCUSSION

PERMIT SALES

During 1991, 646 Arsenal angler permits were issued (503 public permits, 45 Senior Citizen and Handicap permits, 41 Arsenal employees and 57 military personnel). Total permit sales increased by 44 during 1991. It is interesting to note that although permit sales did not start until 0700 on 23 March, the first applicant arrived at the south gate at 1200 on 22 March. More detailed information regarding permit sales is available in the Community Relations Program report, Section E-1.

ANGLER SURVEY AND ANGLER SUCCESS

The Arsenal fishing season extended from 3 April to 14 October 1991. 548 angler contacts were made during the 1991 roving creel clerk data collection work. Volunteers from the Arsenal Anglers Fishing Club assisted with the collection of creel survey data. The Arsenal Lakes successfully supported 646 permitted anglers of fishing during 1991.

Angler Hours. Based upon interviews of 216 Arsenal anglers who had completed their fishing day, Arsenal anglers expended an average of 2.69 hours per day in 1991. This compares to an average Arsenal angler day of 2.75 hours based upon the 1990 CSU Arsenal Angler Use Study (unpubl. data). During 1991, the average length of an Arsenal angler day varied between 1.38 to 2.99 for the three lakes fished at the Arsenal during 1991 (Table 1-3). During 1991, data on Arsenal angler use and success, 548 Arsenal anglers were interviewed using the Colorado Fish and Wildlife Assistance Office creel census format that was modified for the Arsenal by Daryl Jennings and Greg Langer. The 1990 CSU Arsenal Angler Use Study (unpubl. data), and other urban military fisheries studies have shown that the average permit results in about 12.5 days of fishing each year. Based upon the sale of 646 permits and a average of 2.69 hours per angler day, it is estimated that Arsenal anglers expended a minimum of 21,722 hours fishing at the Arsenal in 1991.

However, since up to two adults per family were allowed to fish on one permit at the Arsenal in 1991, the average of 12.5 fishing days per permit may no longer be valid, and more than 21,722 anglers hours may have occurred at the Arsenal during 1991. In 1992, it is recommended that if a spouse of a paid permit holder be issued a "spouse" permit to obtain a true number of adult anglers permitted to fish at the Arsenal.

Distribution of Angler Use. Based upon the distribution of the people interview during the 1991 creel census program, the distribution of angler use on the Arsenal lakes was 8% for Lower Derby, 33% for Mary and 59% on Ladora. This results in use rates

of 17, 164 and 1,024 angler hours per surface acre for Lower Derby (100 acres), Ladora (67 acres), and Mary (7 acres) during 1991. The average angler hours per surface acre for Colorado is about 500, but most urban military fisheries receive 2,000 to 5,000 angler hours per surface acre when managed for put-and-take trout (Rosenlund pers. comm. 1991).

ANGLER SUCCESS

Mary. Lake Mary anglers caught an average of 3.12 fish per hour that averaged 6.85 inches in length. Bluegills represented 66% of the catch, bass 15% of the catch, and trout provided 15% of the angler catch in 1991 (Table 1). Trout had not been stocked into Lake Mary since the late 1970's, but were stocked in 1991 to provide angling opportunities from April through May when cold water temperatures limits the catchability of most warmwater species. During April, the average catch rate was 3.46 fish per hour, with Snake River cutthroats providing 76% of the fish caught.

Ladora. Arsenal anglers caught an average of 1.54 per hour warmwater fish species from lake Ladora during 1991, compared to an average of 0.67 per hour in 1990. Bass represented 24% of the fish caught, with 22% of the bass exceeding 15 inches in length. Northern Pike represented 9% of the catch, with 54% of the pike caught exceeding 25 inches in length. Bluegills represented 67% of the fish caught from Ladora during 1991 (Table 2).

Ladora Largemouth Bass. Lake Ladora anglers caught an average of 0.27 bass per hour in 1990, and 0.36 bass per hour in 1991. Based upon a total estimated angler hours of 14,804 hours in 1990 and 12,816 hours in 1991, Arsenal anglers "recycled" 3,997 bass in 1990, and 4,613 bass during 1991.

Although bass abundance was not established, an average Colorado lake carrying capacity should be near 60 pounds of bass per acre. If bass average 1.5 pounds per fish, bass abundance would be near 40 per acre or (78 acres x 40 per acre) 3,120 catchable bass in Ladora. If the total catchable bass population is near 3,120, and 4,613 were caught in 1991, each bass in Ladora could have been caught an average of 1.47 times during 1991.

Lower Derby. Since about 1982, construction projects have significantly reduced the water level of Lower Derby and the quality of the fisheries. Lower Derby was open to angling in 1991, with anglers catching an average of 2.54 fish per angler hour. Bass represented 95% of this fish caught, but less than 5% of the bass exceeded 15 inches in length. Pike represented the remaining 5% of the fish caught, with 66% of these fish exceeding 25 inches in length (Table 3).

ANGLER SATISFACTION AND EXPERTISE

As with most urban military fisheries, anglers using the Arsenal were highly satisfied with the overall sport fishing program at the Arsenal during 1991 (Table 4). Although the overall satisfaction appears low for Lower Derby, the 66% satisfaction level is based upon a sample of only nine anglers who had completed their fishing day. This compares to over 200 completed day anglers interviewed at the other lakes.

The average Arsenal angler ranked themselves as the most experienced anglers using military fisheries within Colorado, (Rosenlund, 1991) with an average angler expertise ranging from 1.99 to 2.43 (1.0 = inexperienced, 2.0 = experienced, 3.0 = expert). This attribute probably stems from the rareness of warmwater catch and release fisheries in the State of Colorado, and the long term dedication of the anglers to this fishery.

Possibly because of the high expertise level and high expectation of the Arsenal anglers, the overall satisfaction of Arsenal anglers with "length" and "numbers" of fish caught is below that expressed for most urban military and National Park fisheries, although the size and number of fish caught per hour is unique and well above average.

FISH POPULATION ASSESSMENT

Gillnet

Gillnet results for 1979 through 1991 are shown in Table 5. Lake Mary bass have remained fairly small through 1991. The trout stocking may act as an additional forage fish for bass, and if grass carp reduce overall vegetation levels, escape cover for bluegills will be reduced. Lake Ladora bass and pike average sizes have decreased over the last year, however quality fish continue to exist. Lower Derby continues to have an extremely large carp population. Efforts to reduce this population include the addition of hay to increase water clarity, and the stocking of tiger muskies (Esox lucius X masquinongy) as an additional predator species.

Electrofishing

Electrofishing results for Lakes Mary, Ladora, and Lower Derby are shown in Table 6. In most cases, the results very similar to those obtained with gillnets. Electrofishing will be conducted in 1992 for future trend analysis. Electrofishing was not conducted on Lower Derby lake due to equipment problems.

Small Seine

Small seine results for Lakes Mary, Ladora, and Lower Derby are shown in Table 7. Small haul seine sampling of Lake Mary on 2 October 1991, indicated that bluegill are now reproducing well in

Mary, and the bass population should improve in the future. Small seine sampling of Ladora caught few fish as would be expected for a fish population that is dominated by older predator fish species. Due to the lower numbers of adult predator fish species in Lower Derby, and the cover provided by the limited amount of aquatic vegetation, small seine sampling showed excellent recruitment of young fish during 1991.

FISH POPULATION STUDIES

Ladora Northern Pike Study

History: During 1990, about 150 Northern pike >400mm were tagged from 13 March 1990 to 31 March 1990 in Lake Ladora. From 20 March to 31 March 18% of the tagged pike were recaptured. If 18% of the pike population was tagged, the total pike population is 833 pike >400mm in length. Average length of pike tagged was 593mm. Although all anglers did not report the percent of tagged pike caught, reliable anglers reported from 25% to 50% of pike caught from Ladora were tagged. If 18% to 50% of the population was tagged, the total pike population is roughly 300 to 833 pike >400mm in length. The average Arsenal pike weighed 1250 g (2.75 lbs). If 300 to 833 pike exist in lake Ladora, total pounds of pike per surface acre range from 11 to 29 pounds and numbers between 3.8 to 10.7 pike per surface acre.

Ladora anglers reported catching 0.08 pike per hour in 1990 and 0.13 pike per hour in 1991. Based upon overall Ladora angler hours of 12,816 to 14,804 hours in 1991, approximately 1,184 to 1,666 pike were caught during 1990 and 1991. With a pike estimate of 300 to 833 pike, each Ladora pike would have been caught 2.0 to 5.5 times during 1991.

Arsenal anglers reported that 10 to 40% of the pike they caught were tagged in 1991. However, tag numbers are not reported because algae growth makes them difficult to read. The exception to this rule was tag 03333, which was released by four different anglers during 1991. Pike 03333 was also caught during the March 1991 tagging work. Four of the pike tagged in March 1990 were remeasured in March 1991, and revealed an average annual growth of 51 mm, over a range of 0 to 89 mm. The one pike that did not grow was noted as injured when captured in 1990.

Although the present pike estimate has wide range (300 - 833 pike) due to a limited sample size, the high number of times each pike was caught each year, demonstrates the importance of angler fish handling technique required for the long term survival of this fishery.

FISHERIES GRADUATE RESEARCH PROJECT

The Structural Diversity Indices Graduate Research project is

ongoing. Sonic transmitters were implanted into 10 northern pike and 10 largemouth bass. Twenty-four hour tracking was completed on a monthly basis throughout 1991. The computerized sonar equipment for measuring structural diversity was developed by the Cooperative Fishery Research Unit during 1991 and will be utilized in 1992.

MOUTH CONDITION OF ARSENAL FISH

The mouth condition of Ladora pike and bass are being evaluated to determine the effects of sport angling on fish. During 1990, 89% (124/140) of the pike captured in traps showed no visible impacts from the previous years fishing. During 1991, of six bass and 62 pike examined, 84% of the fish showed no sign of hooking damage. Eleven fish did show some hooking damage, one fish had a single hook mark, eight fish showed multiple hook marks and two fish had torn mouth parts.

FISH STOCKING

Catchable Snake River cutthroat trout and surplus rainbow broodstock were stocked in Lake Mary in March and May 1991, to increase the angler success rates early in the year. Few of the eight to nine inch trout survived past June, but several of the rainbow broodstock were captured during the 17 June gill net survey. Attempts were made to feed the trout at the handicapped fishing ramp, but the trout never re-established their hatchery feeding habitats after stocking into Lake Mary.

To help control the carp population, 750 tiger muskies near 50 mm in length from Gavins Point National Fish Hatchery were stocked 22 May 1991.

AQUATIC VEGETATION

Aquatic Vegetation Management

Although chemical means of controlling aquatic vegetation was strongly considered, no chemical control of vegetation was completed in 1991. One hundred five diploid grass carp were stocked in Lake Mary to reduce aquatic vegetation levels and increase angler accessibility. Mechanical removal of aquatic vegetation occurred twice on both Lake Mary and Lake Ladora around the fishing docks.

The maintenance of high water levels in Lake Ladora (resulting from Lower Derby dam construction) may have influenced aquatic vegetation levels. Necessity of vegetation control was evaluated during 1990. Anglers surveyed reported mixed results, some anglers desire high density vegetation because it concentrates fish, and "reduces the number of fishermen on the lake". However, other anglers dislike dense vegetation because of the difficulties encountered attempting to cast and retrieve fishing lures.

Twenty tons of Hay is scheduled to be spread in Lower Derby during 1992, which will increase water clarity, and hopefully increase aquatic plant growth.

Aquatic Vegetation Monitoring

Mary. Although about 300 grass carp near four inches in length were introduced into Lake Mary to control vegetation in the mid-1980's (Rosenlund pers. comm. 1991), there appears to be as much, or more vegetation present on 18 July 1991, as on 20 July 1984 (Figure 2). Most likely, the grass carp stocked in the 1980's were too small in size, and were removed by the large bass population.

Ladora. Vegetation transects conducted on Lake Ladora during the 1990 season showed a reduction in overall vegetation quantity from 1984. Vegetation heights appear similar between July 1984 and 1991, although there appears to have been more vegetation extending east from the dam in 1984. In both July 1984 and July 1991, no vegetation was present in the narrow inlet neck (Figure 3).

Lower Derby. Drawing down the water of Lower Derby had dramatically reduced the amount of aquatic vegetation by 1984. Because of the high turbidity, there was little vegetation growth and there was little difference between the 20 July 1984 and 29 November 1984 transects. Although Lower Derby was partially de-watered in 1990, and refilled early in 1991, vegetation to one foot in height is evident over most of the bottom in the 18 July 1991 transect (Figure 4).

AQUATIC RESOURCES SAMPLING PROGRAM

First Creek

Six sites (Figure 1) were sampled using dip nets and overnight sets of un-baited minnow traps, after electrofishing was found to be inefficient. Overall, the best habitat of First Creek exists on the east side of the Arsenal, with aquatic habitat generally declining downstream. Where First Creek enters the Arsenal, the channel is lined with trees and provides the best pool habitat and cover found on the Arsenal. Downstream, First Creek has been channelized and lacks well established trees. At the north boundary, First Creek has been recently channelized, and represents the worst habitat conditions found during the survey.

Although there is a wide variation in the quality of stream habitat, only two fish species - fathead minnows (Pimephales promelas) and brook sticklebacks (Culaea inconstans) - were found in the stream sample sites (Table 8). Two other fish species - carp and green sunfish (Lepomis cyanellus) - were found in the Storage Yard Pond that is technically part of First Creek. However, the Storage Yard Pond provides habitat that does not exist elsewhere on First Creek.

Storage Yard Pond

The over-night experimental mesh gillnet caught two carp (231-248 mm) in 16 hours, and a 145 mm green sunfish was caught in a single pass of a gill net seined through the pond.

Two passes with a 0.25 inch ace seine caught 69 fathead minnows and three sticklebacks. The ratio of fatheads to sticklebacks caught while seining was similar to that observed in other sections of First Creek.

Leafypond weed (Potamogeton foliosus) was the dominate plant species, covering about 20% of the south portion of the pond. Coontail (Ceratophyllum demersum) was present, as were limited amounts of American pondweed (Potamogeton americanus).

Havana Street Pond

Although the habitat appeared somewhat favorable to fish on 1 October, only Tiger Salamanders (16) were captured in the gill nets. The water level of this pond fluctuates considerably, with no rooted aquatic vegetation present. This area could have potential for sport fishing if the water level was stabilized, with channel catfish fingerlings to be stocked at the rate of 100 per surface acre in 1992.

AQUATIC HABITAT MANAGEMENT

Lower Derby Lake

Concerns of oxygen depletion, potentially caused by decomposing hay, has delayed the spreading until April of 1992. The addition of hay should cause flocculation of suspended sediment colloids, causing them to drop out of the water column and increase water clarity (Boyd 1979).

Lower Derby dam underwent reconstruction during 1990. Tree root systems throughout the dam caused it not to meet State Engineer standards. The newly reconstructed dam face is protected by rubble (8" - 12") and may offer a significant amount of habitat to a lake in which habitat is minimal.

ACKNOWLEDGEMENTS

Special thanks should be given to members of the Arsenal Anglers Club who helped collect creel census data during 1991.

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Table 1. Lake Mary Creel Survey data, Rocky Mountain Arsenal, 1991.

Number of interviewed anglers	Total Hours fished	Ave. # fish hour	Ave. length (inches)
182	301.98	3.12	6.85

Table 2. Lake Ladora Creel Survey data, Rocky Mountain Arsenal, 1991.

Number of interviewed anglers	Total Hours fished	Ave. # fish hour	Ave. length (inches)
323	804.91	1.54	8.68

Table 3. Lake Lower Derby Creel Survey data, Rocky Mountain Arsenal, 1991.

Number of interviewed anglers	Total Hours fished	Ave. # fish hour	Ave. length (inches)
43	48.78	2.54	N/A

Table 4. Angler satisfaction, expertise, fish per hour and average fish length reported at Rocky Mountain Arsenal, 1991.

Area	Percent Satisfied			Average Expertise	Fish/ Hour	Average Length (")
	Number	Length	Overall			
Mary	71.5	68.4	96.9	1.99	3.12	6.85
Ladora	66.5	63.7	89.0	2.25	1.54	8.68
L. Derby	66.6	44.4	66.6	2.43	2.54	11.07

Table 5. Gillnet sampling results on Arsenal Lakes Mary, Ladora, and Lower Derby, 1991.

MARY	TROUT		BASS		BLUEGILLS	
YEAR	Ave Ln	Kg/net H	Ave Ln	Kg/Net H	Ave Ln	Kg/Net H
1979	279	0.22	170	0.02	0	0
1982	0	0	219	0.13	0	0
1985	0	0	268	0.14	178	0.04
1990	0	0	321	0.07	115	0.03
1991	620	1.63	263	0.34	119	0.15

LADORA	PIKE		BASS		BULLHEADS	
YEAR	Ave Ln	Kg/net H	Ave Ln	Kg/Net H	Ave Ln	Kg/Net H
1979	615	0.29	323	0.11	260	0.800
1982	793	1.77	383	0.20	273	0.31
1985	754	0.42	284	0.10	283	0.25
1990	705	1.60	361	0.54	144	<.01
1991	657	2.2	318	0.81	NS	0.0

LOWER DERBY	PIKE		BASS		CARP	
YEAR	Ave Ln	Kg/Net H	Ave Ln	Kg/Net H	Ave Ln	Kg/Net H
1979	541	0.35	347	0.27	459	2.45
1982	568	1.35	401	0.05	513	0.93
1985	703	0.97	399	0.09	378	0.66
1990	691	3.60	0	0	497	7.33
1991	567	0.26	331	0.22	530	1.69

Table 6. Electrofishing sample results from Lakes Mary and Ladora, Rocky Mountain Arsenal, 1991.

MARY	LARGEMOUTH BASS			BLUEGILL			CHANNEL CATFISH		
YEAR	#	Ave Ln	Kg/Net H	#	Ave Ln	Kg/Net H	#	Ave Ln	Kg/Net H
1991	10	296	4.76	109	119	4.4	1	510	1.28

LADORA	PIKE			LARGEMOUTH BASS			BLUEGILLS		
YEAR	#	Ave Ln	Kg/Net H	#	Ave Ln	Kg/Net H	#	Ave Ln	Kg/Net H
1991	1	575	1.08	22	235	7.92	325	104	19.6

Table 7. Small seine sampling results from Arsenal Lakes Mary, Ladora, and Lower Derby lakes, 1991.

Species	Number	Ave Length (mm)	Range (mm)
MARY			
Bluegill	9	12.4	10.0-17.3
Bass	10	7.7	5.5-14.9
LADORA			
Bluegill	2	5.7	5.5-6.5
Bass	5	10.3	5.5-11.5
LOWER DERBY			
Bluegill	77	5.5	3.5-7.5
Greensunfish	5	6.5	4.0-6.95
Bass	33	9.8	6.5-15.9

Table 8. Summary of First Creek sampling data using FOPS habitat methodology, Rocky Mountain Arsenal, 1991

	Tower Road	Station 1	Station 2	E Street	Dewatering Bridge	Station 3
Date	7-9-90	9-30-91	9-30-91	10-1-91	10-1-91	10-1-91
Velocity	--	.44	.96	--	--	.53
CFS	1.0	1.06	.50	--	--	.95
Temp	63F	54F	62F	--	--	65F
Hiding	Poor	Good	Poor	--	--	Poor
Substrate	Fine	Gravel	Fine	Gravel	Gravel	Gravel
Width	9.0	12.4'	5.92	--	--	12.25'
X Depth	.70	.679'	.467'	--	--	.55'
2' Pools	1	2	0	--	--	1
% Cling Veg.	75	0.0	40	0	50	90
% Rooted Veg	35	30	0	80	10	10
FISH #						
Fathead	23*	10	3	121	195	13
Stickleback	8*	1	1	10	1	0
Crayfish	0*	13	4	8	2	2
Variation	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
% Bank Eroded	15	15	5	--	--	5

* Based on electrofishing a 300' segment of stream.

NOTE:

1. Hiding, Flow Variation, and Substrate results are based on F.O.P.S. Methodology.
2. Fish catches are based on average catch per minnow trap set overnight, unbaited.

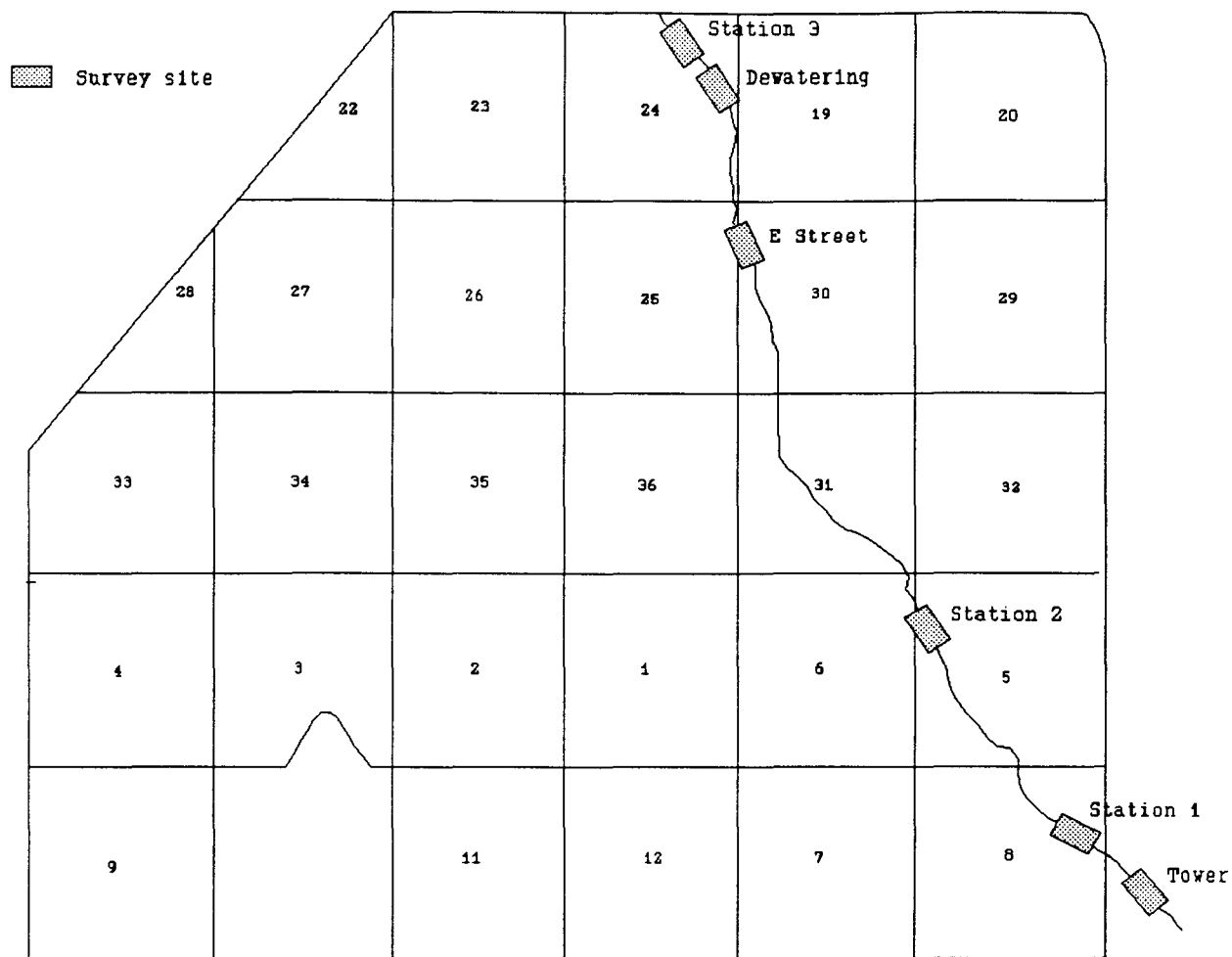
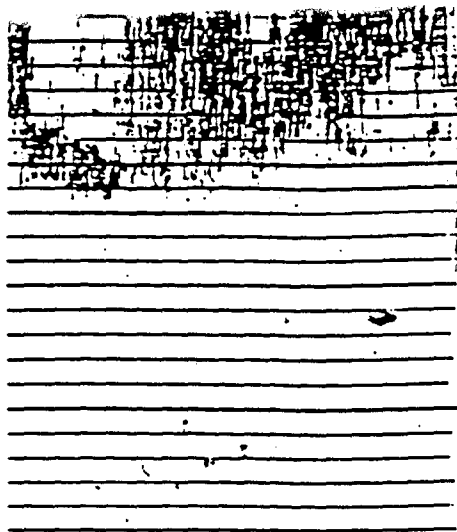


Figure 1. First Creek sampling locations using FOPS methodology on Rocky Mountain Arsenal, 1991.



20 July 1984



7 November 1985

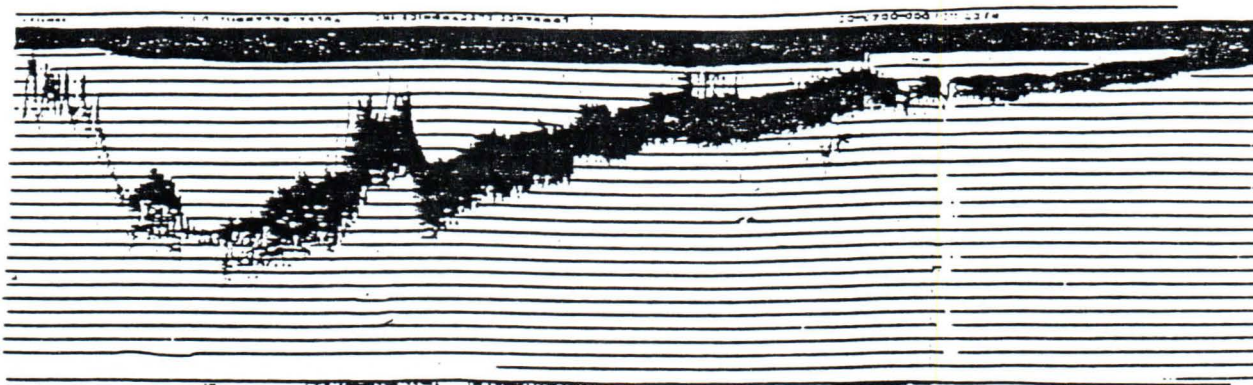


18 July 1991

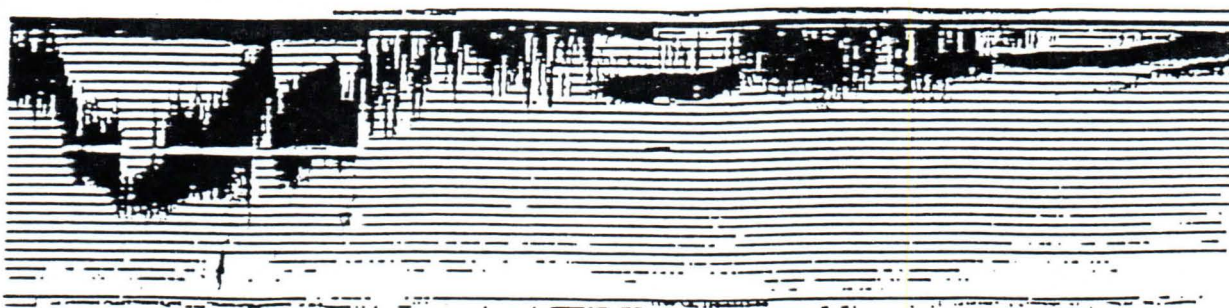
Figure 2. Sonar Transacts of Lake Mary, Rocky Mountain Arsenal, 1984-1991.



20 July 1984

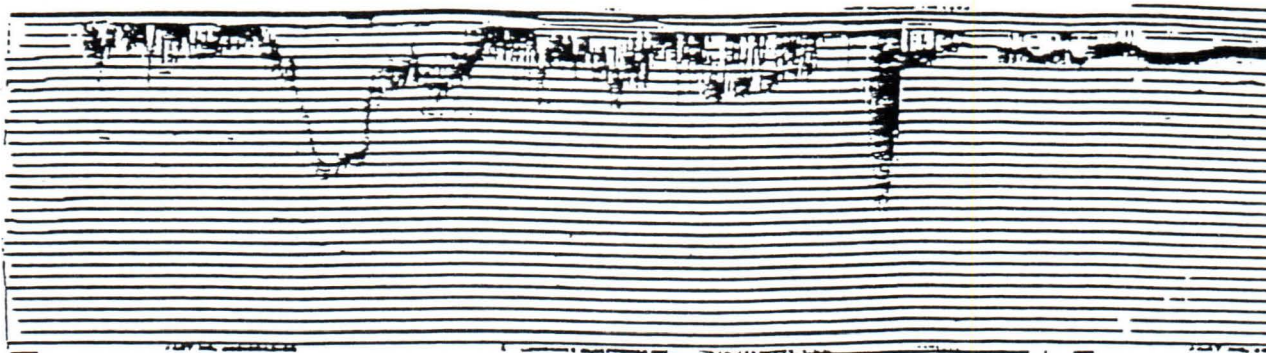


1 November 1990



18 July 1991

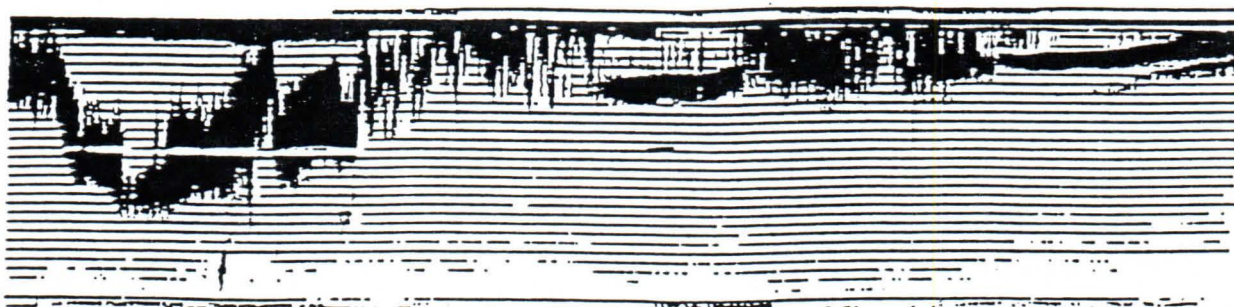
Figure 3. Sonar Transacts of Ladora, Rocky Mountain Arsenal, 1984-1991.



20 July 1984



1 November 1990



18 July 1991

Figure 4. Sonar Transacts of Lower Derby, Rocky Mountain Arsenal, 1984-1991.

TITLE: Bald Eagle Investigations

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INTRODUCTION

A bald eagle communal roost site was first identified on First Creek along the eastern side of the Arsenal in December 1986 (Environmental Science and Engineering, Inc. 1988). This communal roost is classified as "essential habitat" for recovery of the species under the Northern States Bald Eagle Recovery Plan (U.S. Fish and Wildlife Service 1983). Concerns over the effects of various development and cleanup activities on this wintering population led to the initiation of an intensive three year study by the Service and funded by the Army, City and County of Denver, State of Colorado (Department of Highways) and E-470 Authority. While actual work on this cooperative study was completed in 1990, additional work has occurred on the bald eagles. Wintering bald eagle population levels, contaminant levels, and changes in activity areas and prey uses were monitored during FY91 to determine changes associated with increased human development and habitat restriction on the Arsenal. Data collected during the three year study is presently being analyzed and the final report prepared. The final report should be available during FY92. This report covers roost count data from 1987 through 1991 and other work conducted on bald eagles at the Arsenal during FY91. All data presented here are preliminary.

METHODS

Telemetry Study

During FY91 bald eagles were trapped and instrumented with radio transmitters. Eagles fitted with transmitters were intensively tracked through much of the winter to determine key habitat use areas, specific foraging areas, and responses to cleanup

activities. All birds trapped were banded, measured, weighed, and had blood samples collected.

Roost Counts

Since 1987 the Service has conducted evening roost counts to determine the population level and population age structure of the eagles using the Arsenal roost. Roost counts began from mid-October to early November and continued through March each year.

During the winters of 1987-88 and 1988-89 roost counts were conducted an average of every four days. During the winters of 1989-90 and 1990-91 roost counts were conducted a minimum of every other night. Observers arrived at the assigned viewing location two hours before sunset and remained there until it was too dark to see. Binoculars and spotting scopes were utilized for counting birds. The direction the eagle came into the roost, the time the eagle came into the roost, the age of the eagle (i.e. adult or sub-adult), and whether or it was a instrumented eagle (i.e. received a telemetry signal or wing notched) were recorded for each eagle observed.

Food Manipulation Study

The Service was granted authority by the Colorado Division of Wildlife (CDOW) to collect big game road kills in the CDOW Central Region. County highway maintenance offices and sheriffs' departments offices were asked to report road kills to Service staff. Carcasses were either stored in the Service's storage freezer trailer or placed directly at the manipulation site. Supplemental food consisted primarily of deer (white-tailed and mule) carcasses, elk, fish (carp and/or kokanee salmon), and other miscellaneous carcasses when available.

Three manipulation sites were established during the winter of 1990/91. Two of these sites were located near the lakes, while the other was placed behind the toxic storage yard in section 31 (Figure 1). An electric fence was installed around the site in section 31 to prevent coyote use of the carcasses.

The supplemental food was placed at preselected areas after sunset. Fish were distributed every two days. Deer carcasses were placed once a week at each location. Other mammal carcasses were placed when available. The number and type of supplemental food items was recorded when placed at site.

Casual observation of bald eagle responses were documented during daylight hours on Mondays and Wednesdays. On Fridays, 4 observations were made every 2 hours. To minimize any disturbance to the birds, biologists observed the feeding stations with binoculars and spotting scopes from a vehicle approximately 1/4 mile from the manipulation location.

RESULTS AND DISCUSSION

Telemetry Study

During FY91 seven bald eagles (i.e. two juveniles and five sub-adults) were trapped and instrumented with radio transmitters. Approximately 50 hours of tracking were conducted on four of these birds. The remaining two instrumented eagles either moved out of range or their transmitters failed.

Roost Counts

There has been a steady increase in the number of bald eagles using the Arsenal roost over the last five years. During the winter of 1986-87 a high of 21 bald eagles was recorded (ESE 1988). During 1987-88 the high number observed increased to 26 eagles (Figure 2). During 1988-89 the high number observed increased to 30 (Figure 3). During the winters of 1989-90 and 1990-91 38 bald eagles were recorded which is the greatest high to date (Figure 4 and 5). The peaks occurred from early to late January in all five years probably related to local/regional weather conditions. During the coldest winter periods the number of eagles using the Arsenal roost may increase because the Arsenal provides a protected site with abundant prey. This behavior has been reported by a number of researchers (Hansen et al. 1980 and Keister et al. 1987). The relationship between weather, roost use, and prey availability will be evaluated in the final report of The Denver Cooperative Bald Eagle Study.

Sub-adult bald eagles have constituted a decreasing percentage of the eagle roost population over the last five years (Figure 6). This may be an indication that possible growth in the regional (i.e. Denver area front range) population is decreasing. A population that is growing will generally have more young eagles than a declining population (Stalmaster 1987). However, the percentage of sub-adults observed during the first two years was much higher than has been recorded for other populations (Fraser 1981, Harmata 1984, and Keister 1981). Also, prey availability (i.e. greater prairie dog numbers) observed during 1986-87 and 1987-88 was much greater than that observed during the last three years (Ebasco 1989, ESE 1988) (see prairie dog section this report). This decrease in prey availability may have contributed to the decrease in the percentage of sub-adults eagles using the Arsenal roost. It has been reported that sub-adult bald eagles roost in locations close to easily available food sources (Keister 1987) and the numbers of sub-adults observed may fluctuate in relation to prey availability (Knight 1981, Stalmaster 1976). A more complete evaluation of these relationships will be included in the final report of the Denver Cooperative Bald Eagle Study.

Manipulation Study

A total of 33 reports of road killed ungulates consisting of 34 deer and 4 elk were received. Seven deer could not be located upon arrival, or the carcass was unsalvageable.

Supplemental feeding began at the Section 31 location 17 November, 1990; at Lower Derby in Section 1 on 5 December, 1990; and at Lake Ladora in Section 2 on 14 January, 1991. Food items were placed 57 times from 17 November, 1990 to 17 March, 1991. Bald eagle usage observations were made during 40 days of monitoring.

Eagle numbers increased on the Arsenal during the last few days of December and peaked the last two weeks of January. The maximum number of bald eagles feeding at the Section 31 feeding station was 20 (18 January, 1991) while the Lower Derby Lake station had a high of 11 (1 January, 1991). Eagles utilizing the manipulation stations declined dramatically during March.

Feeding at the Lower Derby station was stopped after 3 February due to an early ice-off. High water levels prevented food from being placed along the shoreline.

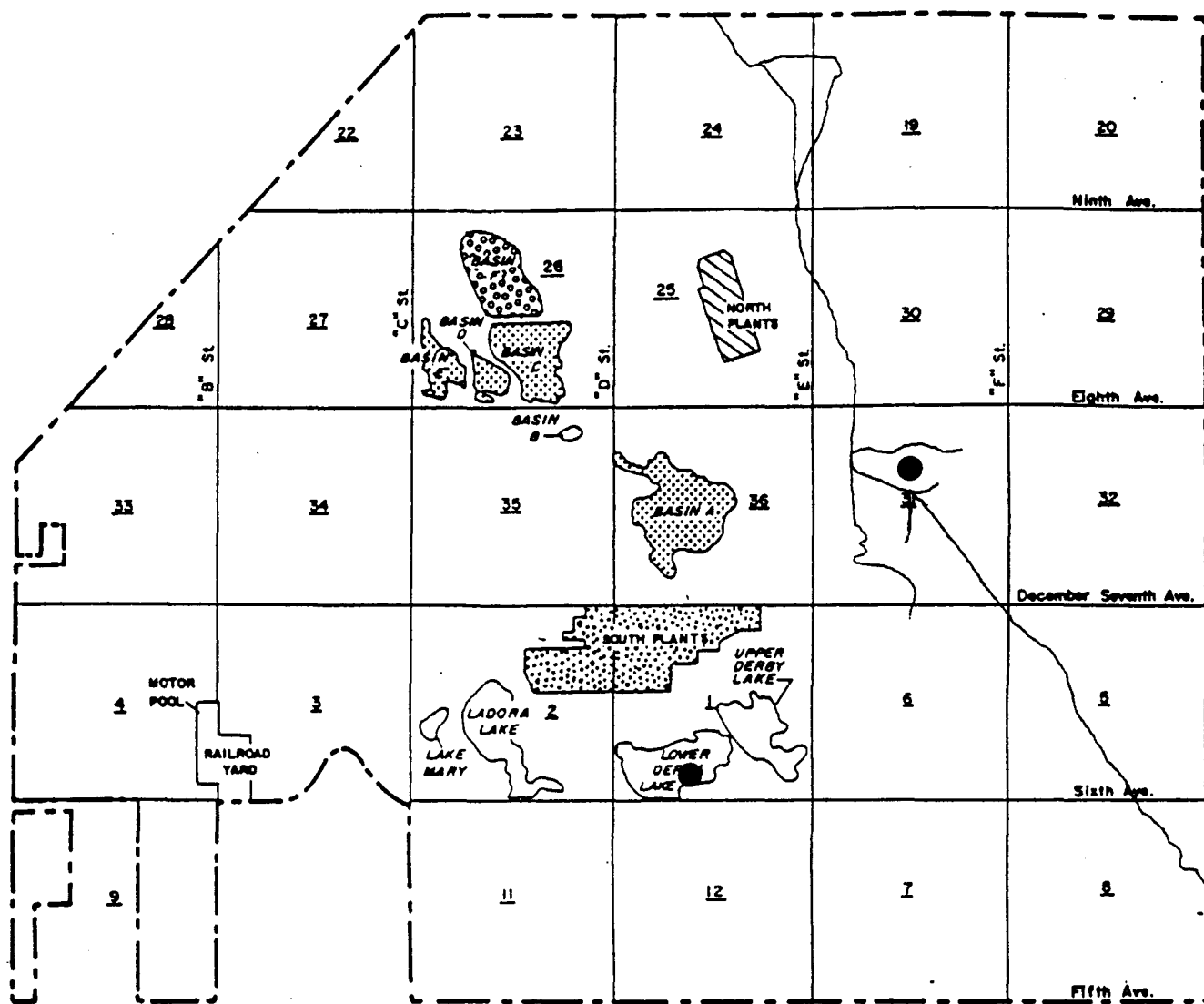
Bald eagles did not initially utilize all of the feeding stations. The Lower Derby station was used almost immediately, possibly because this site was the same site used in the 89-90 season. The eagles appeared to have remembered previous supplemental stations, perching near Section 30 and only started using the new Section 31 feeding station after high numbers of eagles began using the Arsenal's communal roost. Bald eagles switched to using Section 31 station after the Lower Derby feeding was stopped, however some birds continued to use the area for loafing. Eagles never used the Lake Ladora site, possibly due to lack of adequate perching sites near the site. Preliminary results from roost counts appear to show eagles may have altered wintering habits staying longer at the Arsenal than previous years before supplemental feeding practices were initiated.

The electric fence placed around the section 31 site proved to be useless in preventing coyote use of the deer carcasses. Evidently the dense thick fur of the coyotes insulate them from more than just the cold weather. However, bald eagles continued to use these sites just the same.

Results from this study indicate that bald eagles readily adapt to available food placed in areas with adequate perch sites and minimum human disturbance. Most likely the presence of magpies at these manipulation areas act as signals to foraging eagles. Once discovered by the eagles these sites are used almost indefinitely during the time the eagles winter on the Arsenal.

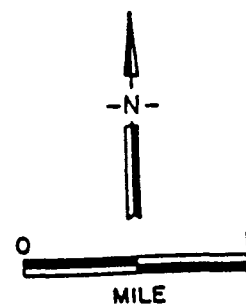
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● Manipulation Site

Figure 1. Bald eagle manipulation sites at the Arsenal during the winter of 1990-91.



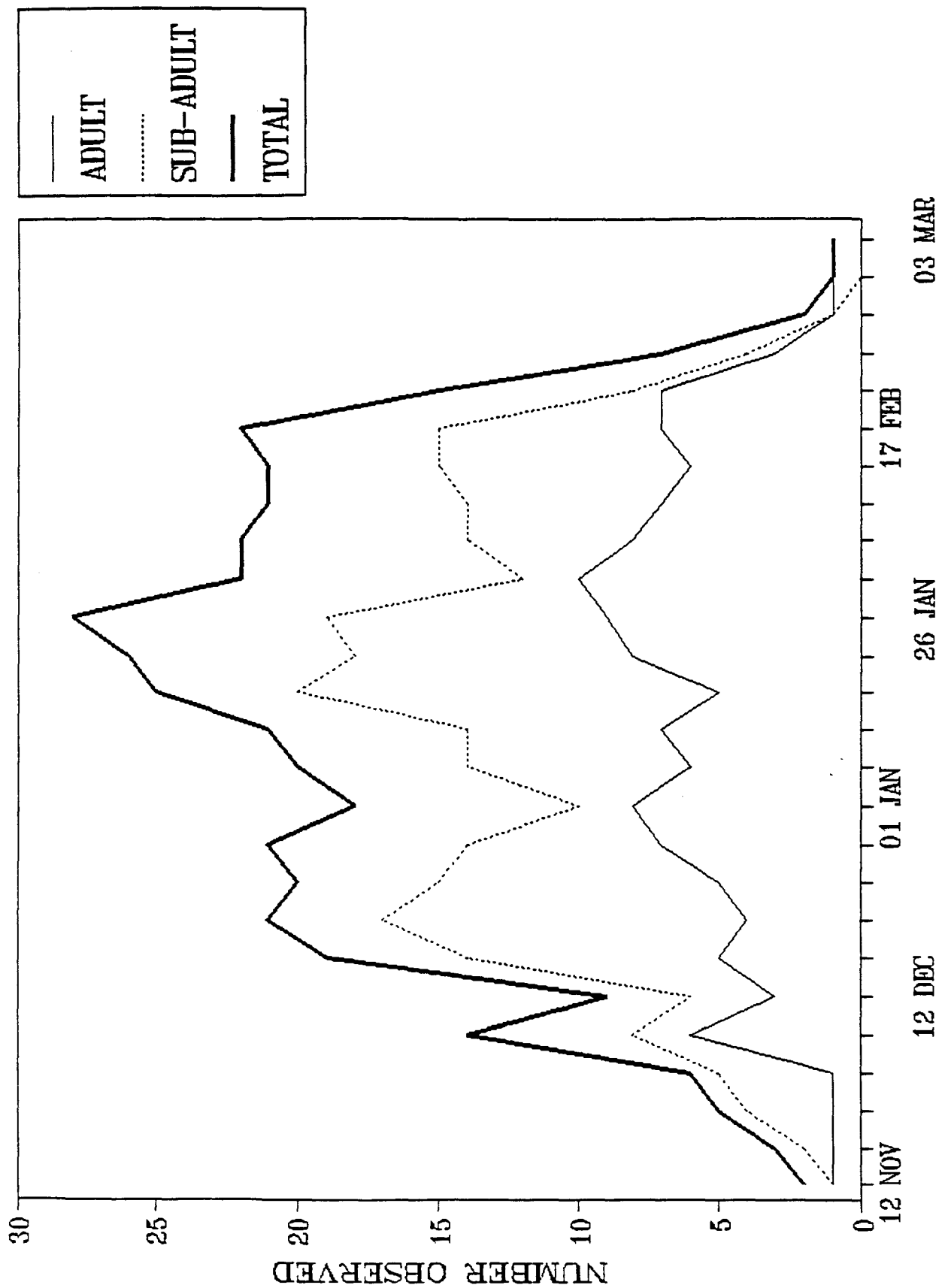


Figure 2. The number of bald eagles observed on the Rocky Mountain Arsenal communal roost during the winter of 1987-88.

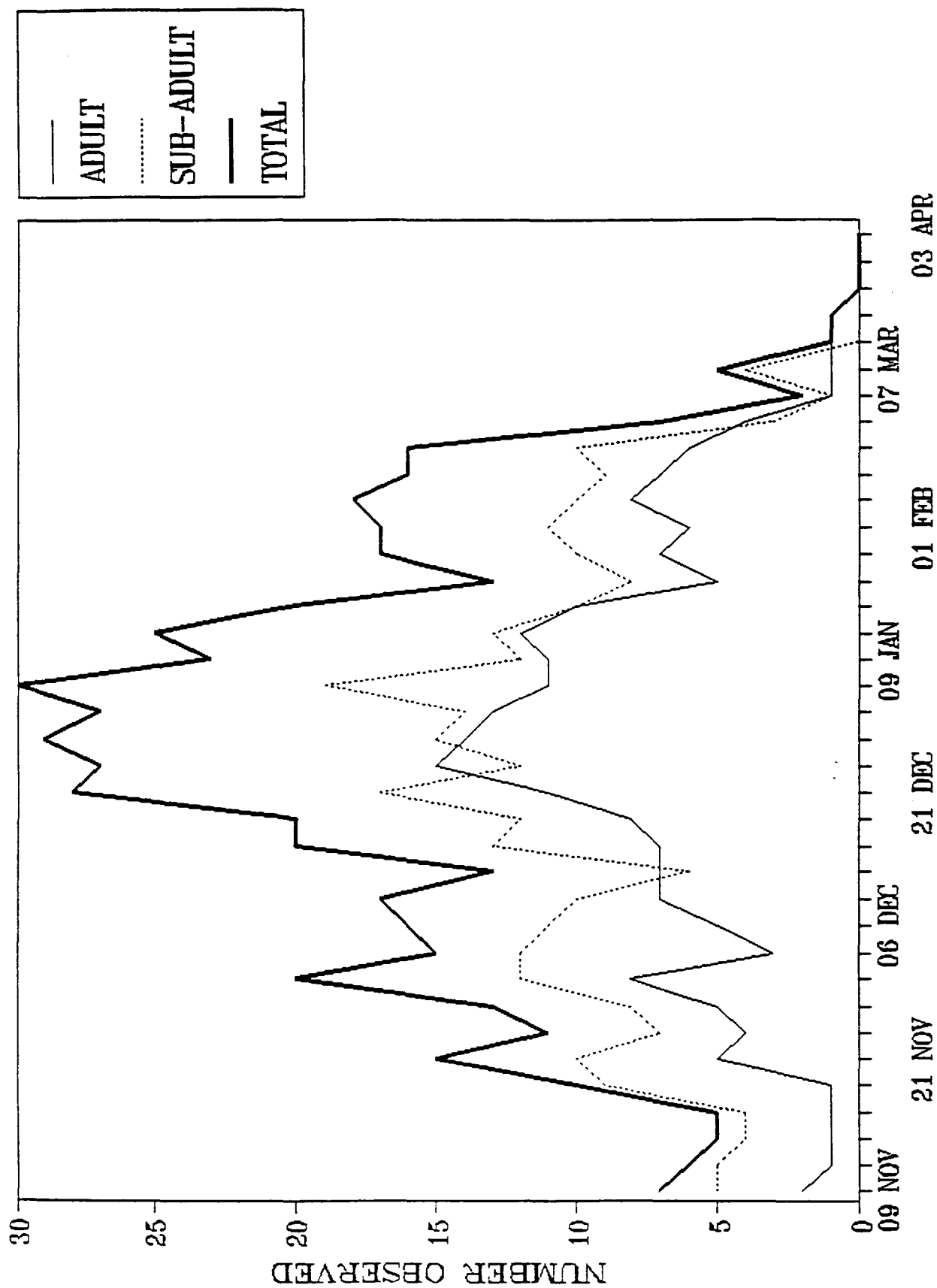


Figure 3. The number of bald eagles observed on the Rocky Mountain Arsenal communal roost during the winter of 1988-89.

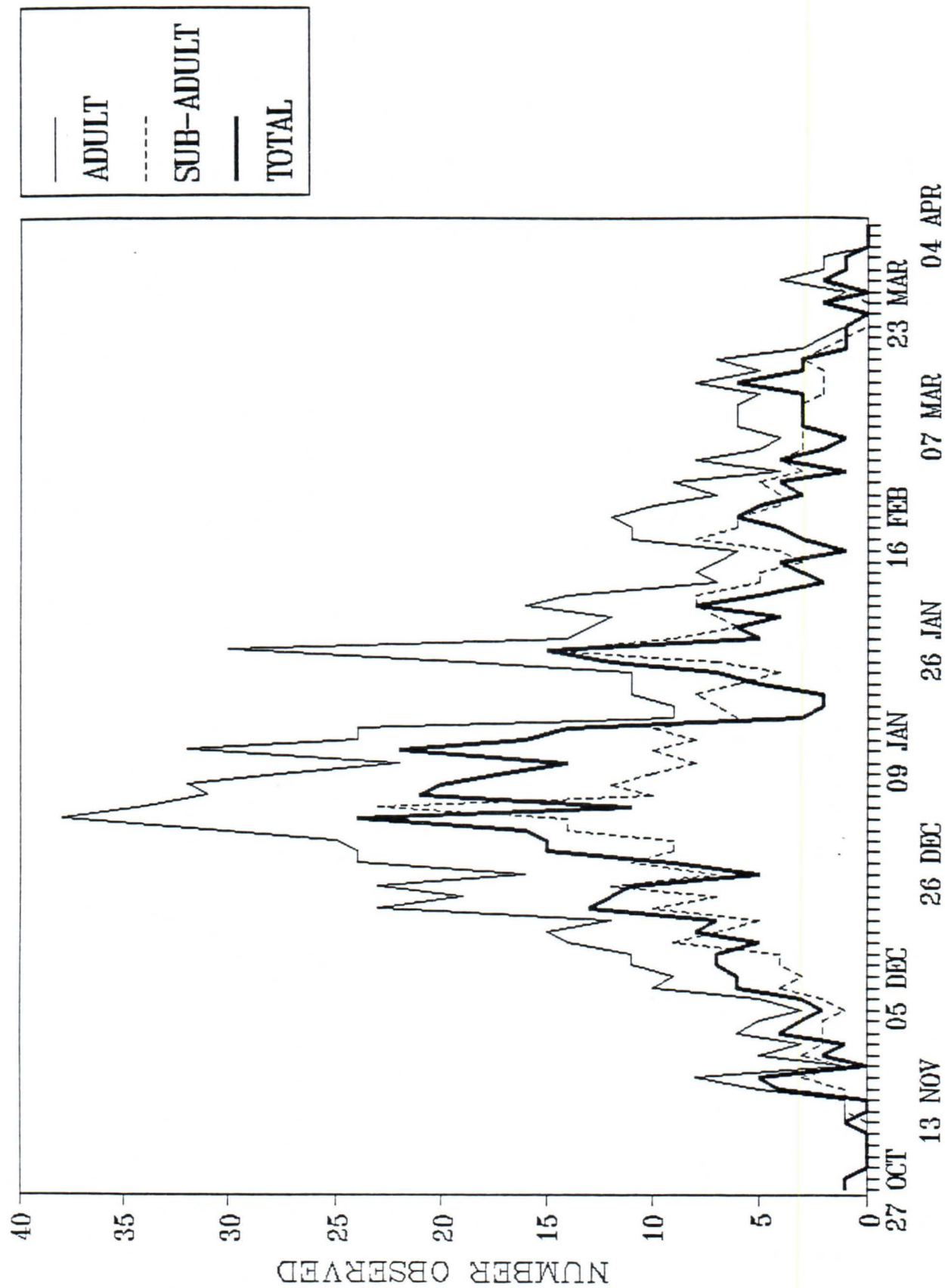


Figure 4. The number of bald eagles observed on the Rocky Mountain Arsenal communal roost during the winter of 1989-90.

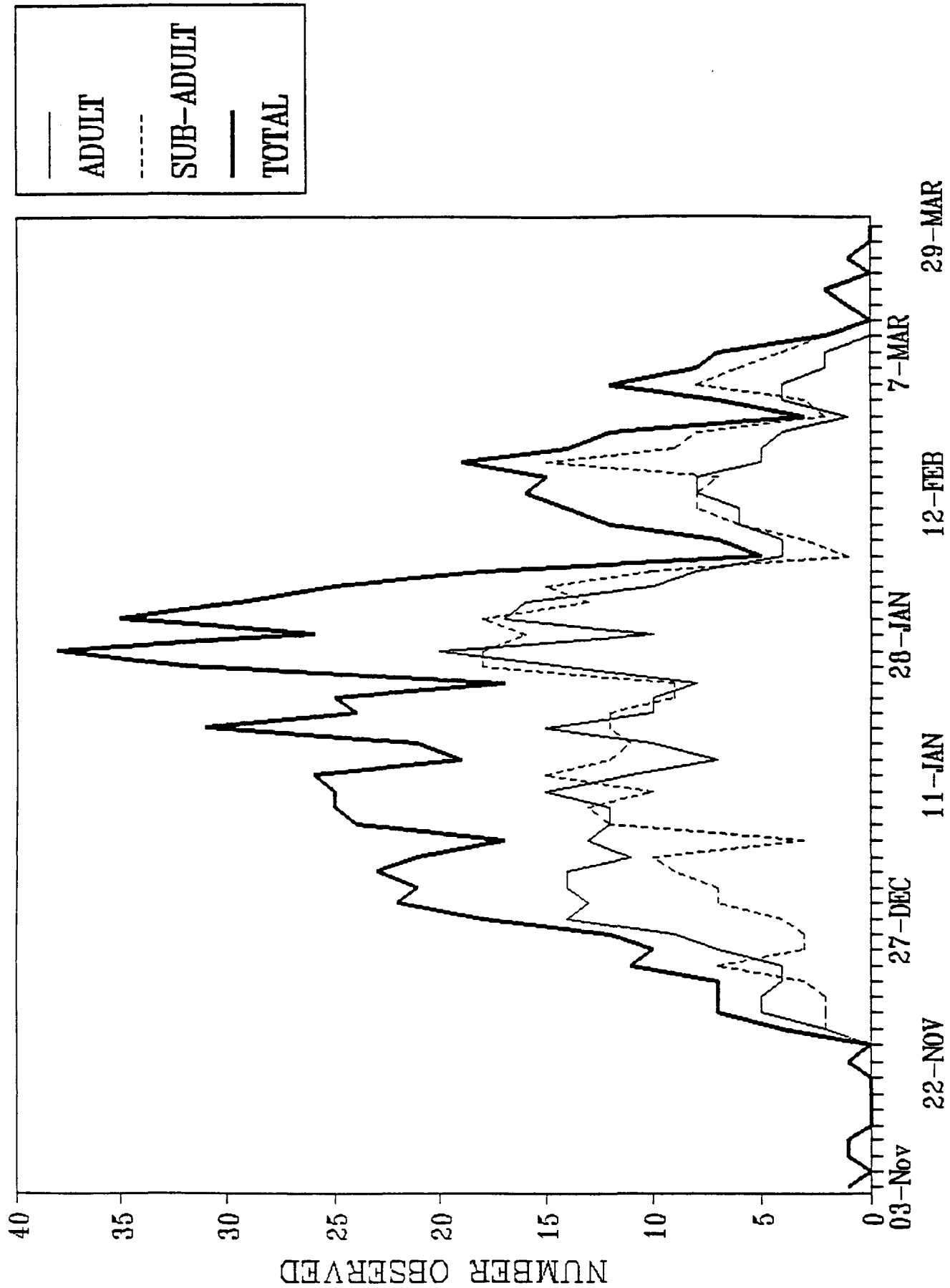


Figure 5. The number of bald eagles observed on the Rocky Mountain Arsenal communal roost during the winter of 1990-91.

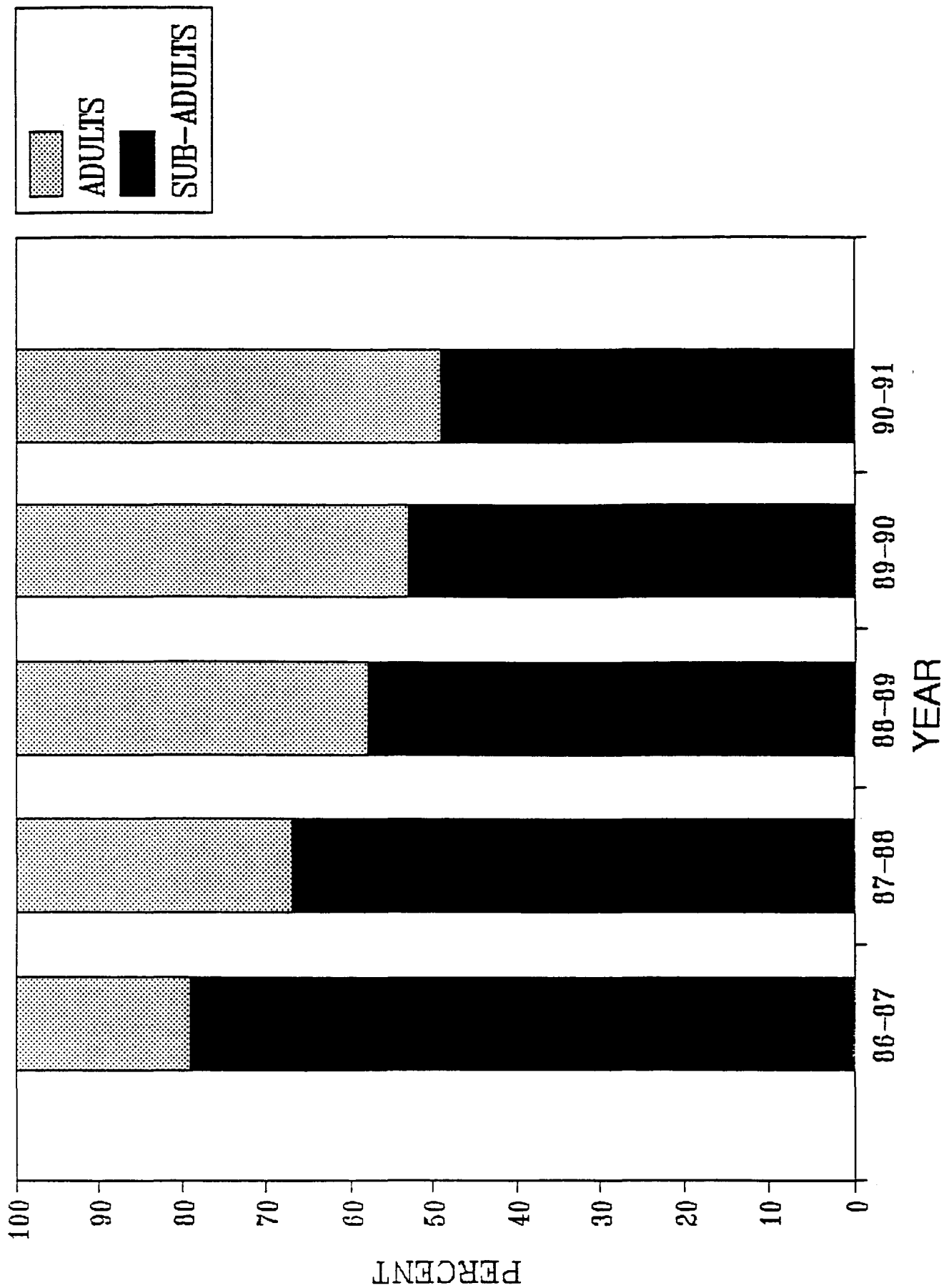


Figure 6. The percent age class of bald eagles using the Rocky Mountain Arsenal communal roost during the winter from 1986 through 1991.

TITLE: Raptor population trends and habitat use.

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INTRODUCTION

The Arsenal supports a large and diverse raptor community (Table 1). The Arsenal contains a mosaic of habitat types including wetland, riparian, and various types and successional stages of grasslands. Service surveys to inventory and monitor raptor populations and habitat use enable the protection of these habitats to maintain population diversity and richness during Arsenal cleanup. The data acquired will assure proper mitigation for habitats impacted during cleanup and assist with habitat management and enhancement. The surveys also provide information for eliminating or minimizing potential exposure of raptors to chemically contaminated areas.

Raptor surveys were designed as part of the Denver Cooperative Bald Eagle Study. Roadside transects were used to monitor bald eagle and other raptor abundance and distribution on the study area, and determine the potential for kleptoparasitism by bald eagles of other raptors. Road censusing is cost efficient method to survey widely distributed raptors. This method has been used extensively by a number of researchers to monitor raptor population trends (Johnson and Enderson 1972, Bauer 1982) and habitat/perch use (Marion and Ryder 1975, Fischer et al. 1984). The Arsenal transect has been continued beyond the three year study to support the Cooperative Agreement for the Conservation and Management of Fish and Wildlife Resources at the Rocky Mountain Arsenal (Arsenal) between the U.S. Fish and Wildlife Service (Service) and the U.S. Army. Data acquired will facilitate Service habitat management and habitat enhancement/mitigation projects for habitats impacted during Arsenal cleanup. This report provides a preliminary summary of wintering raptor data for the Arsenal transect.

Raptor nest monitoring was conducted to support the Cooperative Agreement for The Conservation and Management of Fish and Wildlife Resources at the Rocky Mountain Arsenal (Arsenal) between the U.S. Fish and Wildlife Service (Service) and the U.S. Army (U.S. Army). Estimates of raptor reproductive success and productivity enable comparisons between years which can be used to make inferences about population status (Steenhof 1987) Changes in reproductive

success/productivity may reflect changes in habitat composition and land use (Murphy 1989), contaminants exposure (Risebough and Monk 1989), human disturbance (Knight and Skagen 1988), or natural phenomena (i.e. weather, prey populations) (Garton et al. 1989, Johnsgard 1990). Information acquired will allow the Service to protect sensitive raptor nesting areas through the placement of "Sensitive Wildlife Area" signs. Baseline and long term data will aid in habitat management and habitat enhancement/mitigation for habitats impacted during Arsenal cleanup. Nest monitoring was conducted as time and personnel constraints permitted during 1990 and 1991.

METHODS

A road survey of raptors has been conducted weekly or biweekly from November of 1988 to the present. Data presented here were collected during the winters (October-March) of 1988-89, 1989-90, and 1990-91. A 24 mile road transect was driven 2 hours after sunrise on calm days with no precipitation (Figure 1). Surveys were conducted by a single observer from an automobile cruising at 15-20 mph. Only birds observed with an unaided eye were recorded. If birds were not readily identifiable the vehicle would be stopped and binoculars or a spotting scope would be used to make an identification. Species, age class when possible, and leg (mile) of transect were recorded for each raptor observed during the winters of 1988-89 and 1989-90. During the 1990-91 winter additional data such as activity, perching substrate, and a specific location were recorded for each raptor observed. General habitat use descriptions were developed by comparing distributional peaks with existing vegetation maps.

During 1990 occupied great-horned and long-eared owl territories were located by broadcasting tape recorded calls as described by Fuller and Mosher 1981, by searching past nesting sites, and searching areas of high potential. Other raptor territories were located incidentally by noting the behavior of raptors observed during other wildlife surveys. Once occupied territories were located the areas were monitored to determine whether or not eggs were laid. If eggs were laid the nest was monitored as time permitted until abandoned or young were fledged.

During the late winter and early spring of 1991 a comprehensive nest search was conducted. All potential raptor nest sites on the Arsenal were mapped and typed (i.e. cavity, magpie, or large stick nest). Breeding pairs/occupied territories were located by monitoring high potential nest sites recorded during nest searches, monitoring past nesting sites, searching high potential nesting areas, and through behavioral observations. When a breeding pair or occupied territory was located it was monitored weekly until the nest or territory was abandoned or the young fledged.

Terminology and definitions used in nest monitoring data analysis

are similar to those proposed by Postupalsky 1974 and Steenhof 1987.

Other projects included:

The bald eagle study was continued (see bald eagle section pages H-1 - H-11).

The investigation of burrowing owl ecology at the Arsenal by Texas Tech University's, Cooperative Wildlife Research Unit was continued (Appendix E).

The revegetation and vegetation modification program in the Bald Eagle Management Area to produce prey for eagles and other raptors continued (Appendix C).

Prairie dog management and re-establishment efforts continued (see prairie dogs pages H-73 - H-79).

A study by the Denver Museum of Natural History on ferruginous hawk habitat use, winter home range, food habits, and roosting and foraging habitats was initiated in the fall of 1991 (Appendix F).

RESULTS AND DISCUSSION

Raptor Population Trends and Habitat Use

Population Dynamics

A total of 17 (1988-89), 16 (1989-90), and 23 (1990-91) census were conducted with an average of 56.2, 17.1, and 16.8 raptors per transect respectively. Ferruginous hawks, red-tailed hawks, rough-legged hawks, and bald eagles were the most frequently observed raptors during all three winters (Table 2). Numbers of less frequently observed raptors are presented in Table 2.

1988-1989

During the winter of 1988-89 ferruginous hawks were the most frequently observed raptor followed by red-tailed hawks, bald eagles, and rough legged hawks (Table 2). Ferruginous hawk numbers declined significantly from November through March (Figure 2). Both red-tailed and rough-legged hawk numbers dropped substantially from November through December (Figures 3 and 4). Bald eagle and golden eagle numbers decreased somewhat (Figures 5 and 6) and total raptors decreased significantly (Figure 7) during this period.

1989-1990

During the winter of 1989-90 the number of rough legged hawks increased whereas the number of ferruginous hawks, red-tailed

hawks, and bald eagles decreased (Table 2). The number of ferruginous hawks recorded during the 1989-90 winters was significantly less than numbers recorded during the same periods in the 1988-89 winter (figure 2). Both Red-tailed and rough-legged hawk numbers show no notable trend during this period and only differ from 1988-89 during November when greater numbers were recorded for both species (Figures 3 and 4). There was a slight decrease in the number of bald eagles recorded in this period (Figure 5) except for January when a sharp increase occurred, and very few golden eagles were recorded (Table 2). Total raptors show no notable trend during this period and were significantly less than numbers recorded during the same periods of 1988-89 (Figure 7).

1990-1991

Red-tailed hawk and bald eagle numbers increased in the 1990-91 winter when compared to the 1989-90 winter, whereas ferruginous hawk and rough-legged hawk numbers decreased (Table 2). The average numbers of all four species were lower than the numbers recorded during the 1988-89 winter (Table 2). Ferruginous hawk numbers remained substantially lower than numbers recorded during the same periods of 1988-89 and were not notably different from 1989-90 (Figure 2). Both red-tailed hawk and rough-legged hawk numbers were not remarkably different from 1988-89 and 1989-90 except for November 1988 when greater numbers were recorded for both species. There was no obvious change in total raptor numbers between the 1989-90 and 1990-91 winters and numbers remained significantly less than numbers recorded during 1988-89 (Figure 7).

Distribution and Habitat Use

Peak observations of red-tailed hawks were recorded along survey legs 6 through 8, and legs 14 and 15 during all three winters (Figure 8). A peak also occurred along legs 18 and 19 during the winters of 1988-89 and 1989-90. Habitat along these legs is comprised mostly of wetland/riparian type vegetation (i.e. First Creek, Lake Mary, Lake Ladora, and the Derby Lakes) consisting of mid-age and mature stands of cottonwoods, and grasslands/shrubs dominated by crested wheatgrass and cheatgrass/weedy forbs with native perennial grass, shrubland/succulents and locust thickets in lesser amounts.

Rough-legged hawk distribution changed slightly between the three years (Figure 9). During 1988-89, peaks were recorded along survey legs 1 and 2, and along legs 18, 19, and 20. During 1989-90 the number observed along legs 1 and 2 decreased and peak numbers occurred along legs 14 through 19. There were no observations recorded along legs 1 and 2 during the 1990-91 winter and an overall decrease was observed for legs 1 through 10. Peak numbers were recorded along legs 14 and 15 during this period. Habitat along

legs 1 and 2 is dominated by crested wheatgrass and native perennial grasses with some weedy forbs. Habitat along legs 14 through 19 is comprised of wetland/riparian areas along the first creek corridor and adjacent to Upper Derby and Eastern Upper Derby Lakes. A mosaic of grassland types occur along this section of the transect dominated by cheatgrass/weedy forbs with crested wheatgrass, native perennial grass, shrublands/succulents in lesser amounts.

Peak numbers of ferruginous hawks were observed during the 1988-89 winter along legs 3 and 4, 15 and 16, and legs 21 through 23 (figure 10). However, the pattern of distribution along the transect changed during the winter. Ferruginous hawk numbers decreased from east to west across the Arsenal from November through February (figure 11). As numbers decreased in eastern areas of the Arsenal there was a minor increase in numbers observed in the west (i.e. legs 3, 4, and 5). During the 1989-90 winter there was no distinctive peak in observations along the transect. During 1990-91 peak ferruginous hawk numbers occurred along transect legs 3 and 4, 20, 23 and 24. Habitat along these legs is dominated by grasslands chiefly comprised of cheatgrass/weedy forbs, native perennial grass, and shrubland/succulents with crested wheatgrass in smaller amounts. Wetland/riparian vegetation is also available along northern portions of First Creek (i.e. legs 15 and 16).

The distribution of bald eagles changed somewhat between the three winters. During 1988-89 one major peak occurred at leg 15 and three moderate to small peaks occurred at lags 3, 8 and along legs 21 through 23 (Figure 12). Peak observations during 1989-90 were along lags 8, 9, and various lags adjacent to First Creek (Figure 12). During 1990-91 greatest observation were observed along the legs adjacent to First Creek (i.e. legs 15 and 16) (Figure 12). Riparian/wetland type vegetation is dominant along most transect legs except for legs 3 and 21 through 23 where grassland/shrubs consisting of cheatgrass/ weedy forbs, crested wheatgrass, and shrubland/succulents.

Perch Use

Cottonwood trees were the most frequently used perch substrate by red-tailed hawks followed by utility poles (Table 3). Rough-legged hawks used cottonwood trees and utility poles equally (Table 3). Utility poles followed by cottonwood trees were the most frequently used perches by ferruginous hawks (Table 3).

The decrease in both total raptors and ferruginous hawks numbers during 1988-89 parallels a significant drop in prairie dog numbers and distribution on the Arsenal due to a sylvatic plague epizootic which occurred during this period (Ebsaco 1989). The decrease in ferruginous hawks from east to west across the Arsenal follows a

pattern similar to the decrease in the prairie dog distribution due to the plague (Figures 13, 14, and 15) (Ebasco 1989). The minor ferruginous hawk increase observed in the northwestern portions of the Arsenal during late winter may be attributed to availability of prairie dogs in these areas not yet affected by the plague. The slight decline in golden and bald eagles during this period and the drop in red-tailed and rough-legged hawk numbers from November to December 1988 also parallels the drop in prairie dog numbers. Prairie dog numbers have remained relatively low during the last two winters compared to the 1988-89 winter. This may be the reason for substantially fewer ferruginous hawks and golden eagles observed during the 1989-90 and 1990-91 winters. Red-tailed and rough-legged hawks may not have been as reliant on prairie dogs as their numbers did not notably change between the three winters except for the greater numbers observed during November 1988. The slight decrease in bald eagle numbers observed in the winters of 1989-90 and 1990-91 may be a result of sampling error or may be related directly to the decrease in prairie dog numbers or to the decrease in ferruginous hawks which they often kleptoparasitize. No explanation can be inferred for the sharp increase in bald eagles during January 1990.

There appears to be some differences in the distribution between the three major hawk species (i.e. red-tailed, rough-legged, and ferruginous) using the Arsenal during the winter. Higher numbers of ferruginous hawks occur along transect legs located in northern portions of the Arsenal. These areas are dominated by grassland/shrub vegetation and the riparian habitat along northern portions First Creek. They reflect the prairie habitat commonly occupied by ferruginous hawks (Kochert 1986, Clark and Wheeler 1987). Also, the major Arsenal prairie dog colonies, that are primary ferruginous hawk foraging territories, were located and continue to be located in these areas. Both red-tailed hawks and rough-legged hawks were recorded in greater numbers in wetland/riparian areas (i.e. the lakes and First Creek). However, rough-legged hawks were recorded less often along the major permanent lakes (i.e. Lakes Mary, Ladora, and lower Derby Lake) which probably reflects their preference for more open habitat types (Fischer et al. 1984, Kochert 1986). Bald eagles were more often recorded in wetland/riparian vegetation during 1989-90 and 1990-91. The bald eagle peaks which occurred in predominantly grasslands areas along legs 3 and legs 21 through 23 in 1988-89 probably reflects the greater availability of prairie dogs in these areas which also attracted ferruginous hawks for potential kleptoparasitism.

Perch use by wintering raptors may be related to their availability. Ferruginous hawks use primarily utility poles that are the predominant perch on the Arsenal in grassland habitats. Red-tailed hawk use of cottonwood trees more often than utility poles probably reflects their use of habitats around the larger permanent lakes. Rough-legged hawks use utility poles and

cottonwood trees equally probably due to the high availability of both perch types along the First Creek corridor.

The decrease in ferruginous hawks probably reflects a shifting pattern in local/regional distribution due to changes in the distribution and density of prairie dogs along the front range. Many studies have documented the movement of raptors in response to changes in prey abundance (Hanson 1971, Adamcik and Keith 1978, and Bell et al. 1979). The increase in urbanization along the front range will probably result in a decrease in prairie dogs. This decrease in prey availability will make proper management of prey resources especially prairie dogs on protected areas such as the Arsenal essential. The management of prey habitats may be equally important as habitat components may affect prey availability negating increases in prey abundance (Garton et al. 1989).

Raptor Nest Monitoring

The number of great-horned owl occupied territories was similar during 1990 and 1991. However, a proportion of those listed in Table 4 may have been floaters (i.e. non-nester) (Steenhof 1987). The number of breeding pairs and successful nests decreased in 1991 (Table 4) (Figure 16). The number of successful nests for both years may have been greater as owls leave the nest long before they fledge (Forsman et al. 1984) and counts of young after they leave the nest may be inaccurate. Also, lack of monitoring may have affected the number of successful nests recorded. These variables remained constant or increased for long-eared owls, swainson's hawks, and red-tailed hawks (Table 4) (Figures 17 and 18). The increases noted for these species during 1991 partially reflect increased search efforts as great-horned owls were the primary focus of the nest monitoring program during 1990. The number of northern harrier territories remained the same and the number of screech owl territories increased (Table 4) (Figure 19). There was one breeding pair of barn owls in 1990 and two in 1991 however the number of offspring fledged during both years was uncertain (Figure 17) (Table 4).

The total number of great-horned owls fledged and the mean number fledged per breeding pair decreased during from 1990 to 1991 (Tables 5 and 6), but there was no notable difference in the number fledged per successful nest. The mean number of great horned owls fledged per occupied territory increased (Table 5 and 6). During 1990 four eggs were collected from different nests for a contaminants study which may have caused a decrease in the number of owls fledged. Differences in monitoring effort also may have affected these values in both years.

There was no substantial change in the total number of long-eared owls fledged between 1990 and 1991 (Tables 7). However, this data may be misleading as stated previously counts of young fledged

after they have left the nest may be inaccurate. This is especially true of long-eared owls on the Arsenal that nest exclusively in dense locust thickets.

The total number of swainson's hawks fledged during 1990 and 1991 was not notably different (Tables 8). The number fledged per breeding pair, successful nest, and occupied territory decreased from 1990 to 1991. This is partially due to the increased search efforts and monitoring during 1991. The number fledged per successful and occupied territory is somewhat higher than the mean of 1.2 (sample size = 95) Olendorff 1973 recorded for both in northeastern Colorado.

The single successful red-tailed hawk nest produced one fledgling in 1991. Two young were observed but one was lost at approximately 20 days of age.

FUTURE WORK

Habitat along the road transect will be quantified using existing vegetation maps. This will enable habitat/perch use and availability to be quantified. Perch availability may affect perch and habitat use. Some raptor species may be observed in less preferred habitats with respect to vegetation and prey abundance if these areas provide suitable perch sites that are not available in preferred habitats resulting in a decrease in prey availability. Vegetation type and structure may also affect raptor distribution by affecting prey abundance/availability.

Data acquired from off-post road transects will be analyzed and comparisons made to the Arsenal transect. Summer data for the Arsenal transect will be analyzed. Statistical techniques will be evaluated and used if deemed appropriate, to assess population and habitat use data for all transects. Prairie dog distribution and abundance will be monitored to assess their impact on ferruginous hawks and other raptors.

Raptor nest monitoring will continue during 1992. Nest site characteristics will be evaluated for 1990, 1991, and 1992.

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Table 1. Raptors documented on the Arsenal by the Service.

Golden Eagle (Aquila chrysaetos)
Bald Eagle (Haliaeetus leucocephalus)
Northern Harrier (Circus cyaneus)
Sharp-shinned Hawk (Accipiter striatus)
Cooper's Hawk (Accipiter cooperii)
Red-tailed Hawk (Buteo jamaicensis)
Swainson's Hawk (Buteo swainsoni)
Rough-legged Hawk (Buteo lagopus)
Ferruginous Hawk (Buteo regalis)
Osprey (Pandion haliaetus)
American Kestrel (Falco sparverius)
Merlin (Falco columbarius)
Prairie Falcon (Falco mexicanus)
Peregrine Falcon (Falco peregrinus)
Common Barn-owl (Tyto alba)
Short-eared Owl (Asio flammeus)
Long-eared Owl (Asio otus)
Great Horned Owl (Bubo virginianus)
Eastern Screech-owl (Otus asio)
Burrowing Owl (Athene cunicularia)

Table 2. Raptors observed along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.

<u>Species</u>	<u>1988-89</u>			<u>1989-90</u>			<u>1990-91</u>		
	<u>N</u>	<u>AVG</u>	<u>%</u>	<u>N</u>	<u>AVG</u>	<u>%</u>	<u>N</u>	<u>AVG</u>	<u>%</u>
Red-tailed hawk	112	(6.6)	11.6	54	(3.9)	20.4	135	(5.9)	35.2
Rough-legged hawk	67	(3.9)	7.0	56	(4.7)	21.1	54	(2.3)	14.1
Ferruginous hawk	581	(34.2)	60.3	56	(4.7)	21.1	63	(2.7)	16.4
Bald eagle	71	(4.2)	7.4	46	(2.9)	17.4	68	(3.0)	17.7
Golden eagle	37	(2.2)	3.8	00	(0.0)	00.0	6	(0.3)	1.6
American kestrel	10	(0.6)	1.0	18	(1.1)	6.8	24	(1.0)	6.3
Unknown buteo	64	(3.8)	6.6	20	(1.3)	7.5	16	(0.7)	4.2
Unknown eagle	3	(0.2)	0.3	00	(0.0)	0.0	1	(----)	0.2
Northern harrier	12	(0.7)	1.2	12	(0.8)	4.5	10	(0.4)	2.6
Merlin	2	(0.1)	0.2	00	(0.0)	0.0	1	(----)	0.2
Prairie falcon	4	(0.2)	0.4	3	(0.2)	1.1	4	(0.2)	1.0
Total raptors	963	(56.2)		265	(17.1)		384	(16.8)	

N = number observed
AVG = average
% = percent of total

Table 3. Percent perch use by raptors along the Arsenal road survey during the winter of 1990-91.

Species	Perch Type *									
	UP	CW	SE	GD	AS	WP	RO	LC	OP	MN
Red-tailed Hawk	33.3	58.3	5.6	1.4	0.0	1.4	0.0	0.0	0.0	0.0
Ferruginous Hawk	44.4	16.6	8.3	8.3	13.8	0.0	0.0	0.0	0.0	5.5
Rough-legged Hawk	43.8	43.8	0.0	0.0	0.0	0.0	3.1	3.1	3.1	0.0

* UP = Utility Pole; CW = Cottonwood Tree; SE = Siberian Elm Tree; GD. = Ground; AS = Artificial Snag; WP = White Poplar Tree; RO = Russian Olive Tree; LC = Locust Tree; OP = Other Post; MN = Other Man Made Structures.

Table 4. Raptor nest data for the Rocky Mountain Arsenal for 1990 and 1991.

Species	<u>1990</u>			<u>1991</u>		
	Occupied Territory	Breeding Pair	Successful Nests	Occupied Territory	Breeding Pair	Successful Nests
Great-horned owl	21	11	10	17	8	5
Long-eared owl	3	2	2	6	5	2
Swainson's hawk	5	2	2	9	5	4
Red-tailed hawk	--	--	--	3	1	1
Northern Harrier	2	--	--	2	--	--
Screech Owl	1	--	--	2	--	--
Barn Owl	1	1	--	2	2	--

-- denotes insufficient monitoring to estimate a value.

Table 5. Arsenal great-horned owl productivity data for 1990.

Breeding * Pair	Number of Eggs	Number of Eggs Collected	Number Fledged
1	3	1	1
2	2	1	1
3	3	1	2
4	3		3
5			2
6	3	1	1
7			3
8			3
9			3
10	3		0
11			2
Total	17 ***	4 ****	21 **

* Nests where observations indicated eggs were laid.

** A mean of 1.9 owls fledged per breeding pair, 2.1 per successful nest, and 1.2 per occupied territory.

*** A mean of 2.8 eggs were produced per successful nest. This does not include nests where no egg information was available.

**** Eggs were collected as part of a contaminants study.

Table 6. Arsenal great-horned owl productivity data for 1991.

Breeding * Pair	Number of Nestlings Observed	Number Fledged
1	3	2
2	3	
3	3	2
4	3	2
5	2	
6	2	2
7	3	3
8	3	
Total	22	11 **

* Nests where observations indicate eggs were laid.

** A mean of 1.4 owls fledged per breeding pair, 2.2 per successful nest, and 0.6 per occupied territory.

Table 7. Arsenal long-eared owl productivity data for 1990 and 1991.

	Breeding Pairs	Number of Nestlings Observed		Number * Fledged	
		<u>1990</u>	<u>1991</u>	<u>1990</u>	<u>1991</u>
1	1		2	1	
2	2	5	2	3	
	3		2		
	4				1
	5		4		2
Total		5	10	4	3

* This reflects the number of young observed around the nest site before fledging. The actual number fledged was probably higher.

Table 8. Arsenal swainson's hawk productivity data for 1990 and 1991.

	Breeding Pairs		Number of Nestlings Observed		Number Fledged	
	<u>1990</u>	<u>1991</u>	<u>1990</u>	<u>1991</u>	<u>1990</u>	<u>1991</u>
1		1		1	2	1
2		2		2	3	2
		3		2		2
		4		1		1
Total			0	6	5 *	6 **

* A mean of 2.5 hawks fledged per breeding pair and successful nest, and a mean of 1.0 fledged per occupied territory.

** A mean of 1.5 hawk fledged per breeding pair and successful nest, and a mean of 0.7 fledged per occupied territory.

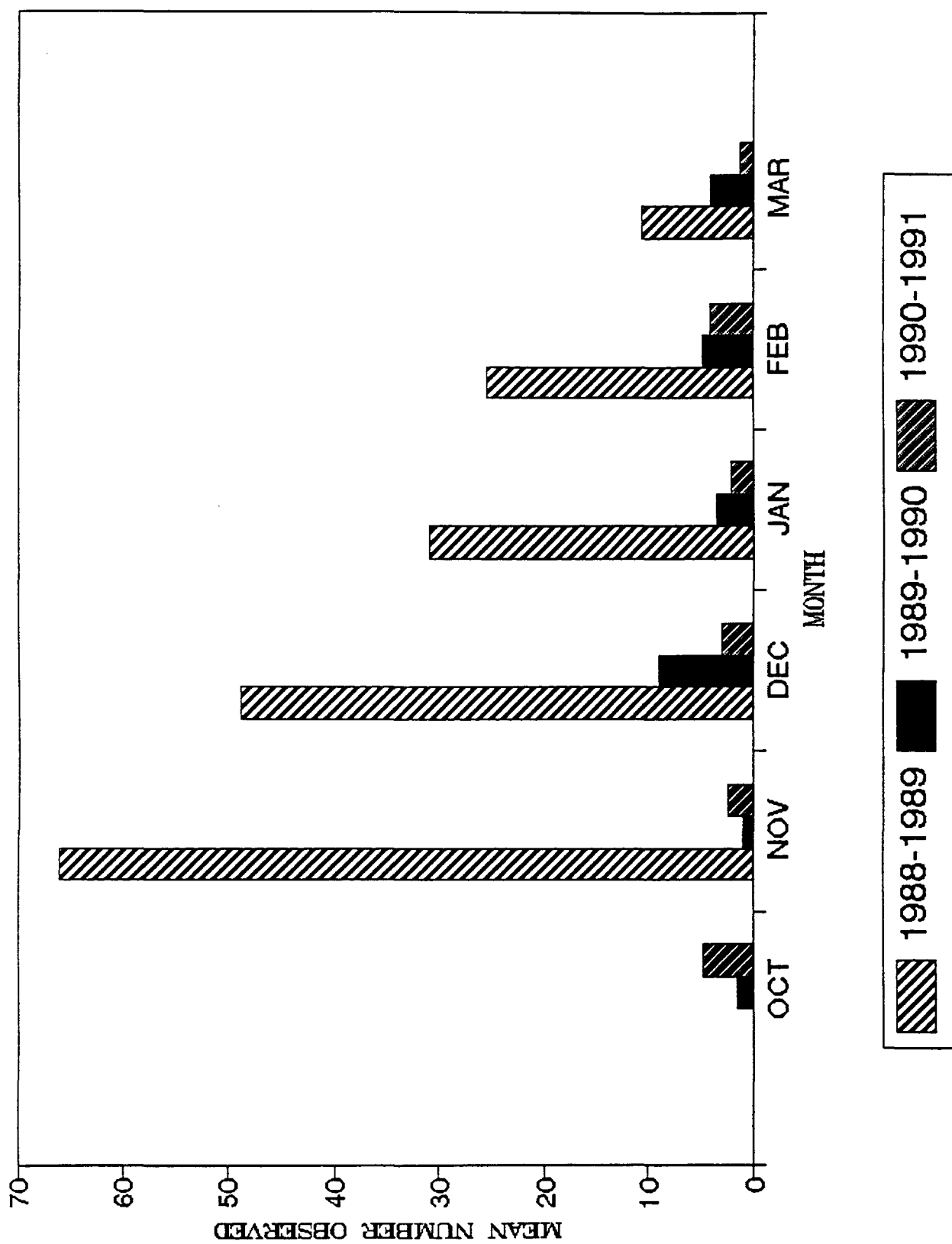


Figure 2. The mean number of ferruginous hawks observed per month along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.

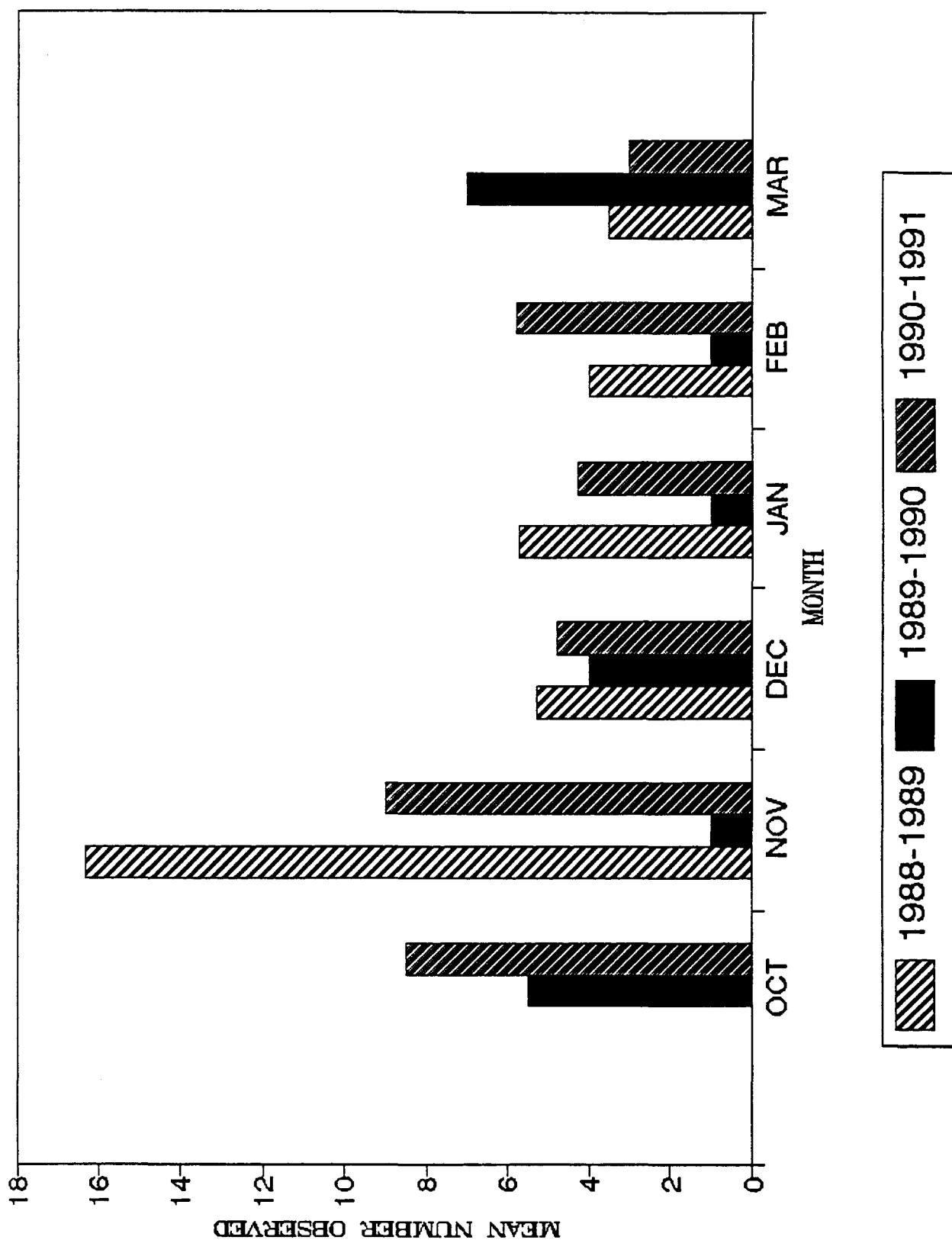


Figure 3. The mean number of red-tailed hawks observed per month along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.

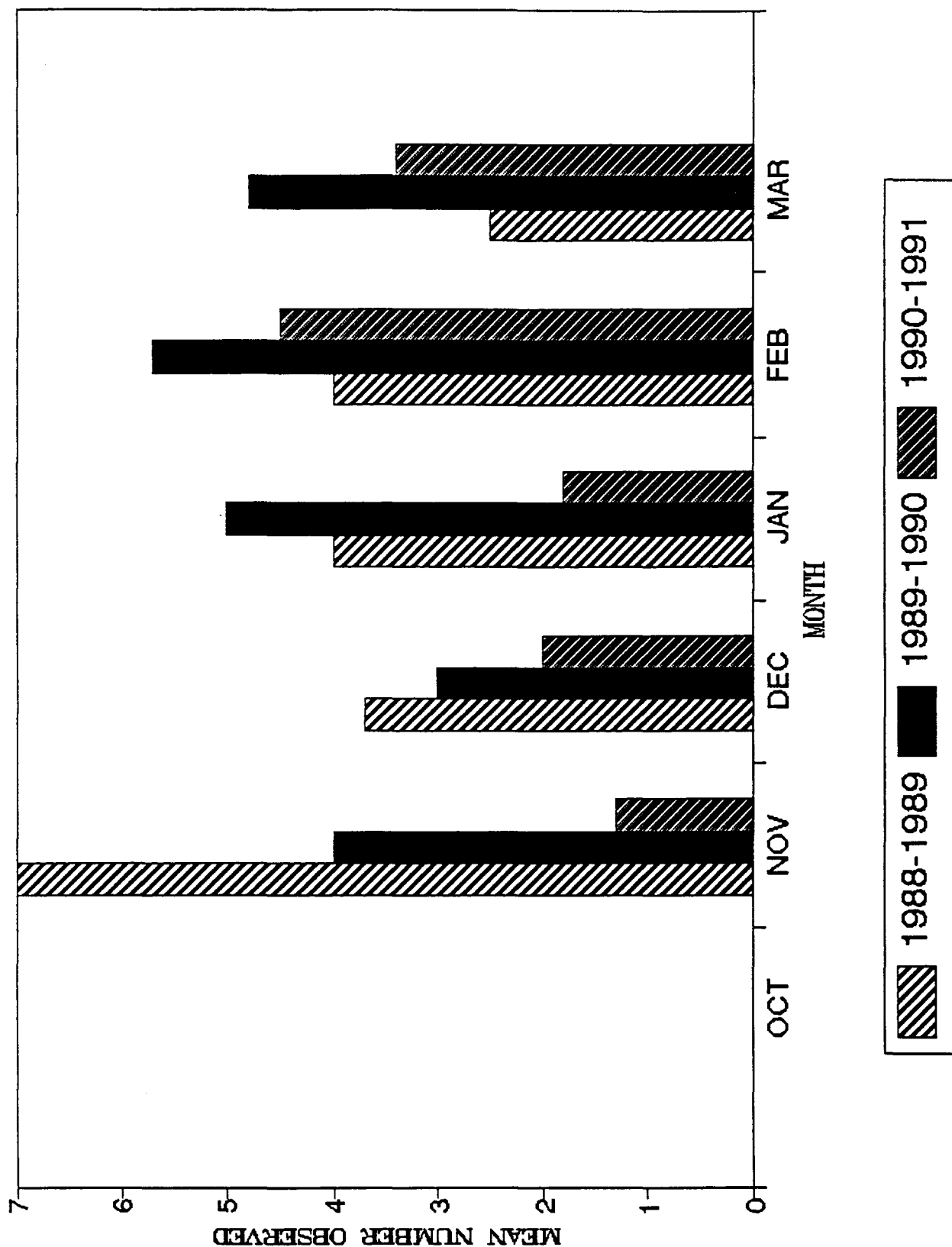


Figure 4. The mean number of rough-legged hawks observed per month along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.

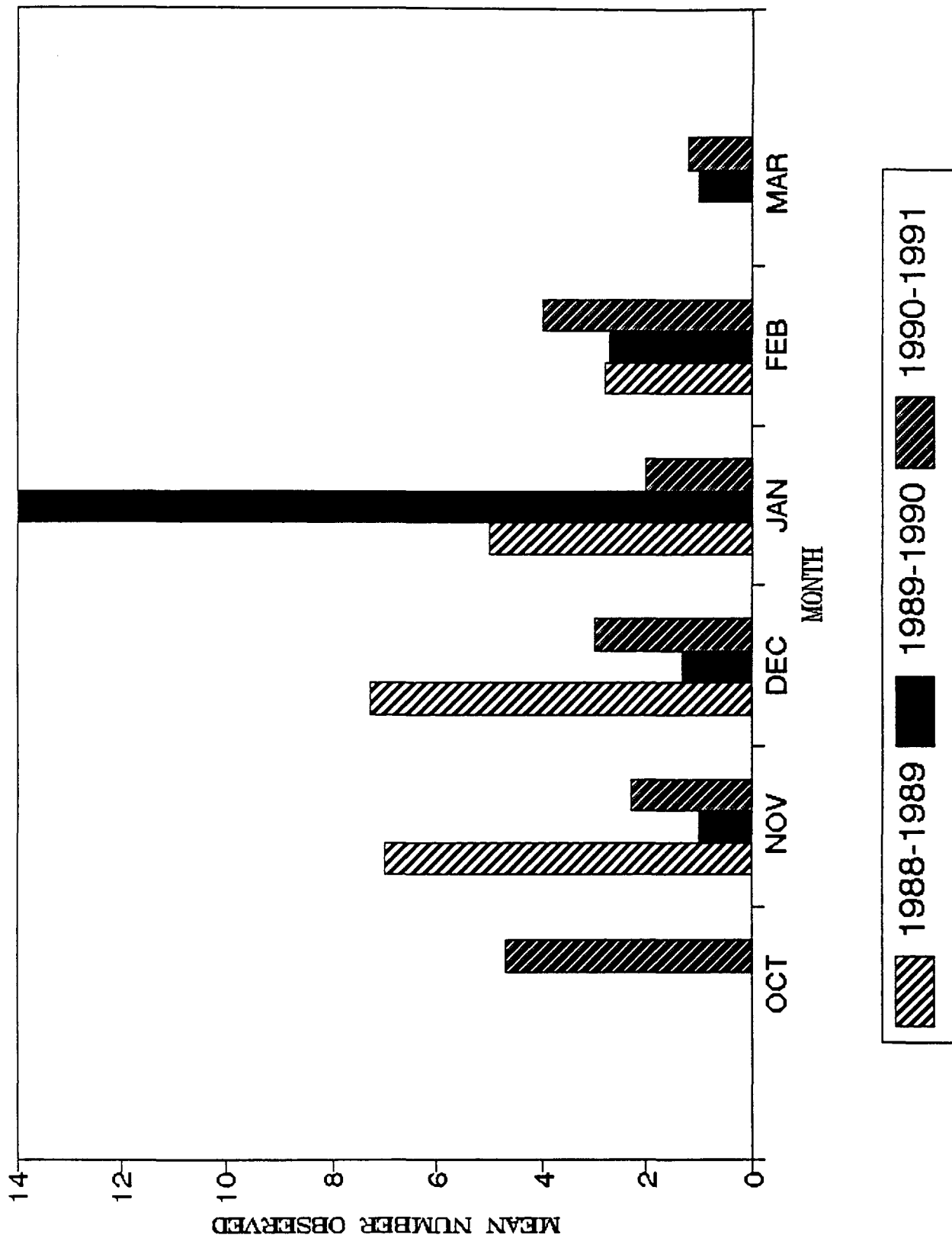


Figure 5. The mean number of bald eagles observed per month along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.

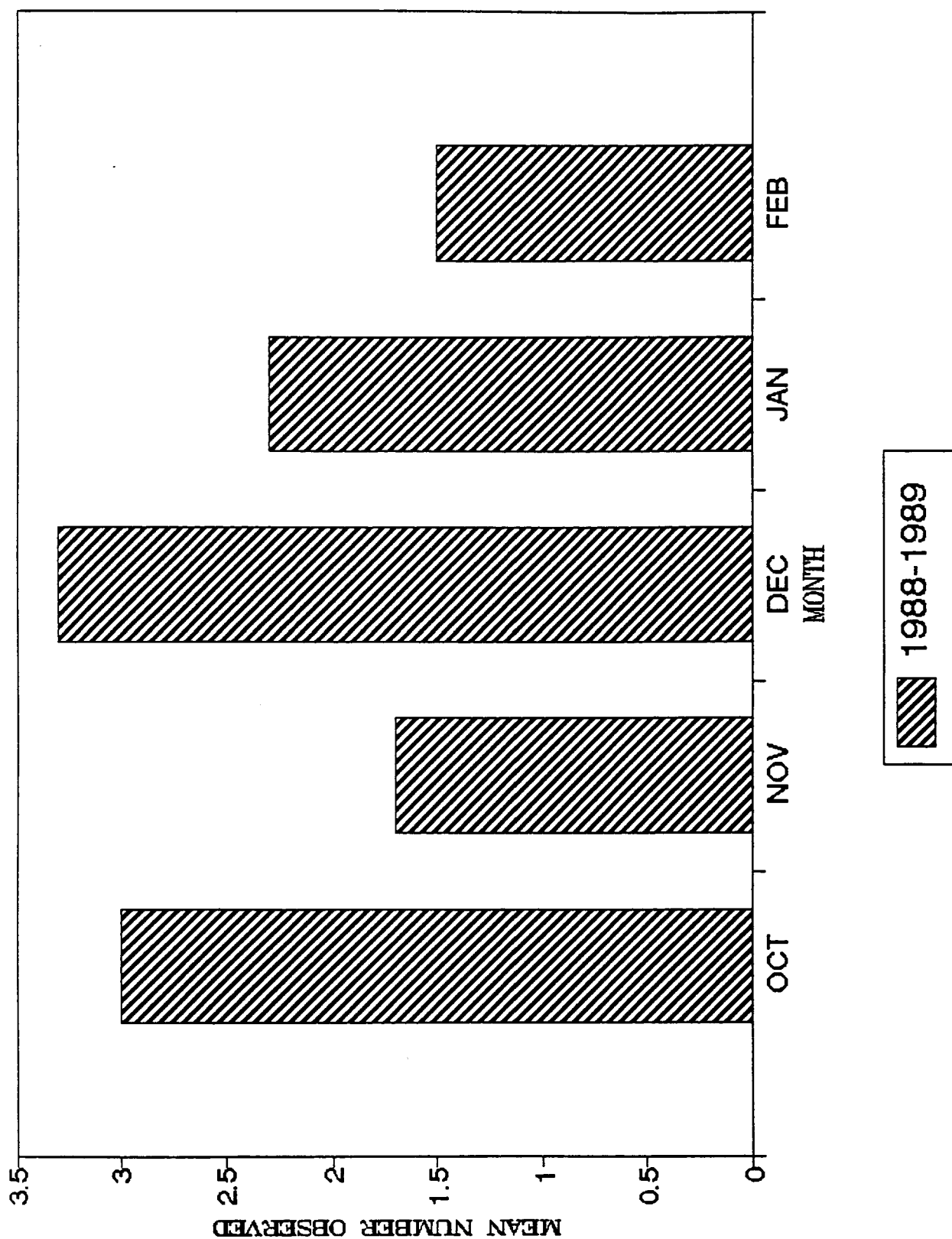


Figure 6. The mean number of golden eagles observed along the Arsenal road survey during the winter of 1988-89.

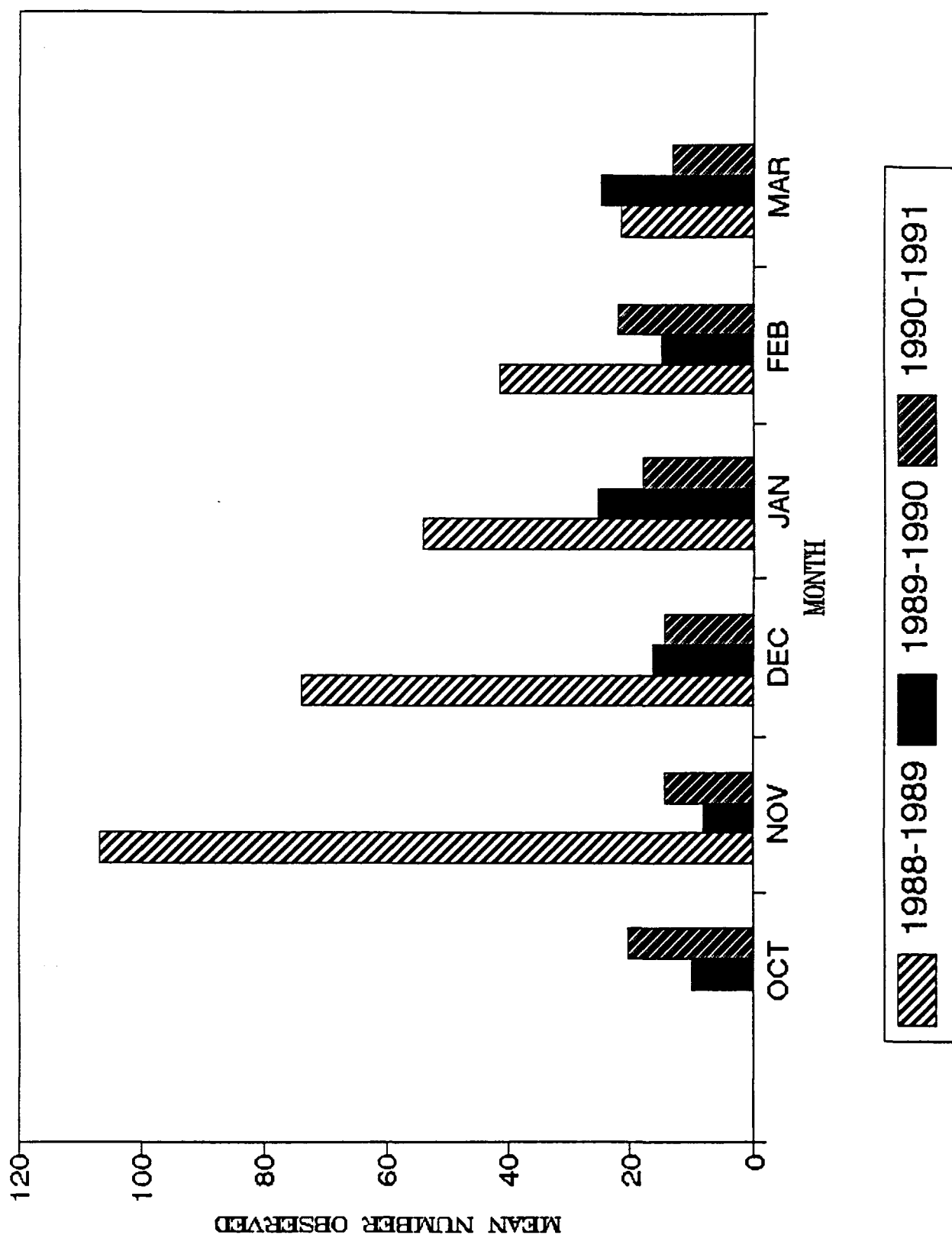


Figure 7. The mean number of raptors observed per month along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.

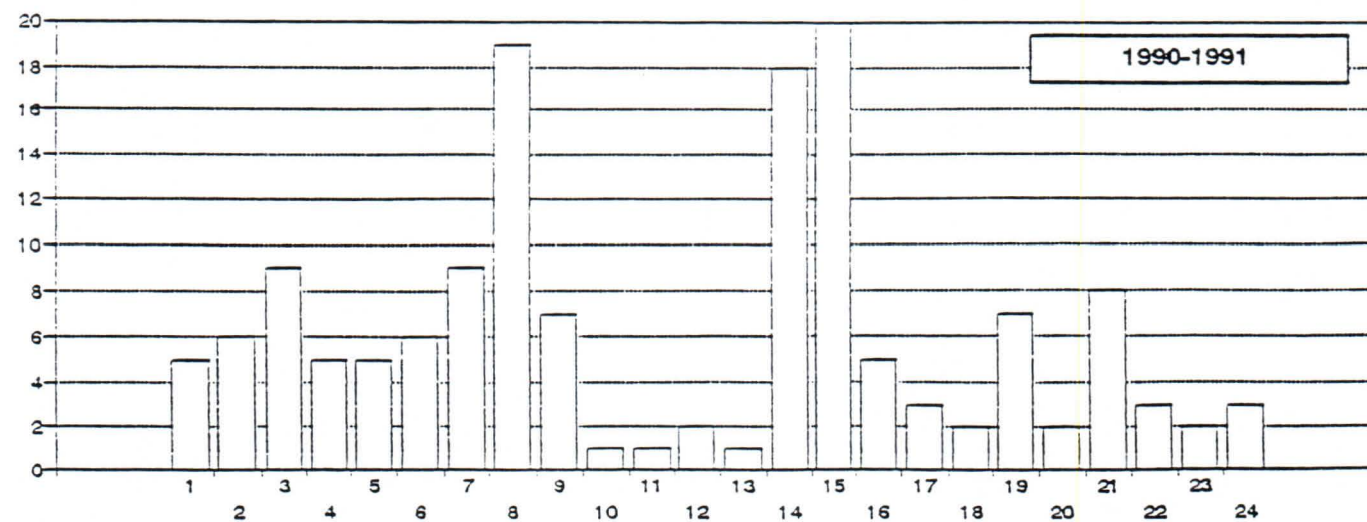
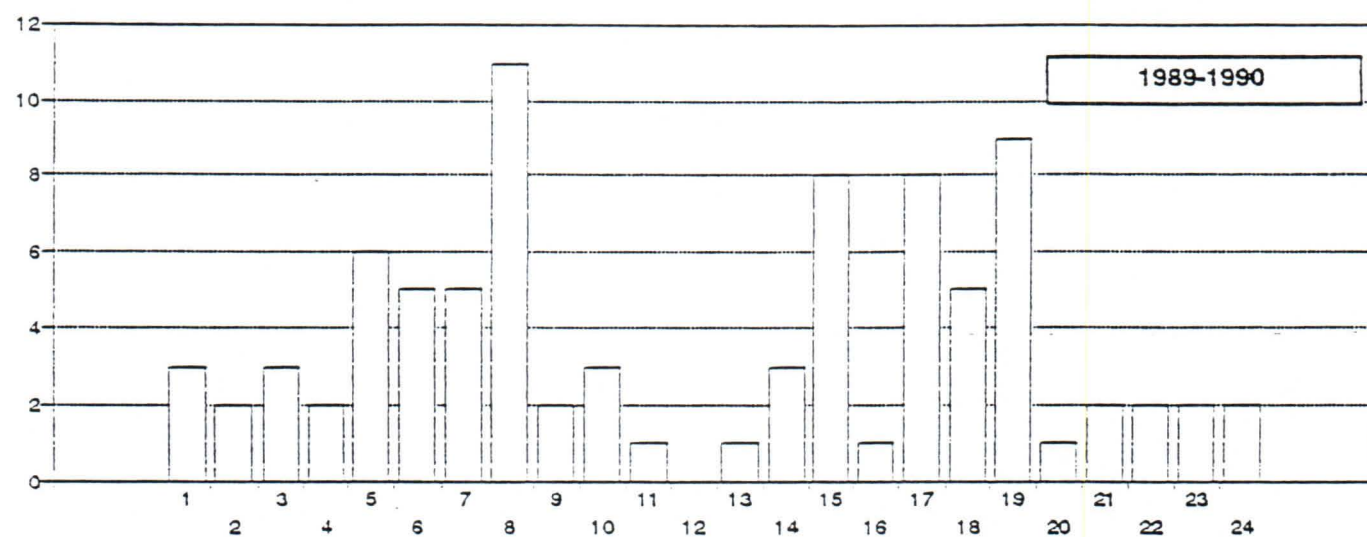
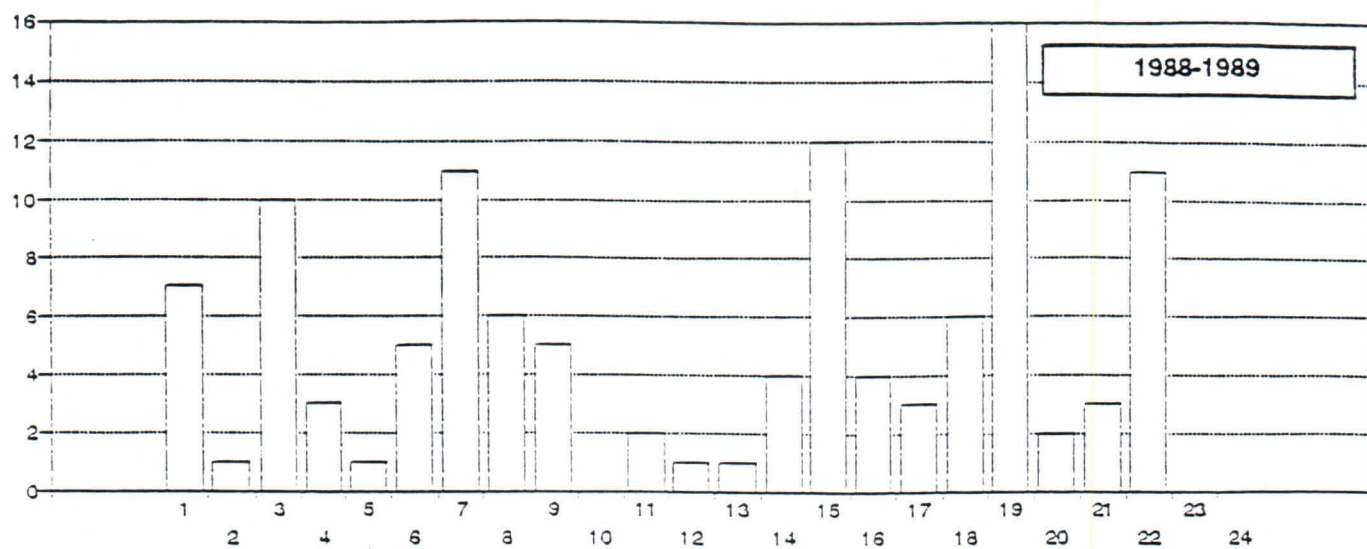


Figure 8. The distribution of red-tailed hawks along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.

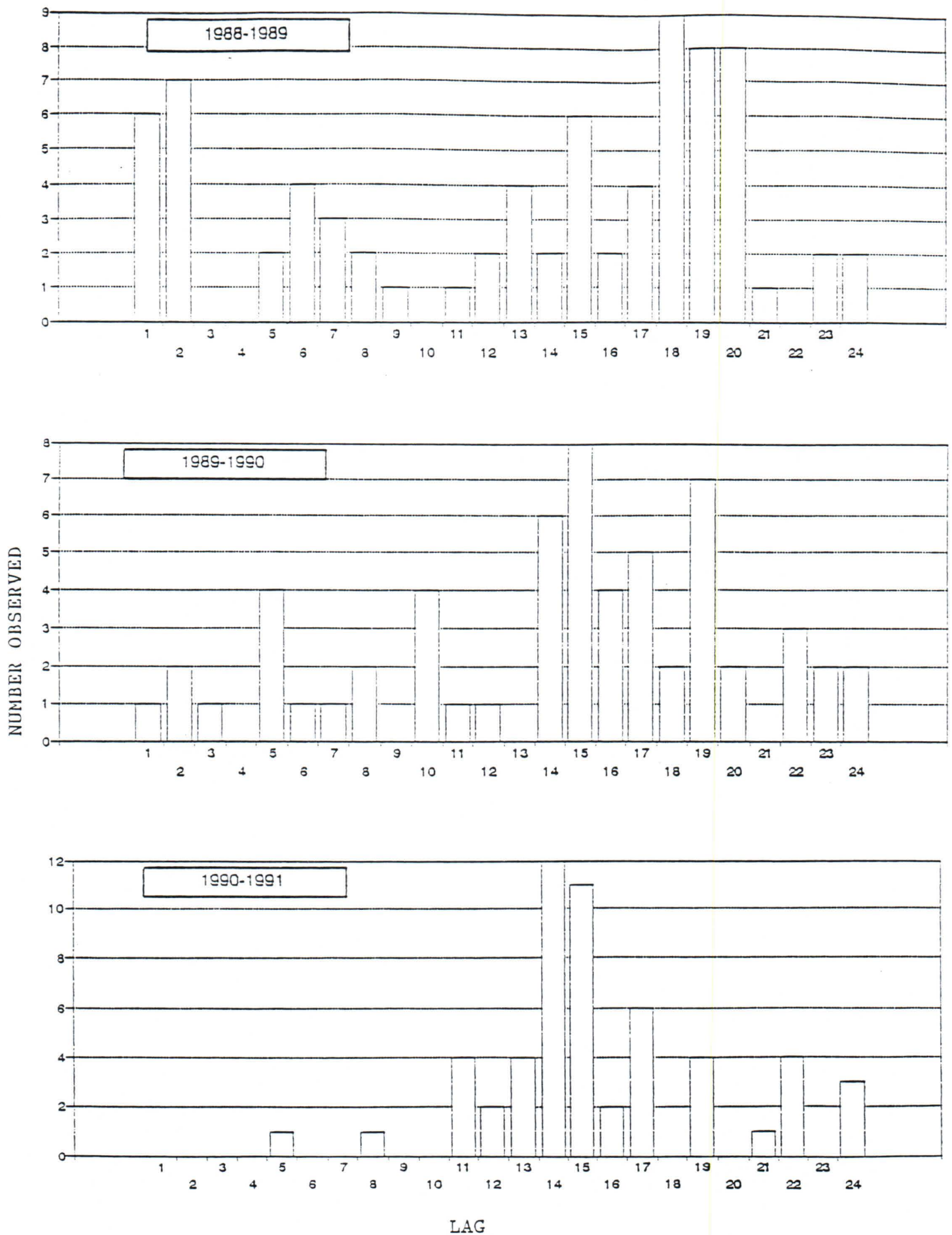


Figure 9. The distribution of rough-legged hawks along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.

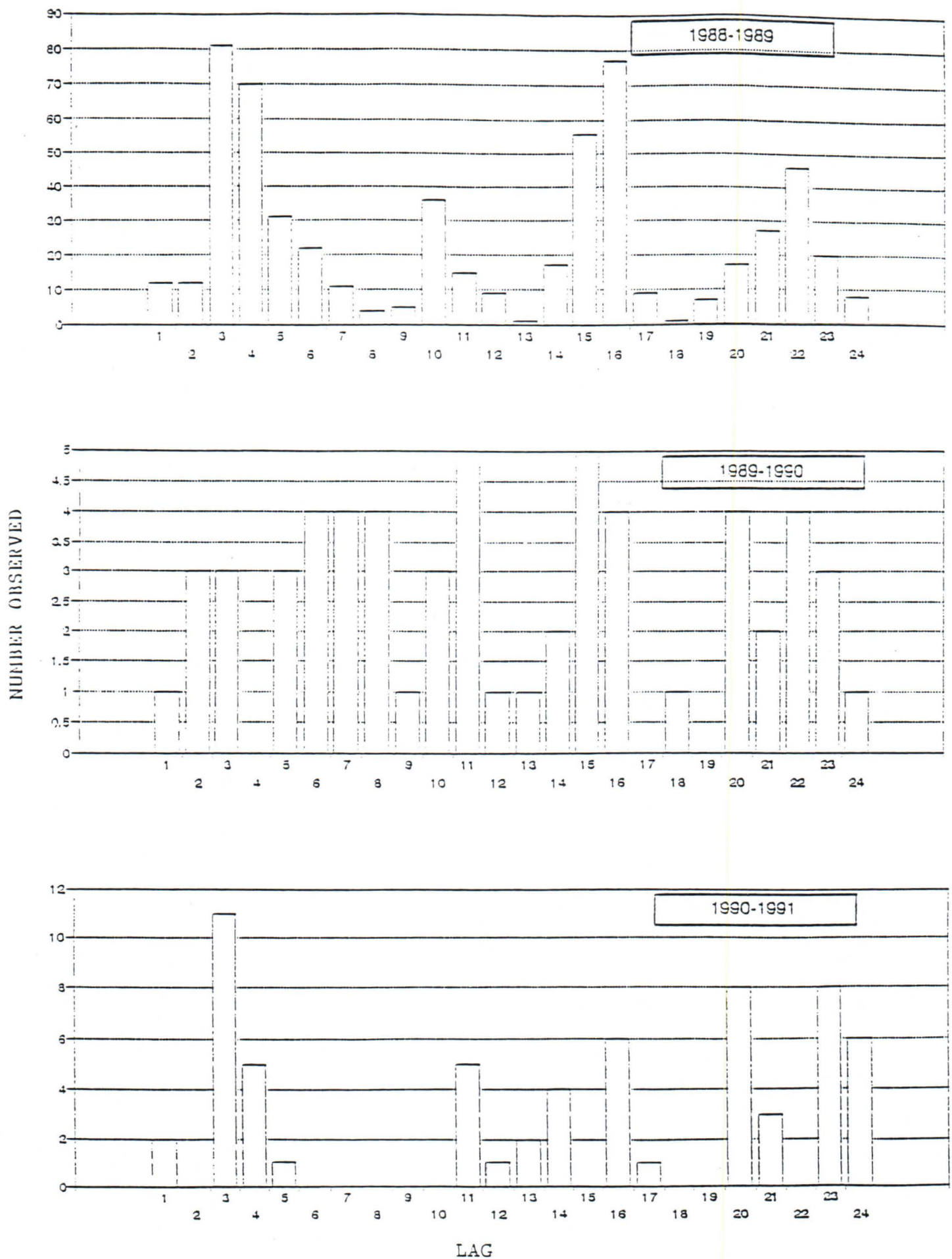
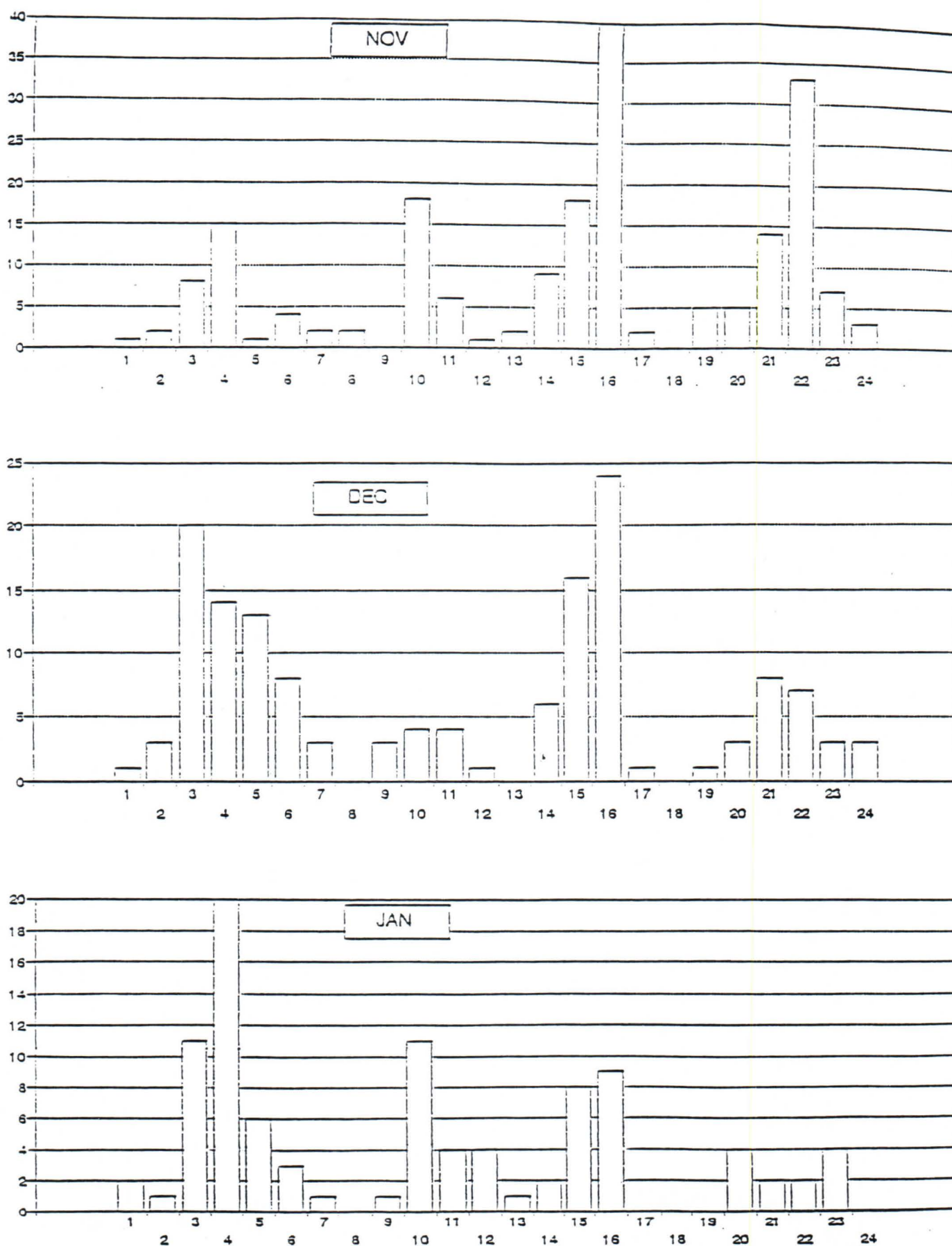


Figure 10. The distribution of ferruginous hawks along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.



LAG

Figure 11. The distribution of ferruginous hawks along the Arsenal road survey during November, December, January, and February 1988-89.

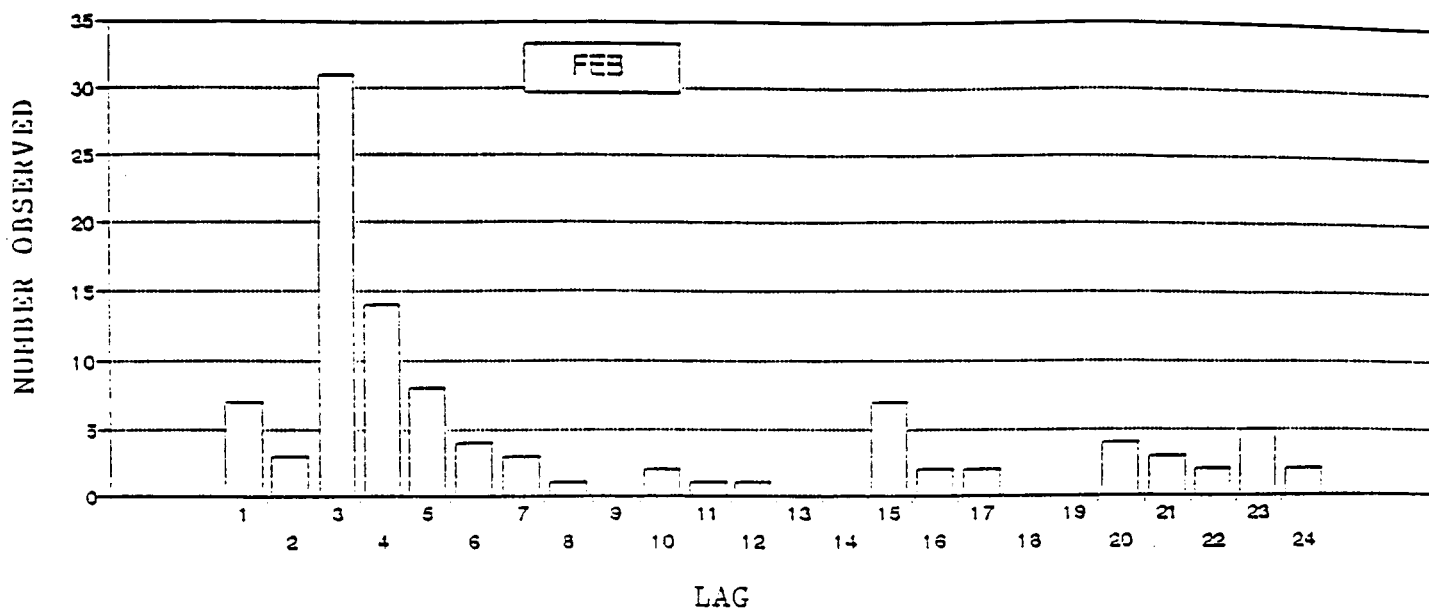


Figure 11. Cont.

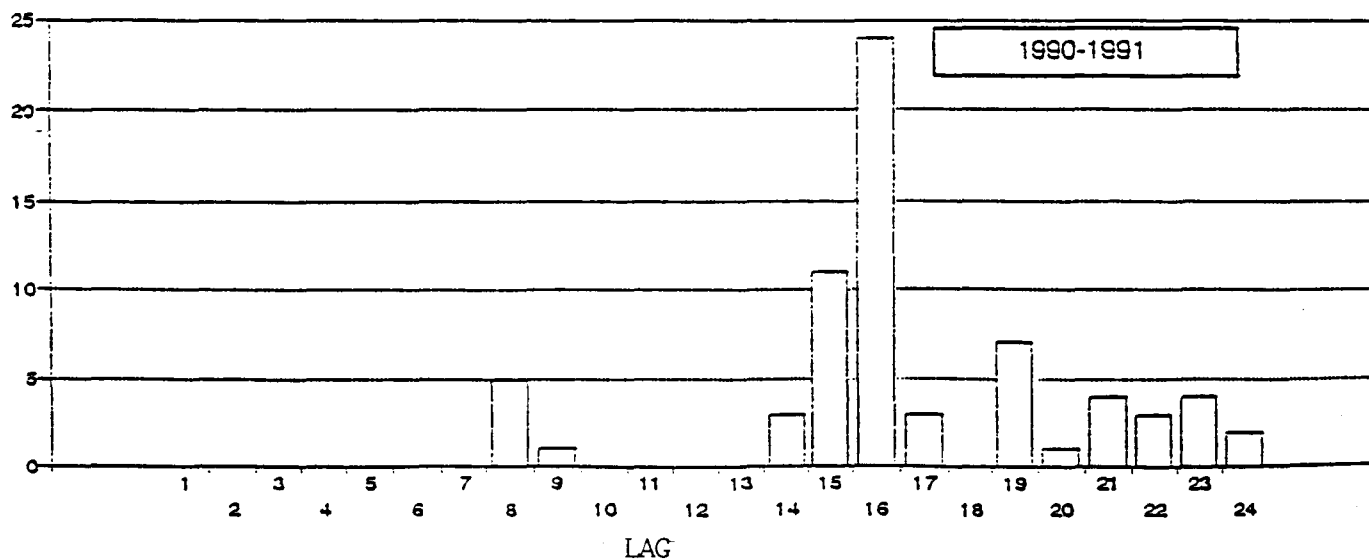
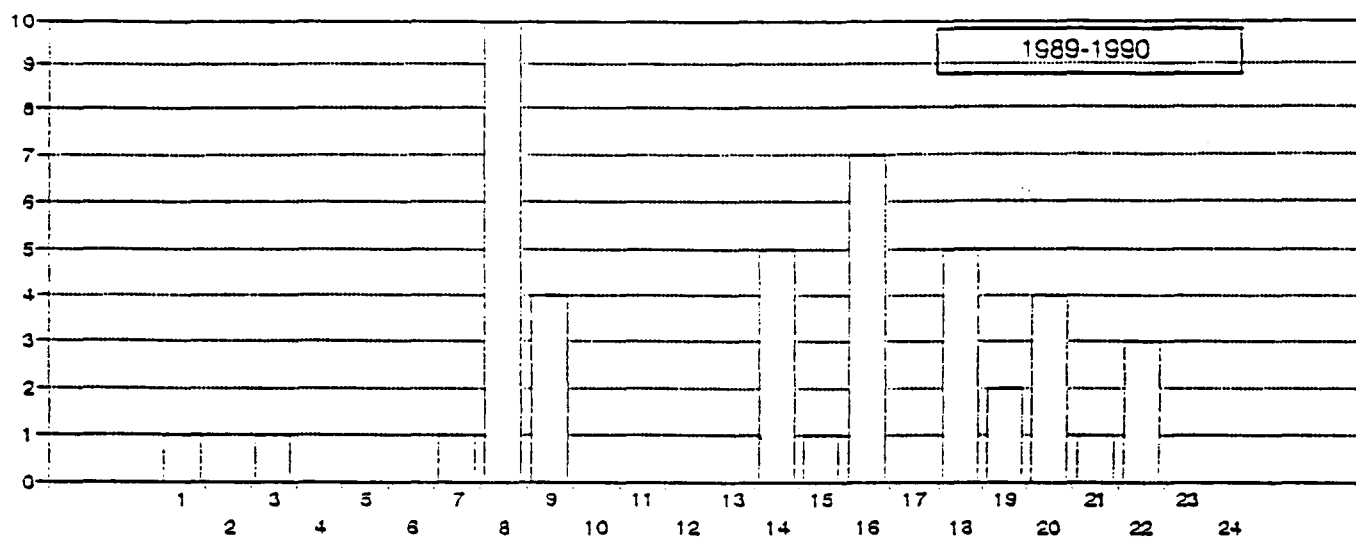
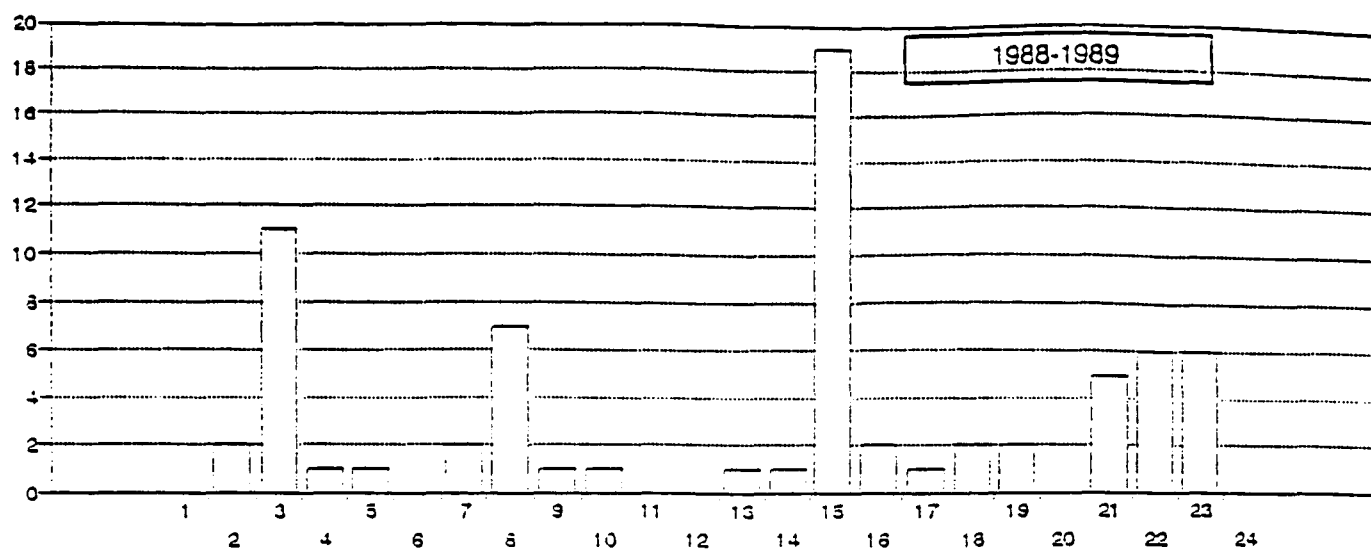


Figure 12. The distribution of bald eagles along the Arsenal road survey during the winters of 1988-89, 1989-90, and 1990-91.

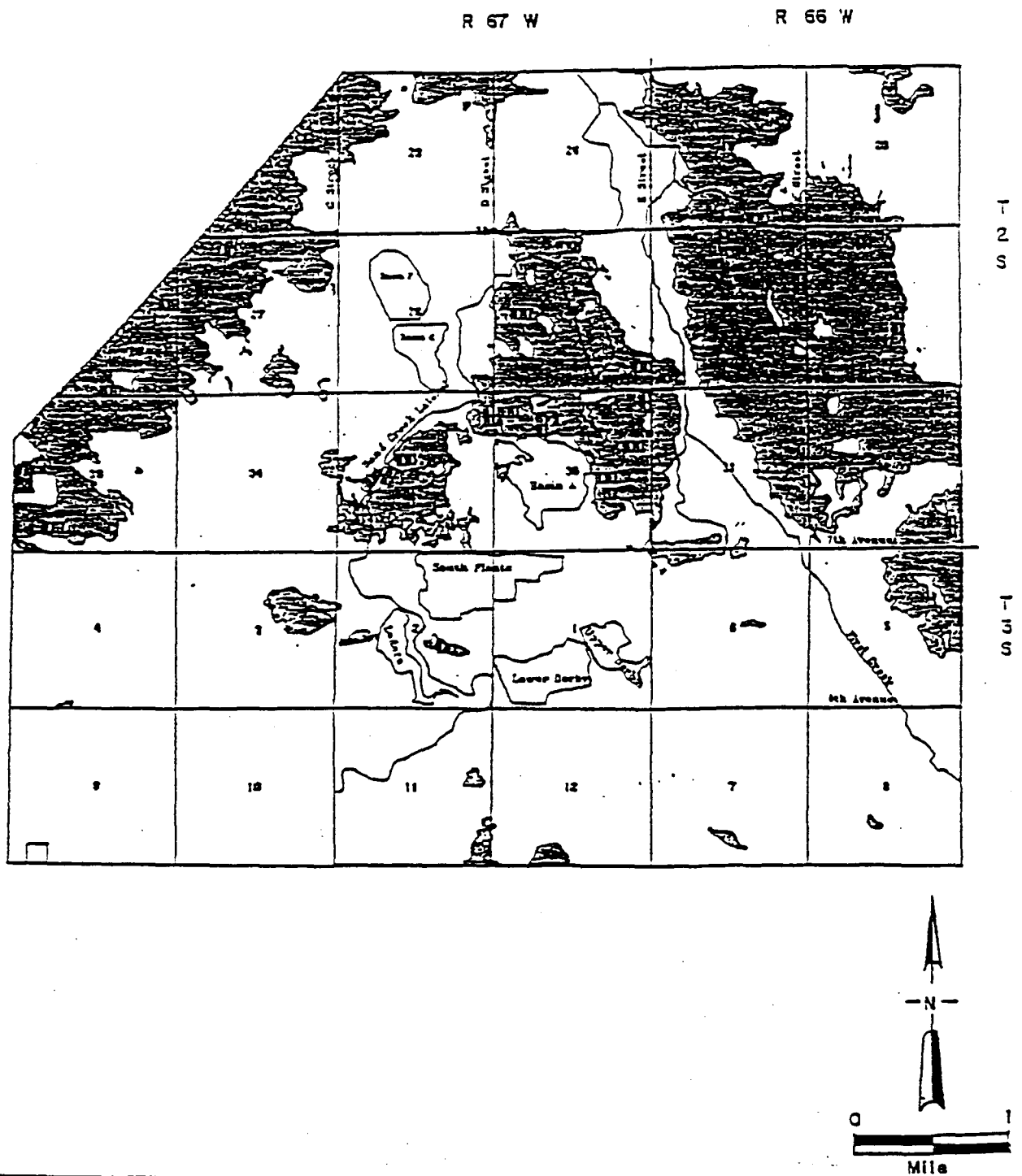


Figure 13. The distribution of black-tailed prairie dog towns on the Rocky Mountain Arsenal in October, 1988 (Ebasco-1989).

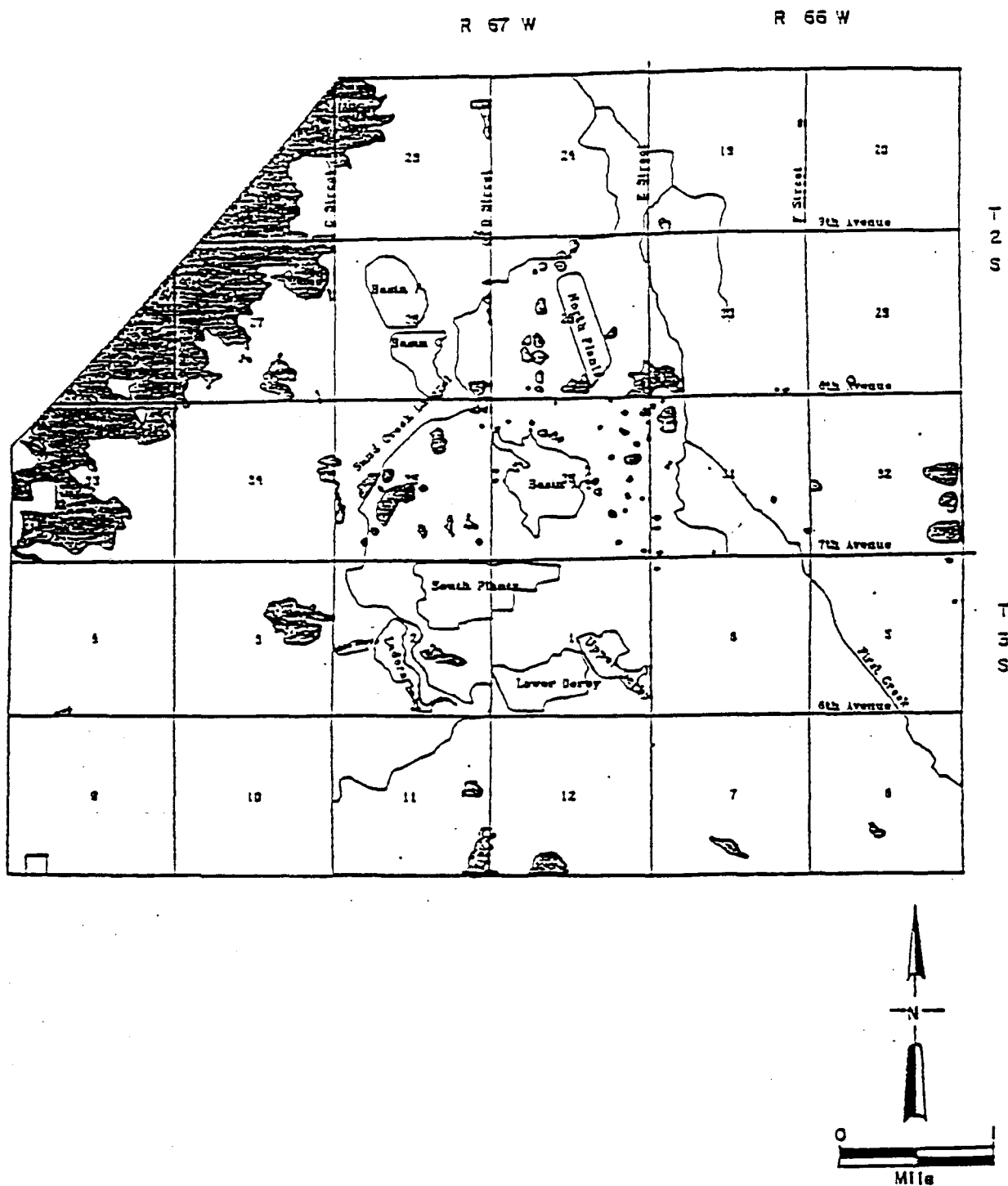
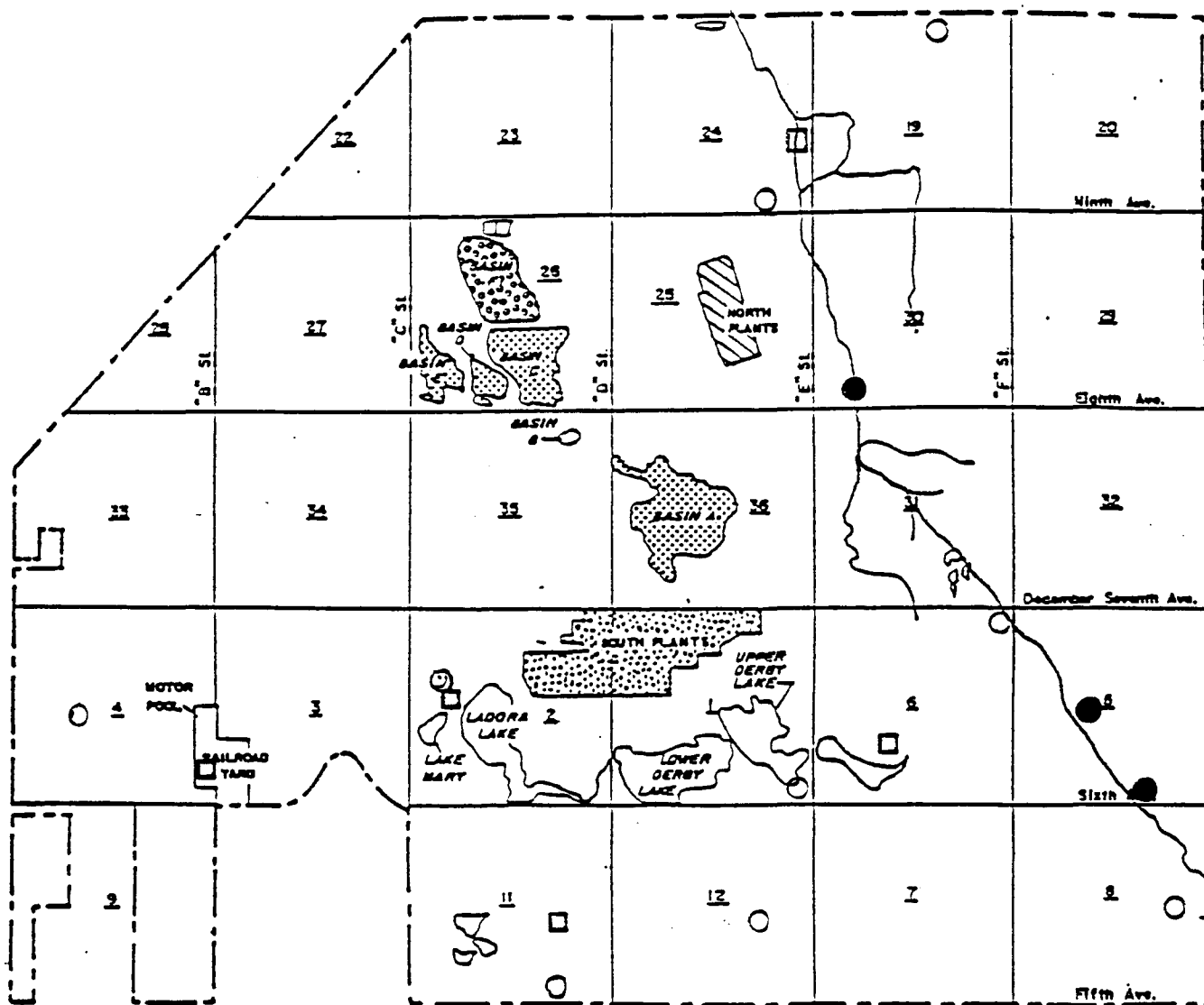
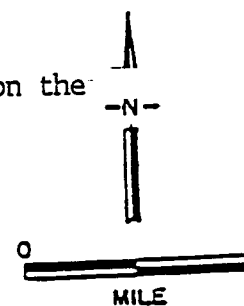


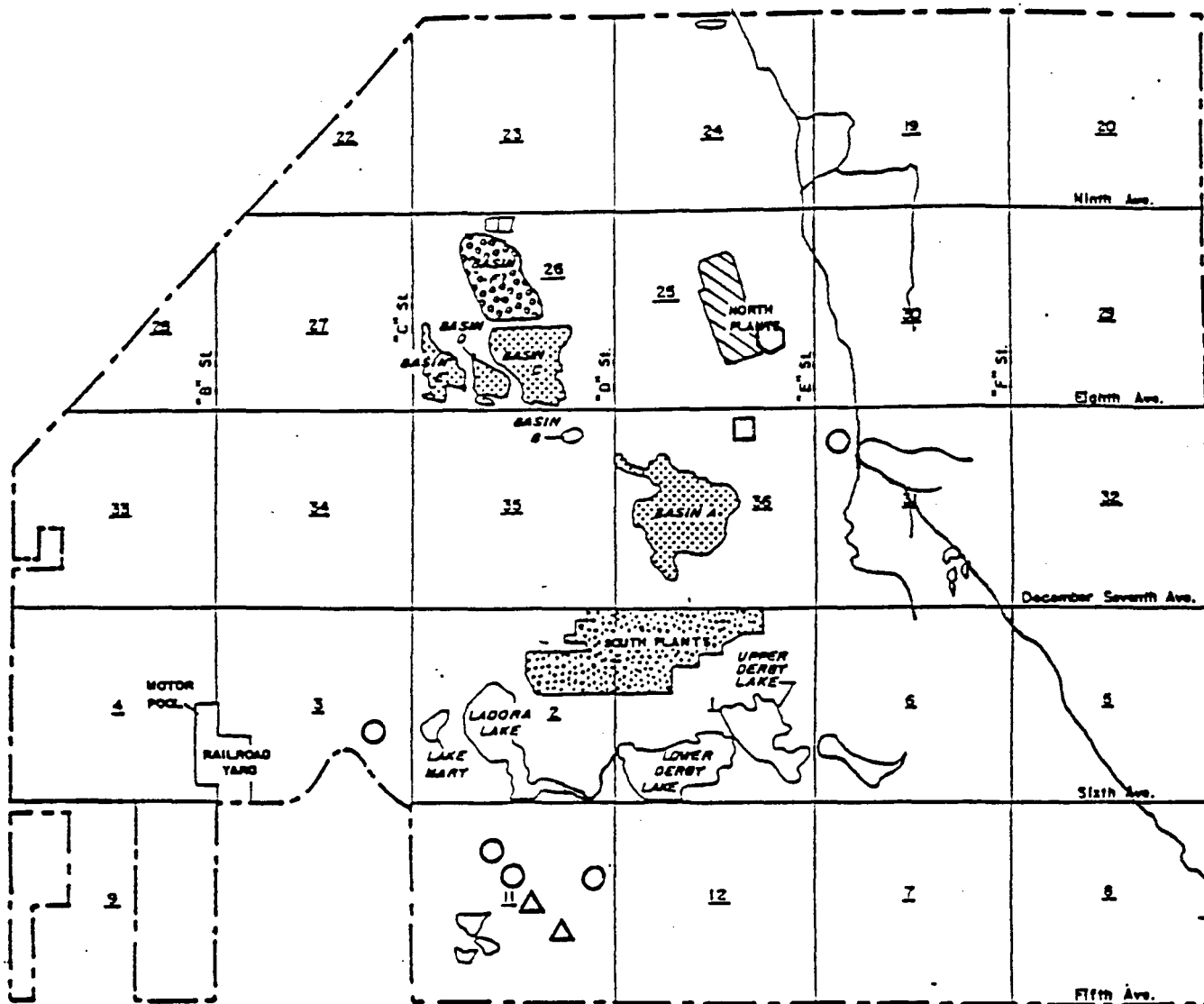
Figure 14. The distribution of active black-tailed prairie dog towns on the Rocky Mountain Arsenal in February, 1989, (Ebasco 1989).



- 1991
- 1990
- 1990 and 1991

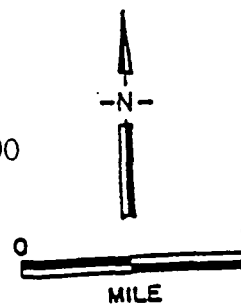
Figure 16. Breeding pairs of great horned owls during 1990 and 1991 on the Arsenal.

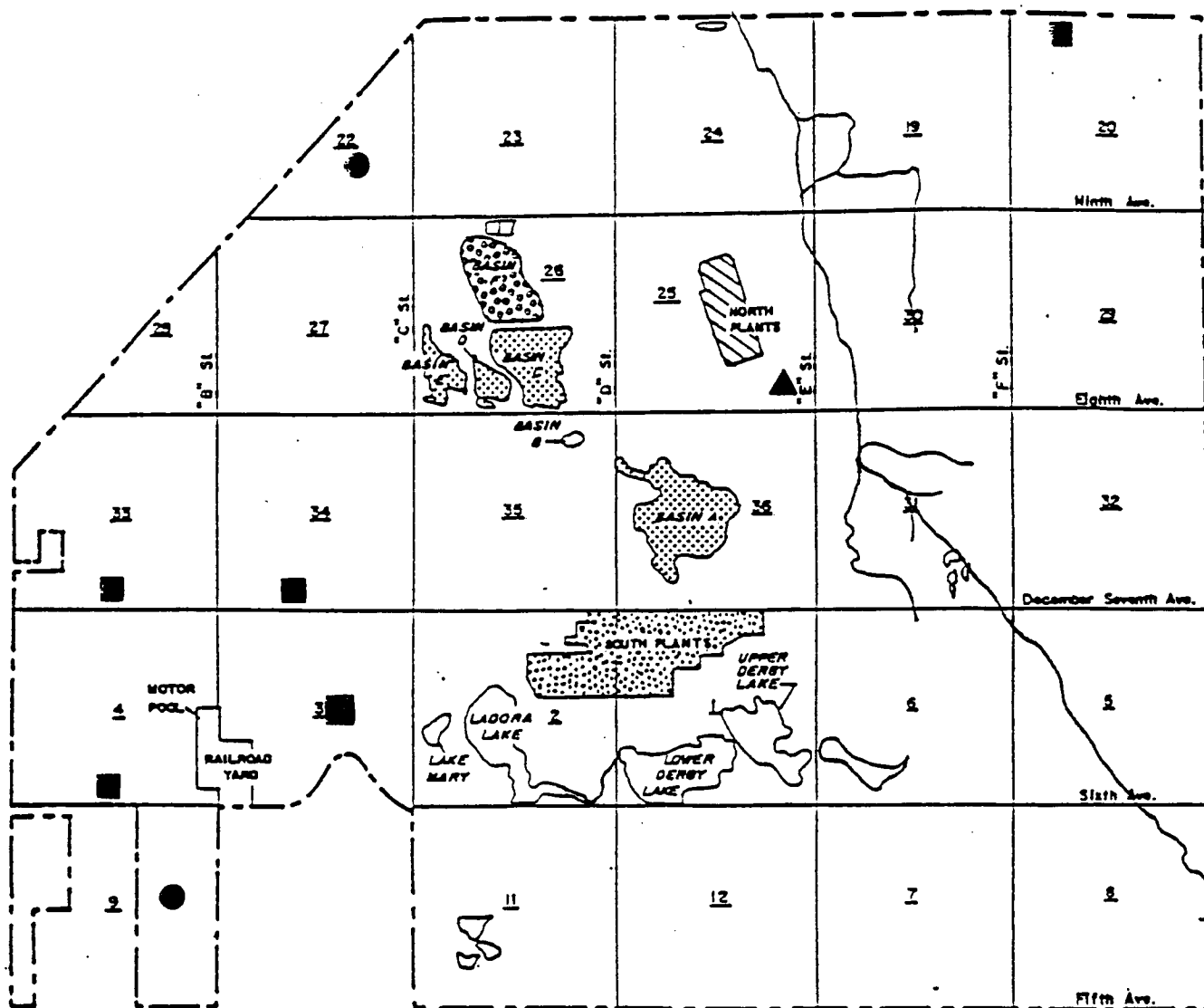




- △ Long-eared owl 1990
- Long-eared owl 1991
- ⬡ Barn owl 1990
- Barn owl 1991

Figure 17. Breeding pairs of long-eared owls and barn owls during 1990 and 1991.



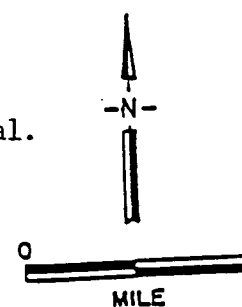


● swainson's hawk 1990

■ swainson's hawk 1991

▲ red-tailed hawk 1991

Figure 18. Breeding pairs of hawks during 1990 and 1991 on the Arsenal.



TITLE: Relative abundance and distribution of waterfowl.

PERSONNEL: Daniel J. Matiatos, Wildlife Biologist, USFWS,
Rocky Mountain Arsenal.

Sheila Dufford, Wildlife Biologist, USFWS, Rocky
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Scott Peltier, Wildlife Biologist,
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INTRODUCTION

Surveys to monitor seasonal abundance and distribution of waterfowl on the Arsenal were initiated during the fall of 1988 to acquire information on wintering waterfowl as a bald eagle prey item. The Arsenal contains a myriad of wetland types that support a diverse waterfowl community (Table 1). The data acquired facilitates habitat management and mitigation for waterfowl habitats that may be impacted during Arsenal cleanup. This information will assist with future plans to enhance public viewing potential of waterfowl and other waterbirds.

METHODS

Waterfowl were counted two hours after sunrise on calm days with no precipitation. Counts were conducted from fixed observations points two to four times a month. Waterfowl surveys were not conducted from March through July 1991 due to other priorities. Surveys of the new wetland sites were conducted from August through October 1991.

The waterfowl survey plan continues to be modified to include additional sampling points and data (USFWS 1990). Currently, 21 observation points are sampled including four representing the new wetland sites (Figure 1). For ease of analysis, data acquired from the 21 observation points were compiled into seven areas representing similar habitats or the same wetland.

RESULTS AND DISCUSSION

Waterfowl population trends followed a pattern similar to the last two years (USFWS 1990). Waterfowl numbers decreased during iceover periods or migration (Figures 2 and 3).

Mallards were the most widely distributed species followed by Canada Geese (Table 2). Canada geese occurred in the greatest numbers followed by american coots and mallards (Table 2).

The greatest number of waterfowl (Table 3) and species (Figure 4) were observed on Lake Ladora followed by the Upper Derby Lakes and the Havana Ponds.

LITERATURE CITED

U.S. Fish and Wildlife Service 1990. U.S. Fish And Wildlife Service Rocky Mountain Arsenal Field Office Fiscal Year 1990 Annual Progress Report. Partial Fulfillment of the Cooperative Agreement Between The U.S. Fish And Wildlife Service And The U.S. Army.

Table 1. Waterfowl documented by the Service on the Rocky Mountain Arsenal.

Species

Canada Goose (Branta canadensis)

Greater White-fronted Goose (Anser albifrons)

Snow Goose (Chen caerulescens) *

Mallard (Anas platyrhynchos)

Northern Pintail (Anas acuta)

Gadwall (Anas strepera)

American Wigeon (Anas americana)

Northern Shoveler (Anas clypeata)

Blue-winged Teal (Anas discors)

Cinnamon Teal (Anas cyanoptera)

Green-winged Teal (Anas crecca)

Wood Duck (Aix sponsa)

Redhead (Aythya Americana)

Canvasback (Aythya valisineria)

Ringed-necked Duck (Aythya collaris)

Lesser Scaup (Aythya affinis)

Greater Scaup (Aythya Marila)

Common Goldeneye (Bucephala clangula)

Bufflehead (Bucephala albeola)

Red-breasted Merganser (Mergus serator)

Common Merganser (Mergus merganser)

Hooded Merganser (Lophodytes cucullatus) *

Ruddy Duck (Oxyura jamaicensis)

White-winged Scoter (Melanitta deglandi) *

Barrows's Goldeneye (Bucephala islandica) *

* Indicates waterfowl species first observed in the period from November 1990 through October 1991.

Table 2. The total number of each species observed and the number of areas each waterfowl species was observed on the Arsenal from November 1990 to October 1991.

Species	Number Observed	Number of Areas observed
Gadwall	421	5
Canvasback	9	3
Redhead	70	3
Ring-Necked Duck	291	2
Common Goldeneye	41	3
American Coot	1471	4
Canada Geese	2065	6
Bufflehead	22	3
Green-winged Teal	274	5
American Widgeon	344	3
Lesser Scaup	23	2
Northern Shoveler	104	5
Northern Pintail	314	4
Greater Scaup	1	1
Common Merganser	29	4
Mallard	1251	7
B-W-Teal	477	4
Wood Duck	1	1
Ruddy Duck	1	1

Table 3. The number of waterfowl observed per area during surveys on the Arsenal from November 1990 through October 1991.

Species	Area *						
	1	2	3	4	5	6	7
Gadwall		41	124	16	225	15	
Canvasback		2			6	1	
Redhead			47		21	1	
Ring-Necked		24			267		
Com. Goldeneye			10		28	3	
Am. Coot		50	230	8	1184		
C. Geese	85	190		873	799	82	36
Bufflehead				1	11	10	
G-W-Teal			53	12	2	177	30
Am. Widgeon		3	340		21		
Lesser Scaup					20	3	
N. Shoveler		1	8		2	87	6
N. Pintail			264		1	47	2
Greater Scaup					1		
Com. Merganser			2	8	1	18	
Mallard	14	17	502	4	24	629	61
B-W-Teal	5		340			64	68
Wood Duck	1						
Ruddy Duck			1				
Total	105	328	1921	922	2613	1137	203

* 1= First Creek Corridor; 2= Lake Mary; 3= Upper Derby Lakes; 4= Lower Derby Lake; 5= Lake Ladora; 6= Havana Ponds; 7= New Wetlands Sects. 7 and 8.

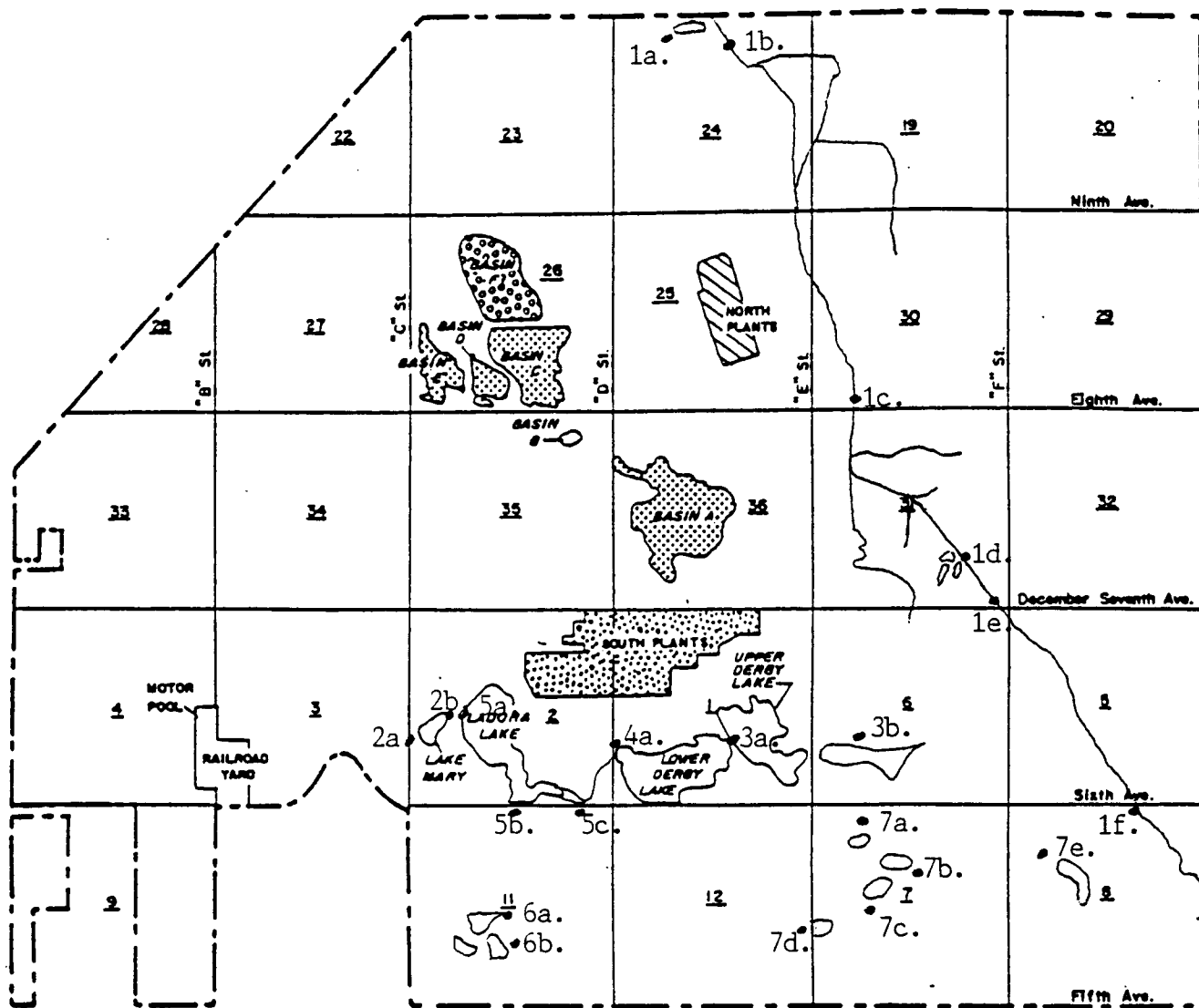
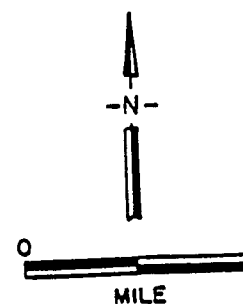


Figure 1. Waterfowl survey locations at the Arsenal from November 1990 through October 1991.



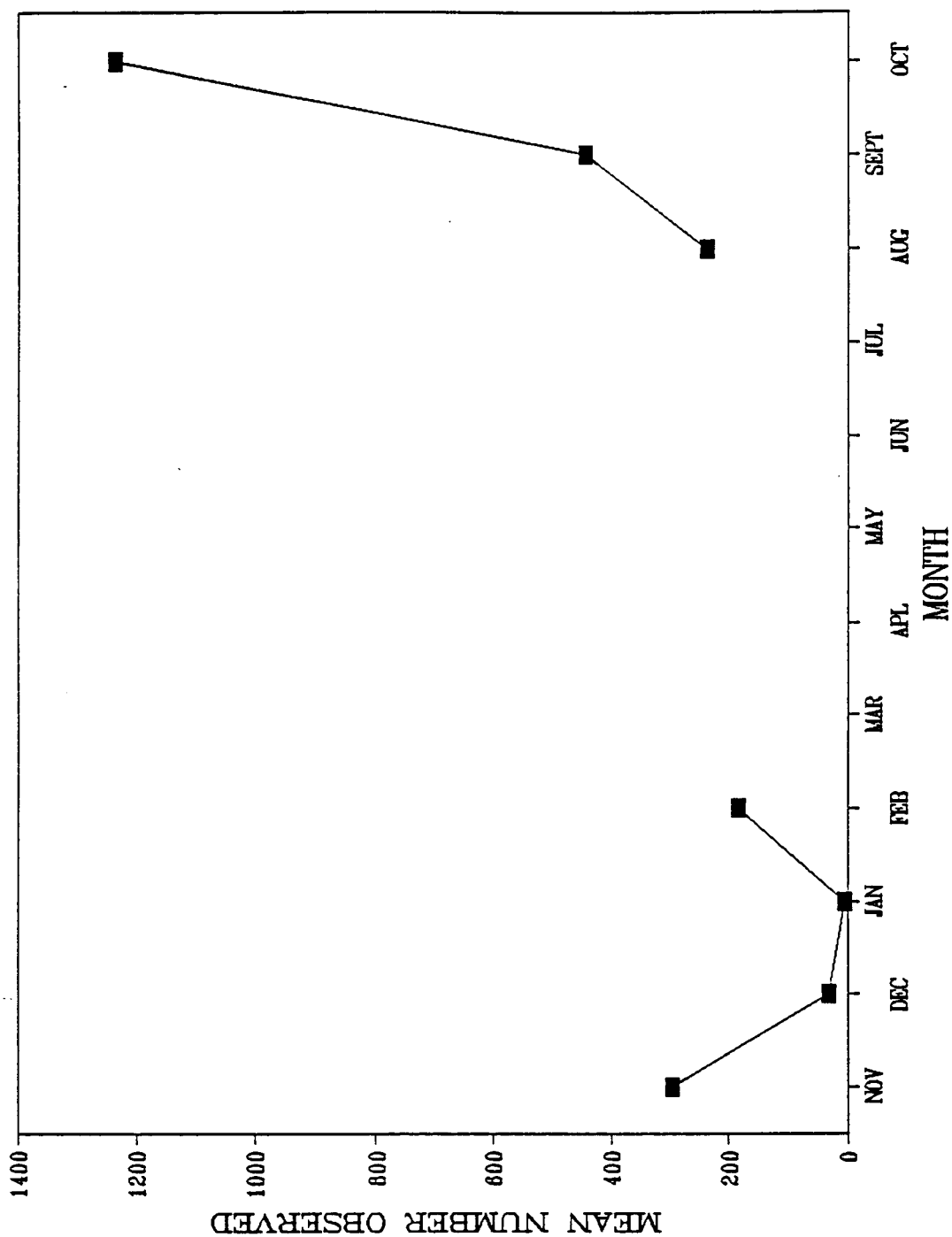


Figure 2. The mean number of ducks observed per month during surveys at the Arsenal from November 1990 through October 1991.

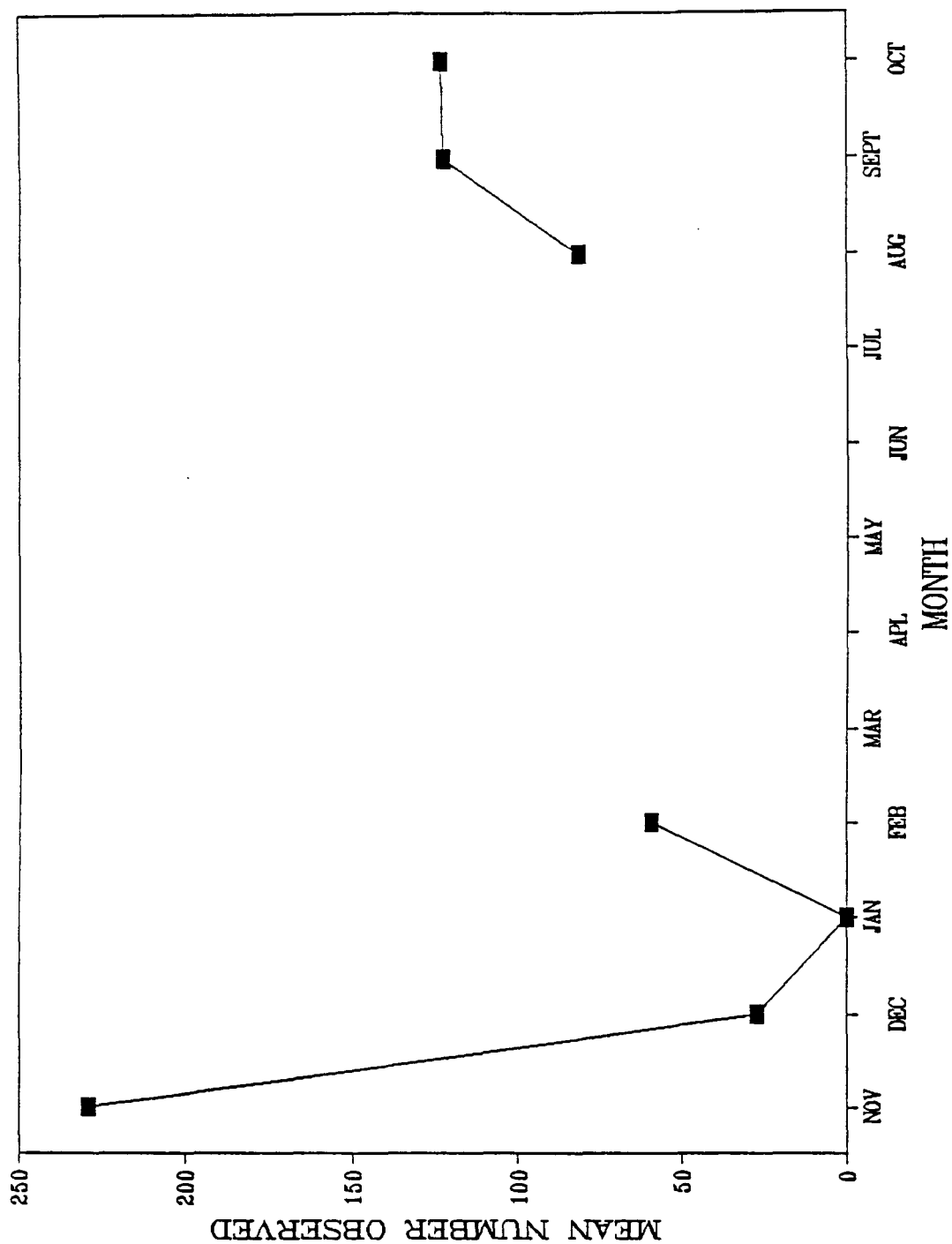


Figure 3. The mean number of Canada geese observed per month during surveys at the Arsenal from November 1990 through October 1991.

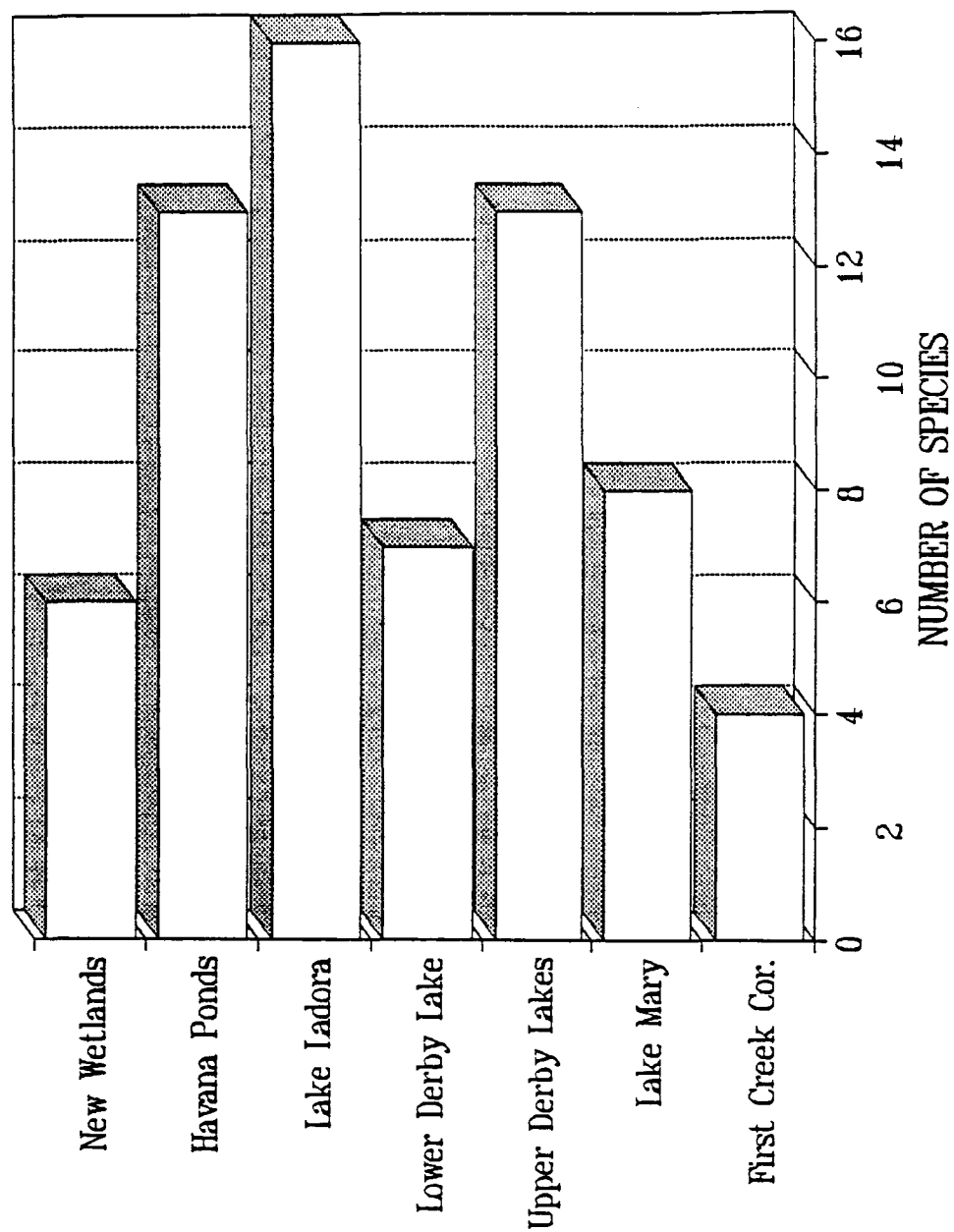


Figure 4. The number of waterfowl species observed per area during surveys at the Arsenal from November 1990 through October 1991.

TITLE: Distribution and abundance of the black-tailed prairie dog.

PERSONNEL: David Seery, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

Fred Krampetz, Biological Technician, USFWS, Rocky Mountain Arsenal.

INTRODUCTION

Since the sylvatic plague epizootic of 1988-89 reduced the population of black-tailed prairie dogs (Cynomys ludovicianus) (BTPD) on the Arsenal by an estimated 95% (Ebasco, 1989, U.S. Fish and Wildlife, 1989/90), the Service has been working to re-establish black-tailed prairie dogs to former levels. Since prairie dogs form the prey base for a variety of predators on the Arsenal, including the endangered bald eagle (Haliaeetus leucocephalus), it was deemed crucial that their population levels be restored as soon as possible. The focal point of this effort has been through relocations of prairie dogs into areas of former occupation (Fig. 1). Several private organizations have assisted the Service with relocations by supplying the Arsenal with 5229 prairie dogs since 1989. This study was initiated to determine the current distribution and abundance of prairie dogs on the Arsenal and to assess the future prairie dog relocation policies of the Service. Additional work has been accomplished by a Colorado State University graduate student on survival of relocated prairie dogs on the Arsenal, and evaluation of prairie dog barriers. Results from this study can be found in Appendix E.

METHODS

Distribution

Prairie dog distribution was mapped using the most current 8 1/2 by 11 inch black and white aerial photographs. Each photo showed a different section of the Arsenal with a scale of approximately 1 inch equal to 660 feet. An 8 1/2 by 11 piece of frosted mylar was attached to each photo for delineation of prairie dog town perimeters in the field. Only areas of active prairie dog town were included in the survey. Upon completion of the mapping, areas of the prairie dog towns were determined using a digital planimeter.

Abundance

The methods used to estimate population parameters were based on those used by the Service's National Ecology Research Center in Fort Collins (Biggins, 1989), to evaluate potential black-footed ferret habitat. Visual counts were used to determine population densities and burrow transects were conducted to yield burrow densities and relative activity levels. Both methods are used to

ascertain overall fitness of the population and values will be compared to other black-tailed prairie dog populations.

Study plots were selected on a representative, rather than a random basis, due to area contamination and to certain site characteristics needed for the study (Fig. 2). The plots ranged in size from 4 to 9 hectares, based on size of the individual prairie dog towns and visibility requirements for visual counts (i.e., being able to see the entire plot from a single vantage point). The plots were laid out using a surveyors transit and geodimeter, and corners marked with PVC tubing. Pin flags were set out at regular intervals along the sides of the plots to further assist in determining whether prairie dogs were in or out of the plot during counts.

Visual counts and burrow transects were conducted on each of the study plots (n=10) from 24 June to 14 August 1991. Visual counts were performed for three consecutive days on each plot, with the highest count used as the population estimate for that plot. These estimates were then summed and divided by the number of plots to determine the mean estimate. A correction factor for visual counts developed by the National Ecology Research Center in Fort Collins was then used to arrive at the final mean population estimate (in prairie dogs per hectare). Burrow transects were conducted on the same study plots using prescribed methods. Rol-a-tape wheels with three meter conduit attached were used to determine the area on each plot to be sampled, eg. a 200 meter-wide plot would yield a series of 600 square meter strips of area sampled. The number of active burrows as well as the total number of burrows were tabulated for each plot. The burrow densities were compared to other black-tailed prairie dog towns.

RESULTS AND DISCUSSION

Distribution

A total of 1372 acres (555.56 hectares) of active prairie dog towns were mapped in June, 1991 (Fig. 1, Table 3). This area does not include new relocation sites for FY91, in sections 27, 23, 19 and 20. These areas will be mapped in the subsequent survey, scheduled for January 1992. The mapping will be repeated annually or every six months, if possible, to closely monitor changes in prairie dog distribution.

Visual Counts

The visual counts conducted on the ten study plots yielded a mean of 14.64 prairie dogs per hectare, with a range from 9.5 to 20.4 per hectare and a standard deviation of 3.4 (Table 1). The corrected values generate a mean of 25.87/ha, a range of 16.78 to 36.1/ha and a S.D. of 6.0. Using the mean of 25.87 prairie dogs per hectare for the entire Arsenal (555.56 ha) generates a mean

population estimate of 14,372, with a 95% confidence interval of 11,983 to 16,761.

Burrow Transects

The burrow transects collected data from 2.8% of the active prairie dog town area with a mean of 106.9 total burrows per hectare and a range of 58.0 to 134.13 (Table 2). There was a mean of 74.28 active burrows per hectare (range 43.29 to 112.7/ha), a standard deviation of 21.34, and a relative activity of 72.5% (active/total burrows).

Prairie dogs have made a dramatic comeback following the plague epizootic of 1988-89. From an estimated population of over 68,000 in 1987 to a low of less than 3500 in September 1989 (based on data in Clippinger, 1987 with NERC correction factor), prairie dogs have rebounded to a population of almost 15,000 in only 2 years. Black-tailed prairie dog densities on the Arsenal are comparable to those found in other studies (Fig. 3) (Biggins 1989, King 1955, Koford 1958, Lewis 1979, Tileston and Lechleitner 1966). The density found in Section 29 (36.11 BTPD's per hectare) exceeds the values found by other researchers in northern Colorado (32 BTPD's per hectare, Tileston and Lechleitner, 1966). BTPD burrow densities found on the Arsenal are also comparable to those reported by other investigators such as Koford (1958) 6-116/ha, King (1955) 125/ha, Knowles (1982) 101-104/ha, and Tileston and Lechleitner (1966) 104/ha. Garret et al. (1982) noted that "newly established and expanding towns have a greater proportion of successful pregnancies, have larger and faster growing litters, have higher adult survivorship, and twice the population density than old colonies with stable populations of black-tails." The BTPD colonies on the Arsenal are estimated to be at least two to three years from attaining stable populations in the areas they presently occupy, which is at present about 40% of their former distribution (Ebasco, 1989).

Table 1. Prairie dog visual count data summary, August, 1991.

SECTION	PLOT SIZE (HA)	HIGHEST COUNT	DENSITY (PD/HA)	DENSITY (CORRECTED)
19	9	162	18.00	31.80
20	4	61	15.25	26.94
22	4	53	13.25	23.41
29	9	184	20.44	36.11
5	4	46	11.50	20.32
32 (SE)	4	50	12.50	22.08
32 (NE)	4	49	12.25	21.64
30	4	69	17.25	30.47
35	6	99	16.50	29.15
2	4	38	9.50	16.78

Table 2. Prairie dog burrow transect data summary, August, 1991.

SECTION	ACTIVE BURROWS	TOTAL BURROWS	PERCENT ACTIVE	BURROWS/ HECTARE
19	284	338	84.02	134.13
20	108	136	79.41	111.1
22	101	141	71.63	106.82
29	226	287	78.74	106.3
5	61	109	55.96	100.9
32 (SE)	105	139	75.54	115.83
32 (NE)	67	135	49.63	119.05
30	95	129	73.64	114.67
35	103	174	59.19	85.93
2	50	67	74.63	58.0

Table 3. Active prairie dog towns, June, 1991 (by Section).

<u>SECTION</u>	<u>AREA</u>
22	12.56 ha (31.02 acres)
23	5.65 ha (13.97 acres)
19	69.59 ha (171.87 acres)
20	19.55 ha (48.28 acres)
28	3.83 ha (9.46 acres)
27	16.40 ha (40.5 acres)
26	5.48 ha (13.53 acres)
25	20.64 ha (50.97 acres)
30	35.55 ha (87.80 acres)
29	78.92 ha (194.91 acres)
33	4.28 ha (10.57 acres)
34	.127 ha (.313 acres)
35	85.74 ha (211.75 acres)
31	13.26 ha (32.76 acres)
32	65.12 ha (160.83 acres)
4	4.19 ha (10.35 acres)
3	8.37 ha (20.67 acres)
2	8.31 ha (20.52 acres)
6	6.71 ha (16.57 acres)
5	38.70 ha (98.58 acres)
9	37.03 ha (91.45 acres)
11	8.13 ha (20.08 acres)
12	5.79 ha (14.30 acres)
8	1.63 ha (4.02 acres)
<u>TOTAL AREA</u>	<u>555.56 ha (1372.06 acres)</u>

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Fig. 1. ROCKY MOUNTAIN ARSENAL
PRAIRIE DOG DISTRIBUTION, 1991

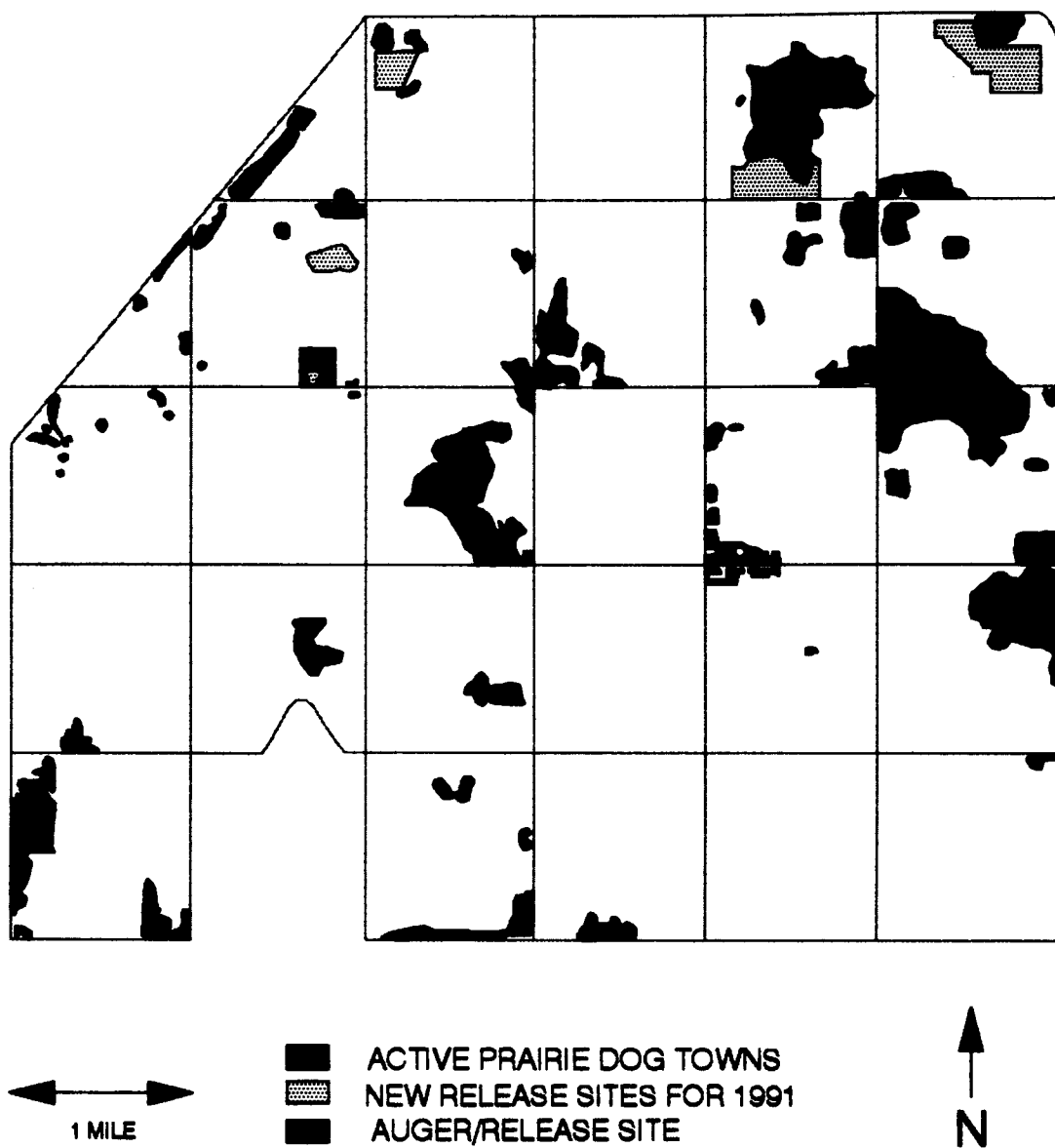


Fig. 2. ROCKY MOUNTAIN ARSENAL
PRAIRIE DOG STUDY PLOTS, 1991

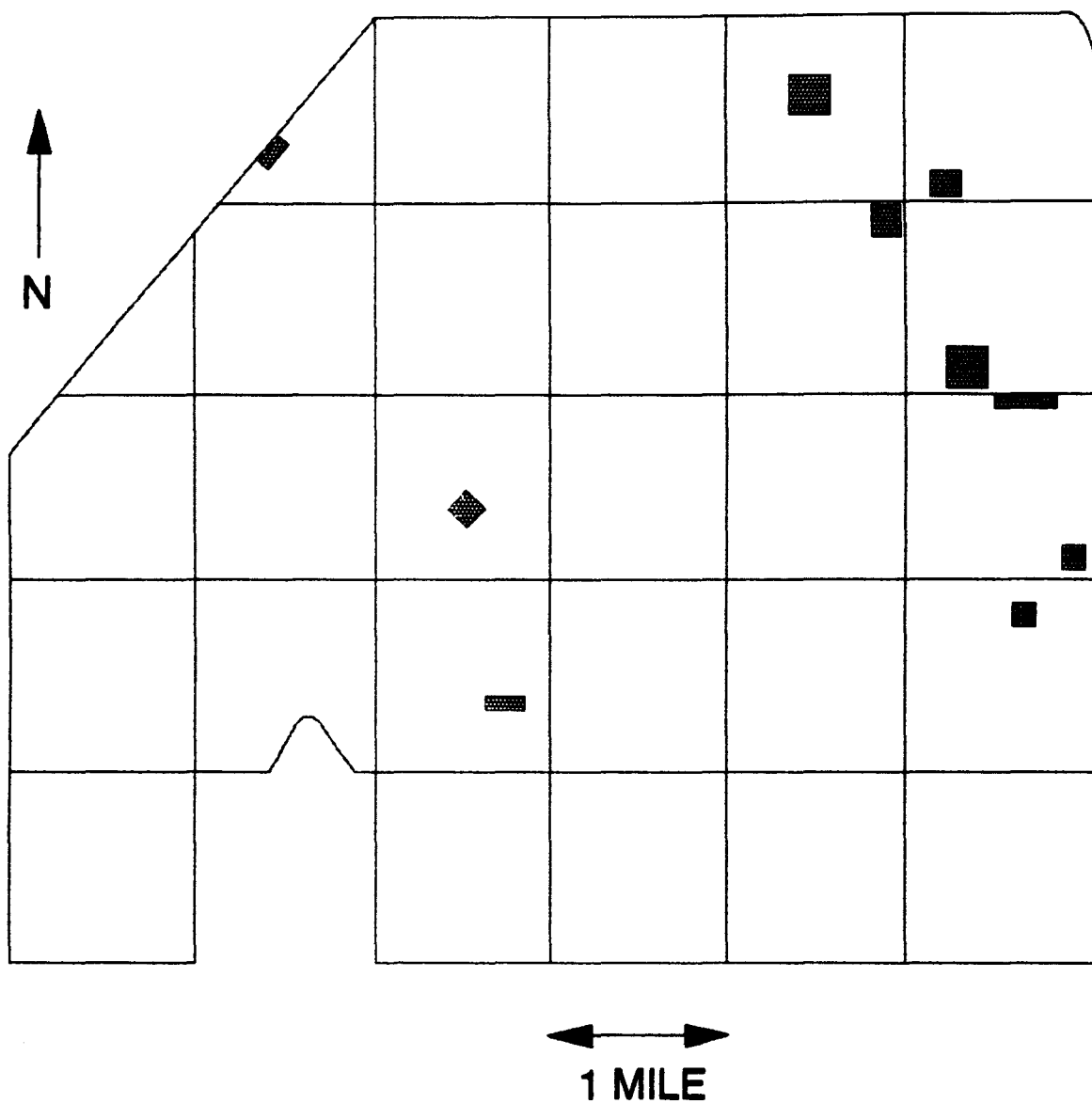
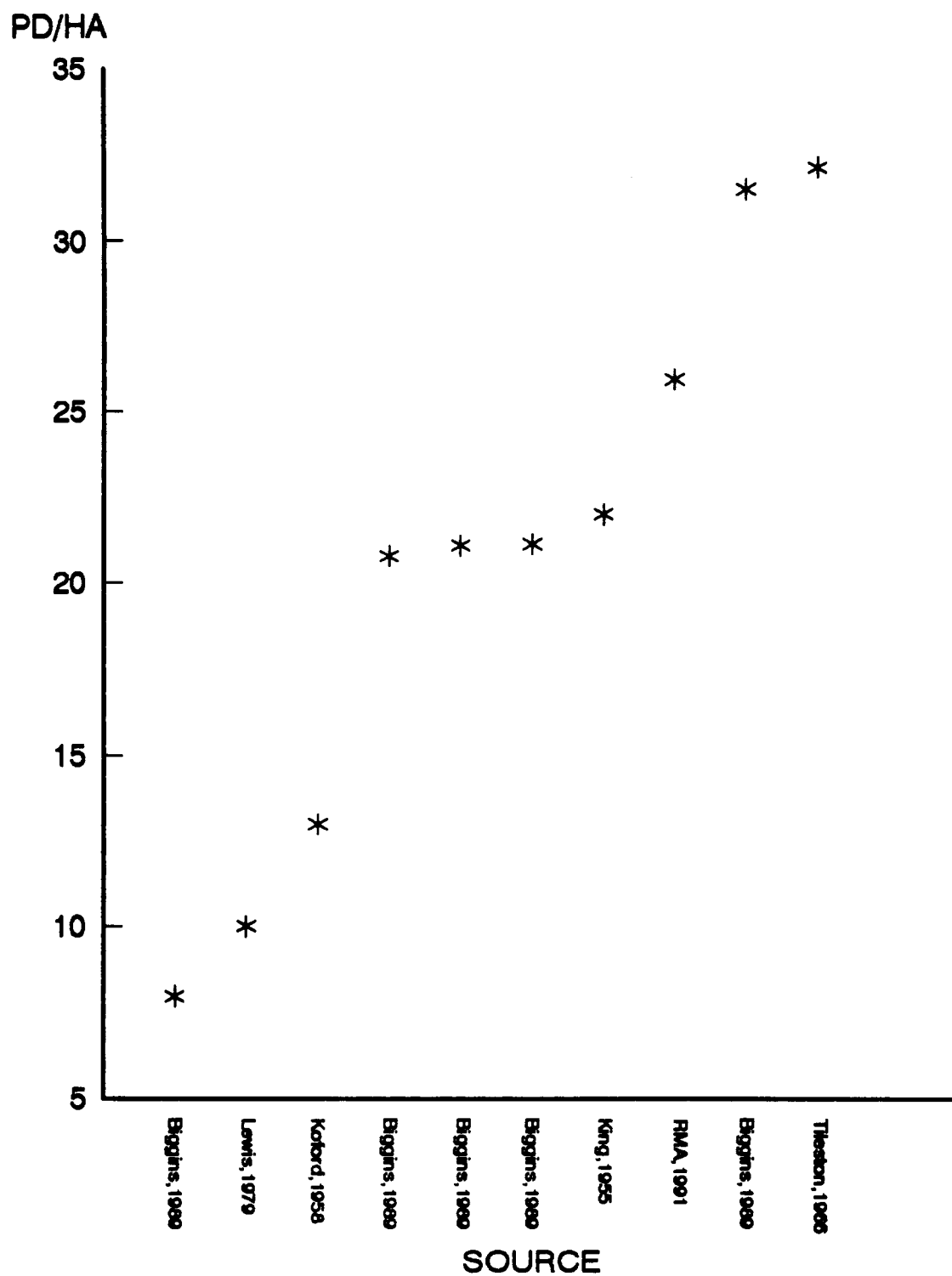


Fig. 3. PRAIRIE DOG POPULATION DENSITIES
FROM VARIOUS SOURCES



TITLE: Black-tailed prairie dog relocations, 1989 - 1991.

PERSONNEL: David Seery, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

Fred Krampetz, Biological Technician, USFWS, Rocky Mountain Arsenal.

Sheila Dufford, Wildlife Biologist,
USFWS, Rocky Mountain Arsenal,

Kevin Robinette, Graduate Research
Assistant, Colorado State
University

INTRODUCTION

During 1988 and 1989, 95% of the existing black-tailed prairie dog (Cynomys ludovicianus) population on the Arsenal was destroyed by sylvatic plague. In August 1989, the Service initiated a prairie dog reintroduction project. The purpose of this project was to assist the recovery of the prairie dog colonies decimated by sylvatic plague and to develop procedures for relocating prairie dogs. Beginning in FY90 and extending through FY91 the project was expanded to include the relocation of prairie dogs from areas on the Arsenal where they were interfering with other projects. Prairie dogs were also relocated to minimize human conflicts with Arsenal prairie dogs both on and off post. Near the end of FY91 a research project was initiated to determine the feasibility of artificially augering prairie dog burrows. A study site was chosen in Section 27, around an existing prairie dog town. A mark/recapture experiment has been designed and implemented to determine survivability of the prairie dogs released into the augered burrows. Initial results from this study should be available early in FY92.

METHODS

The methods used for relocating prairie dogs onto the Arsenal in FY91 were the same as those used in the two previous years of relocation efforts. Basically these included: 1) sending a letter to each prairie dog relocater stating Service policy, 2) inspecting prairie dogs for fleas prior to bringing them on the Arsenal, 3) spraying or dusting all prairie dogs before releasing them on the Arsenal, and 4) recording the sex, age, weight and attaching ear tags to every prairie dog released on the Arsenal. Five new release sites were chosen in FY91 (Fig. 1), since those used in FY90 were rapidly filling up. The new sites were first inspected to determine their suitability as relocation sites (ie. formerly occupied by prairie dogs, adequate number of open burrows, etc.), then the area was flagged and the size determined. The Service then requested that Facilities

Maintenance mow and dust (with Sevin) the site prior to releasing prairie dogs. Each relocation site was used until all available burrows were occupied, at which time additional sites were prepared.

RESULTS AND DISCUSSION

During FY91, 2125 prairie dogs were released onto the Arsenal from off-post sources. The following organizations provided a total of 2010 prairie dogs: Prairie Dog Rescue - 1000; Loveland Prairie Dog Action - 342; Concerned Citizens for Wildlife - 262; Denver Water Department - 186; Boulder County Humane Society - 111; Weld Wildlife Relocators - 61; Jefferson County Open Space - 48. Service personnel trapped 115 off-post prairie dogs for Shell Oil Co. on their property north of the Arsenal. The Service trapped and relocated 237 prairie dogs from the following areas around the Arsenal proper: Section 35 (Bldg. 111) and Section 27 (N.W. boundary wells) - 33 in October; Section 23 N.E. - 9 in March; Bldg. 111 - 82 in May; Bldg. 111 and Section 25 (Borrow Pit) - 46 in June; Bldg. 111 - 67 in August. A combined total of 2362 prairie dogs were released by the Service from all sources in FY91 (Table 1).

Several sections of the Arsenal were utilized for relocations in FY91. Early in FY91, prairie dogs were released into section 5, near the eagle watch, section 19 north, sections 29/32, and section 30. These release sites were the focus of operations in FY90. Relocations were not conducted during December and January. Prairie dogs were again released into the combined area of sections 29 and 32. A total of 254 prairie dogs were relocated at this location in March, April, and May. Several areas of old habitat were mowed during the summer to facilitate expansion. Thus, prairie dogs were relocated into the following areas on the Arsenal: section 27 north - 175 in May and June; section 20 N.E. - 906 in June, July, and August; section 19 south - 138 in September. A 6 hectare study plot was created by augering artificial burrows in section 27 south. Four prairie dogs were placed in the section 27 auger site in September (Table 2.).

To date, a total of 5229 prairie dogs have been introduced onto the Arsenal from all sources during the 3 year period of FY89 - FY91 (Table 3). Releases increased significantly in FY90 and FY91 compared to FY89. Only 11.1 percent of the total were released in FY89 as shown in Table 3. This difference is accounted for by a short relocation period of only August and September.

All off-post relocator organizations were sent a letter stating that the Service will no longer accept prairie dogs after November 30, 1991. Therefore, the number of relocated dogs in

FY92 will be low compared to the previous 3 fiscal years, since only Service personnel will be conducting trapping.

Dispersals

The following incidences of dispersals by 5 individual prairie dogs reveals distances that prairie dogs will travel from their point of release on The Arsenal. A lactating female, previously released near building 111 on 12-2-89, was re-trapped on 5-29-91. This individual had survived for 17 months in the release site. A lactating female, previously released in section 19 north on 7-3-90, was recaptured on 3-27-91. This prairie dog, a 9 month survivor, had emigrated 3 miles. An adult male, previously released in section 27 north on 5-23-91, was re-captured on 8-14-91. In 3 months, this individual moved 1.5 miles from its release area. Ear tag numbers were noted on an adult male found dead on 10-23-91 in the northeast corner of section 30. This prairie dog travelled a distance of 1.6 miles in nearly 2 months from where it was released in section 20 northeast on 7-29-91.

Mortalities

The Service confirmed two prairie dog killings by hawks in section 20 northeast. On 8-19-91, ear tags were collected from the remains of a 690 gram female released in section 20 on 8-16-91. This individual survived for only 3 days. On 8-22-91, ear tags were collected from the carcass of a 560 gram male released on 8-21-91, which had survived for only 1 day. Ferruginous hawks and a turkey vulture were seen feeding near the carcasses.

Fig. 1. ROCKY MOUNTAIN ARSENAL
PRAIRIE DOG DISTRIBUTION, 1991

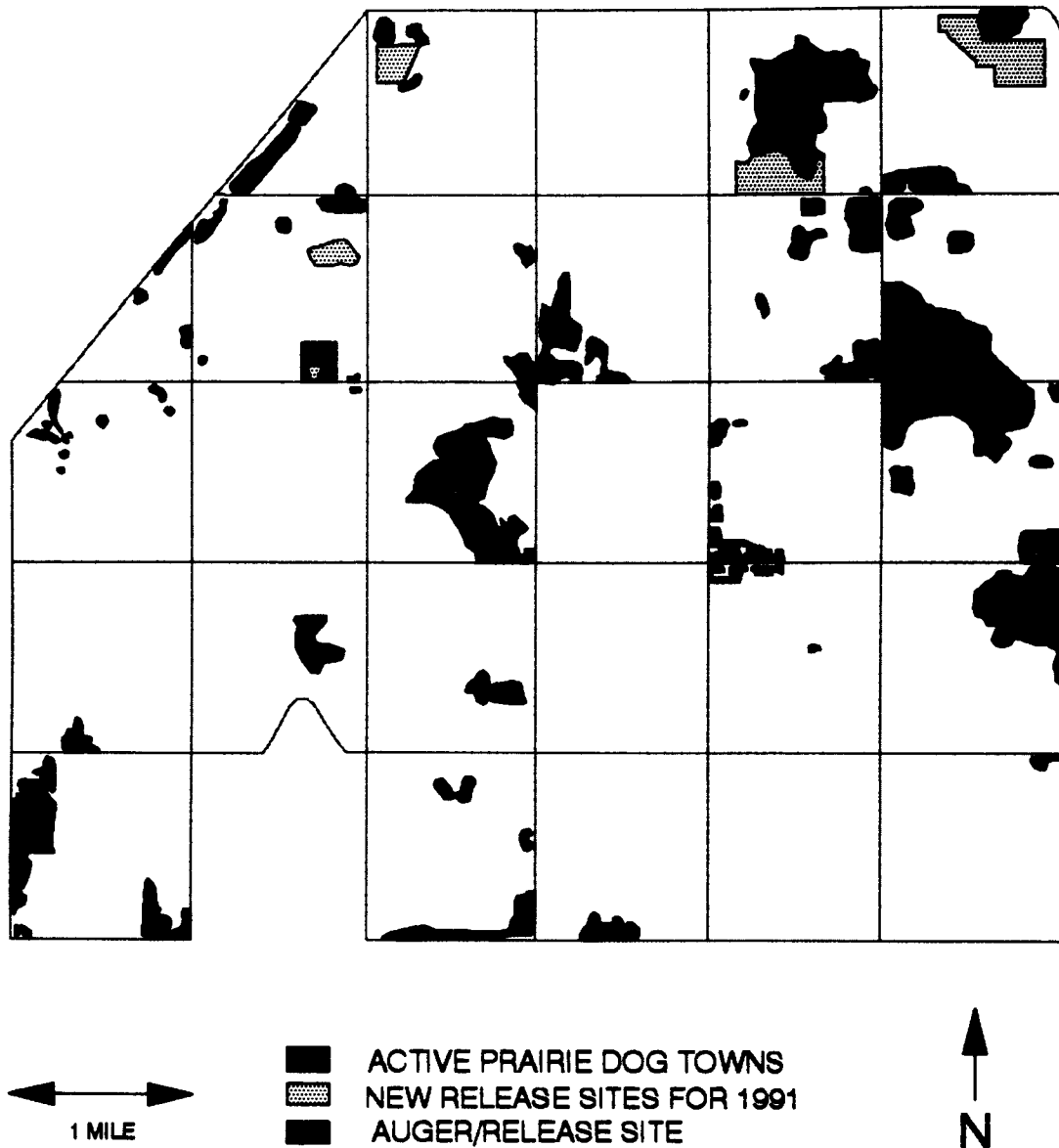


Table 1. FY-91 Monthly Prairie Dog Releases on RMA by Capture Source.

CAPTURE SOURCE	MONTH												TOTAL
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
ROCKY MTN ARSENAL	33					9		82	46		67		237
SHELL PROPERTY								79	36				115
DENVER WATER DEPARTMENT								2	28	65	73	18	186
PRAIRIE DOG RESCUE	434	33	7			128	11	37	8	112	120	110	1,000
LOVELAND P.D. ACTION	100								73	79	51	39	342
CIT. CONCERN. FOR WILDLIFE	80								23	159			262
JEFFCO OPEN SPACE											41	7	48
WELD WILDLIFE RELOCATORS	32						29						61
BOULDER CO HUMANE SOCIETY											111		111
TOTAL	679	33	7			137	40	200	214	415	463	174	2,362

Table 2. Prairie Dog Releases By Relocation Area FY 91

LOCATION	MONTH												TOTAL
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
SECT 5	577	2											579
SECT 19N	69												69
SECT 19S												138	138
SECT 20NE									124	415	367		906
SECT 23NW											96	32	128
SECT 27N								88	64				152
SECT 27S								76	26			4	106
SECT 29&32	3	31	7			137	40	36					254
SECT 30	30												30
TOTAL	679	33	7			137	40	200	214	415	463	174	2362

Table 3. Relocations From Off-Post Sources FY89 - FY91

CAPTURE SOURCE	YEAR			TOTAL	PERCENT
	FY 89	FY 90	FY 91		
SHELL			115	115	2.2%
BUCKLEY		87		87	1.2%
STAPLETON		55		55	1.1%
L. HANNEBURY	46			46	1.0%
K. ROBINETTE		2		2	---
D.W.D.		125	186	311	6.0%
C.C.W.		97	262	359	7.0%
P.D.R.	533	1810	1000	3343	64.0%
L.P.D.A.		349	342	691	13.2%
JEFFCO			48	48	1.0%
W.W.R.			61	61	1.2%
B.C.H.S.			111	111	2.1%
TOTAL	579	2525	2125	5229	
PERCENT	11.1%	48.3%	40.6%		100%

TITLE: Aspects of nest site selection and habitat use by burrowing owls at the Rocky Mountain Arsenal

PERSONNEL: R. Scott Lutz, Assistant Professor, Texas Tech University

David L. Plumpton, Graduate Research Assistant, Texas Tech University

Jane Griess, Wildlife Biologist, USFWS, Rocky Mountain Arsenal

INTRODUCTION

This project is a Cooperative Agreement between the Service and Texas Tech University.

Objectives of the study are:

1. To determine burrowing owl abundance on the Rocky Mountain Arsenal.
2. To locate areas on the Rocky Mountain Arsenal used by burrowing owls, and to quantify habitat variables in occupied and non-occupied habitats.
3. To determine the behaviors, productivity, and growth rates, and food habits of burrowing owls on the Rocky Mountain Arsenal.
4. To determine differences in behavior, productivity, and density between burrowing owl populations subjected to various management treatments.

The status of burrowing owls is classified as "undetermined" by the Service. Relatively little is known of owl habitat preference, migration routes, and daily habits. Consequently, possible impacts to burrowing owl populations due to future cleanup operations requires investigation. Field work was conducted between April 1990 and August 1991.

METHODS

The 1991 annual report from David L. Plumpton can be found in Appendix E.

RESULTS AND DISCUSSION

Results at this time are inconclusive. However, Plumpton reports that 35 pairs successfully nested, producing 163 known fledgling burrowing owls in 1991 compared to 22 nesting attempts, 20 successful pairs, and 109 known fledglings in 1990. Casting analysis is ongoing. Final results of the study will be presented in a M.S. thesis available May 1992.

TITLE: The population status, habitat use,
and management of mule deer and
white-tailed deer

PERSONNEL: Fred Lindzey, Professor of Fish and
Wildlife Biology, University of
Wyoming, Laramie, Wyoming.

Don Whittaker, Graduate Student,
University of Wyoming, Laramie,
Wyoming.

Jane Griess, Wildlife Biologist,
USFWS, Rocky Mountain Arsenal.

INTRODUCTION

Work was initiated in May 1990 to determine the interspecific patterns of coexistence between mule deer (Odocoileus hemionus) and white-tailed deer (Odocoileus virginianus) on the Arsenal. This work was initiated under a Cooperative Agreement between the Service and the University of Wyoming.

Specific objectives of this study are to:

- 1) To determine interspecific relationships between sympatric mule and white-tailed deer on the Arsenal.
- 2) To determine the intraspecific interactions of mule and white-tailed deer on the Arsenal.
- 3) To determine recruitment and adult mortality for sympatric mule and white-tailed deer on the Arsenal.
- 4) To compare sympatric mule and white-tailed deer population statistics from the Arsenal with allopatric and sympatric mule and white-tailed deer.
- 5) To provide management recommendations and protocols to the Service and Army personnel concerning mule and white-tailed deer populations and habitats on the Arsenal.

METHODS

Trapping and Marking

Mule deer and white-tailed deer were captured using Clover traps (Clover 1956) and Capchur gun (Palmer Chemical + Equipment Co., Douglasville, Georgia). Trap sites were selected to representatively sample deer populations. Captured deer were instrumented with radio-transmitter collars (Telonics, Mesa

Arizona). All deer were ear tagged and measured prior to release.

Composition Survey

Composition surveys were conducted by driving primary and secondary roads on the Arsenal and recording all deer seen. Deer numbers and locations were plotted on aerial photos and composition of observed deer recorded. An entire section was covered before moving to the next section. Transects started in the southwest corner of the Arsenal and progressed in a west to east, east to west direction until the entire Arsenal was covered.

Aerial surveys were flown in a Bell Jet Ranger III helicopter. One quarter mile transects were flown, starting at the southeast corner of the Arsenal and progressing in an east to west then west to east direction until the entire area was covered.

Monitoring

All instrumented deer were located with telemetry and were visually observed. Once located, data collected included date, time, habitat type, animal activity, group size and composition, and interspecific distances.

RESULTS AND DISCUSSION

Thirty-two adult deer were outfitted with transmitters. Radio-tracking and vegetation sampling continued throughout FY91. Preliminary results can be found in Appendix E. Present population estimates indicate that approximately 330 mule deer and 120 white-tailed deer inhabit the Arsenal. Preliminary results of the habitat use study indicate mule deer primarily selected cheatgrass/weedy forbs, locust thickets, and dryland tree habitats. White-tailed deer primarily selected wetland/riparian, wetland trees, and dryland trees.

TITLE: Ecological Aspects of Predatory Mammals at Rocky Mountain Arsenal.

PERSONNEL: William F. Andelt, Assistant Professor of Wildlife Biology, Colorado State University, Fort Collins, Colorado.

Eric Hein, Graduate Student, Colorado State University, Fort Collins, Colorado.

J. Chris Cole, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

INTRODUCTION

In a cooperative agreement between the Service and Colorado State University, a field study emphasizing ecological aspects of coyotes (Canis latrans) and badgers (Taxidea taxus) was initiated in May 1990. Aspects of the study investigated during the reporting period were: (1) to delineate the abundance of coyotes at the Arsenal, and (2) to evaluate the effectiveness of Canine Lure Operative Devices (CLODs).

METHODS

Abundance Estimation

Coyote abundance was estimated via visual surveys of marked and unmarked coyotes (Lincoln-Peterson Index/Mark-Resight) from December 1990 - January 1991. Approximately 20 coyotes were captured on the Arsenal with padded leghold traps (Linhart et al. 1986) equipped with tranquilizer tabs (Balser 1965). Each captured individual was fitted with a colored neck collar supporting a radiotransmitter, and tagged with a colored ear tag prior to released at the trap site.

Visual surveys of marked and unmarked coyotes were administered for 2 to 3 hour periods following sunrise on 15 snow-covered mornings to aid visibility. Survey routes traversed along section roads. Routes were altered from north-south to east-west regularly. Identification of marked and unmarked individuals was aided by a spotting scope and/or binoculars. A scanning radiotelemetry receiver with a vehicle-mounted dual 4-element null-peak antenna system was utilized to verify transmitted coyotes. Field data were entered into program NOREMARK to ascertain an abundance estimate.

CLODs

The effectiveness of CLODs for delivering ingestible substances to coyotes was tested by using a solution of syrup/powdered sugar (Marsh et al. 1982) and biological markers, including iophenoxic acid (10 mg) (Larson et al. 1981, Knowlton et al. 1987) and tetracycline hydrochloride (100 mg) (Johnston et al. 1987). A

detailed description of the field technique employed is provided in Appendix E.

RESULTS AND DISCUSSION

Coyote Abundance

Preliminary analysis indicates coyote abundance at the Arsenal during December 1990 - January 1991 was approximately 58 individuals (final results forthcoming in a Master's thesis). It should be recognized that even though the Arsenal is completely encompassed by a 3.25 m chain-linked fence coyote abundance does fluctuate as a result of emigration and immigration. Coyotes supporting radiotransmitters were frequently located both on-post and off-post (Eric Hein, pers. comm., December 1991). One collared individual was recovered approximately 20 km northwest of the Arsenal following a collision with a tractor-trailer rig.

CLODs

Results from the CLODs experiment are presented in Appendix E.

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TITLE: Non-predatory Small Mammals (Other than Prairie Dogs and Lagomorphs)

PERSONNEL: Patty Stevens, Toxicologist, USWFS, Rocky Mountain Arsenal

John Boone, Graduate Student, University of Colorado, Boulder, Colorado

Charles Preston, , Denver Museum of Natural History, Denver, Colorado

INTRODUCTION

In 1990, a cooperative agreement among the U.S. Fish and Wildlife Service, the Department of the Army, the National Fish and Wildlife Federation, and Denver Museum of Natural History was initiated to determine the distribution, abundance, and/or habitat association of non-predatory small mammals on the Arsenal. This information will be used to quantify the response of small mammals to physical habitat disturbance associated with contamination cleanup activities. Field work began in 1991 and will continue through 1993.

METHODS

During FY91, the U.S. Fish and Wildlife Service provided oversight for the small mammal study. Six variable but distinctive vegetation types were selected for study; vegetation types were selected based on historical and current significance. Plots were established in each vegetation type; live-trapping was accomplished to determine small mammal community structure. Vegetative characteristics were measured in the immediate area surrounding each trap in which a small mammals was captured.

RESULTS

Vegetative analyses of all study sites was completed in early August. Trapping sessions at each vegetation type occurred in June and October. Approximately 4200 trap nights produced 1212 captures of 704 individual animals yeilding an overall capture rate of 28.9 percent. A total of 11 species were captured.

A more detailed description of both methods and results can be found in Appendix F.

TITLE: Habitat manipulation and baseline studies of lagomorph species

PERSONNEL: Scott Peltier, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

Carron Meaney, Curator, Denver Museum of Natural History.

INTRODUCTION

The lagomorph population on the Arsenal consists of the black-tailed jackrabbit, Lepus californicus, and the cottontail, Sylvilagus sp.. It is important to have a stable population of lagomorphs in the event that the raptors primary food base, the prairie dog, Cynomys ludovicianus, succumb to a population crash as happened in 1987/88.

Since 1989, projects have been initiated to diversify wildlife habitat and the raptor prey base by manipulating lagomorph habitat. During FY91, a plot was manipulated in sections 5 and 6 to establish open habitat (Appendix B, Task Plan 13), a habitat requirement for most lagomorph species.

Two other projects occurred on the Arsenal during FY91. A one year study was conducted by Metropolitan State University (MSU) to determine if parasites are present in the Arsenal's jackrabbit population. This study was a repeat of a similar study conducted in August 1972 through July 1973. During FY91, the Denver Museum of Natural History (DMNH) initiated a study, to determine the habitat preferences of lagomorphs by comparing lagomorph diversity and density in different habitats. Data collected will provide valuable information for subsequent management decisions during cleanup.

METHODS

The Service assisted MSU with the collection of black-tailed jackrabbits for the parasitology study. Two jackrabbits were collected each month for one year and taken to MSU for examination of endoparasites and ectoparasites.

The habitat manipulation project is located west of First Creek in south-central Section 5. The 20 acres that it encompasses was vegetated mostly by crested wheatgrass, Agropyron cristatum, and smooth brome, Bromus inermis, when the project was initiated in 1989. This area will be mowed once yearly, in a random mosaic pattern. The "random mosaic" of mowing is defined as followed; 60-75 % mowed, in Kidney-shaped areas such that there are open mowed areas in plots with adjacent cover of tall grasses at the outside edges, and between "Kidneys".

The DMNH selected routes and roads for headlight counts, spotlight transects, and eight one-mile transects for flush transects (Appendix F). Vegetation types of all transects were mapped. Methods for surveys employed is as follows:

- 1) Headlight counts, which involve driving 19 miles along section roads and counting lagomorphs seen in headlights.
- 2) Spotlight transects, which involve driving 24 road segments, on back roads, using 2 spotlights and the truck headlights to count lagomorph species.
- 3) Flush transects, which involve 10 people and 6 dogs walking eight transects that are one mile by 200 meters, and attempting to flush all lagomorphs.

RESULTS/DISCUSSION

The Service collected a total of 24 jackrabbits for the MSU parasitology study. The study was completed in May, 1991. Preliminary results of endoparasites found 2 species of adult tapeworms, 1 larval tapeworm, and 1 protozoan; all unidentified species at this time. Ectoparasites found in jackrabbits were 1 species of rabbit tick (Haemaphysalis leporis palustris), and 3 species of fleas, one of which was identified as Hoplopsyllus affinis. There were a total of 20 fleas of the 3 species. All of the jackrabbit carcasses were returned to the Arsenal after examination.

Comparisons with the parasitology study conducted on the Arsenal in 1972, found that fewer fleas exist on the present population of jackrabbits. Final results of the parasitology study will be forthcoming in 1992.

Habitat manipulations have shown that jackrabbits have an affinity for mowed areas (Meaney, pers. comm., September 1991). They are known to concentrate on the adjacent mowed, airport lands. Other studies have clearly shown that jackrabbits prefer open habitat with good visibility (Peek 1986). In 1992, the DMNH plans to evaluate the use of mowed areas by jackrabbits. This will be accomplished by the use of infra-red camera units.

Preliminary results of the study conducted by the DMNH can be found in their Annual Report (Appendix F). Quarterly Reports indicate higher percentages of jackrabbits compared to cottontail species. Spotlight transects appeared to be the most effective technique for determining habitat preference information on lagomorphs on the Arsenal. Flush counts produced relatively few lagomorphs and may not be continued during FY92.

LITERATURE CITED

Peek, James M. 1986. A Review of Wildlife Management. Simon
and Schuster, Inc. Englewood Cliffs, New Jersey. 486pp.

TITLE: Upland Game Birds

PERSONNEL: J. Chris Cole, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

INTRODUCTION

A shortage of Service personnel limited the amount of attention extended to indigenous gallinaceous bird species at Rocky Mountain Arsenal (Arsenal) during the reporting period. However, a population sampling scheme for ring-necked pheasants (Phasianus colchius) was formulated, and will be initiated in late December 1991. Additionally, a management element addressing the reintroduction of prairie grouse onto the Arsenal was prepared and is pending review. The focus of this report is to provide information relative to the release of pen-reared gallinaceous birds onto the Arsenal by local pointing dog field trail clubs.

METHODS

Pen-reared northern bobwhite quail (Colinus virginianus) and chukar partridge (Alectoris chukar) were released into designated sections of the Arsenal by field trail personnel. Small groups of birds were randomly placed along the trial course in close proximity to woody vegetation prior to and during each brace. Handlers with dogs entered in the Gun Dog class were permitted to harvest flushed birds from pointed coveys with shotguns using steel shot. No attempt was made to collect unharvested birds.

RESULTS AND DISCUSSION

A total of 1825 northern bobwhite quail (n=1482) and chukar partridge (n=343) were released into portions of 5 Arsenal sections by 7 local pointing dog field trial clubs on 13 occasions from October 1990 - September 1991 (Table 1). Clubs were not responsible for recording the number of released birds harvested during Gun Dog competitions. However, it is inferred through conversation with club members that only a small portion were harvested. This inference could suggest that the uncollected released birds positively impacted the abundance of corresponding wild species inhabiting the Arsenal. Contrarily, the vitality of pen-reared game birds released into the wild is significantly reduced (due primarily to an unrefined survival instinct), therefore, contributing little to the perpetuation of the species (Ralph Dimmick, pers. comm., December 1991).

Table 1. Pen-raised game birds released at Rocky Mountain Arsenal during field trial competitions, October 1990 - September 1991.

Organization	Number Released		Section(s)	Date
	bobwhite	chukar		
Mile High	80	0	03	03/18-19/91
Weimaraner Club	111	0	03, 33, 34	04/27-28/91
German Shorthair	200	100	03, 34	10/11-13/90
Pointer Club of	15	125	03, 34	03/02-03/91
Colorado	111	118	03, 33, 34	03/16-17/91
Colorado Field Dog				
Association	105	0	03, 34	03/09-10/91
Irish Setter Club	180	0	03, 33, 34	03/23-24/91
of Colorado	180	0	03, 34	04/20-21/91
Northern Colorado				
Brittany Club	85	0	03, 33, 34	04/13-14/91
Skyline Brittany	75	0	07, 08	05/11/91
Club	60	0	07, 08	09/07/91
Rocky Mountain				
Pointing Dog	140	0	03, 04, 33	04/06-07/91
Association	140	0	03, 04, 33	09/14-15/91
Total	1482	343		

TITLE: The status of reptiles and amphibians

PERSONNEL: David Seery, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

INTRODUCTION

The objectives of the Service Management Element for reptiles and amphibians calls for maintaining current population diversity and abundance, as well as establishing annual surveys for reptiles and amphibians on the Arsenal. The Biota Remedial Investigations Report (MKE 1989) lists 7 amphibian and 23 reptile species that either inhabit or potentially occur on the Arsenal, none of which are threatened or endangered.

METHODS

During FY91, the Service maintained species occurrence records for reptiles and amphibians. Species identification was verified with a common field guide (Hammerson 1986). However, due to personnel and time constraints, no annual surveys were developed.

RESULTS AND DISCUSSION

Table 1 lists reptile and amphibian species that are known to occur (previously observed) on the Arsenal and denotes those species that were observed in FY91 by Service personnel.

Table 1.

Common Name	Scientific Name	FY91
Plains garter snake	<u>Thamnophis radix</u>	X
Common garter snake	<u>Thamnophis sirtalis</u>	
Western terrestrial garter snake	<u>Thamnophis elegans</u>	
Bullsnake	<u>Pituophis melanoleucus</u>	X
Smooth green snake	<u>Opheodrys vernalis</u>	
Racer	<u>Coluber constrictor</u>	X
Western hognose snake	<u>Heterodon nasicus</u>	
Western rattlesnake	<u>Crotalus viridis</u>	X
Many-lined skink	<u>Eumeces multivirgatus</u>	
Short-horned lizard	<u>Phrynosoma douglassi</u>	
Lesser earless lizard	<u>Holbrookia maculata</u>	

Common Name	Scientific Name	FY91
Northern chorus frog	<u>Pseudacris triseriata</u>	

Common Name	Scientific Name	FY91
Bullfrog	<u>Rana catesbyiana</u>	X
Northern leopard frog	<u>Rana pipiens</u>	
Plains spadefoot	<u>Spea bobifrons</u>	
Woodhouse's toad	<u>Bufo woodhousei</u>	X
Great Plains toad	<u>Bufo cognatus</u>	
Tiger Salamander	<u>Ambystoma tigrinum</u>	X
*Spiny softshell	<u>Trionyx spiniferus</u>	X
*Painted turtle	<u>Chrysemys picta</u>	X

* denotes species previously classified as "potentially present".

LITERATURE CITED

Hammerson, G. 1986. Amphibians and Reptiles in Colorado.
Univ. Colo. Boulder and Colorado Division of Wildlife,
Denver, CO.

Morrison-Knudsen Environmental Services, Inc. 1989. Wildlife
Resources of Rocky Mountain Arsenal, Adams County,
Colorado. Prepared for Shell Oil Company.

TITLE: Invertebrates

PERSONNEL: Arlene Tortoso, Microbiologist,
USFWS, Rocky Mountain Arsenal.

John Meisner, Fishery Biologist,
USFWS, Rocky Mountain Arsenal.

Will Clements, Assistant Professor,
Department of Fishery and Wildlife
Biology, Colorado State University.

Alan Polonsky, Graduate Student,
Department of Fishery and Wildlife
Biology, Colorado State University.

Diana Hammerdorfer, Research
Associate, Department of Fishery
and Wildlife Biology, Colorado
State University.

INTRODUCTION

Due to the lack of personnel and adequate research facilities, the Service did not conduct invertebrate studies on the Arsenal during FY91. Service personnel, did however, provided oversight for a cooperative research project, entitled "Successional Changes in Benthic Communities Established in Wetlands at the Rocky Mountain Arsenal: Effects on Water Quality", with Dr. Will Clements of the Department of Fishery and Wildlife Biology at Colorado State University.

METHODS

The Service provided review and guidance on the development and implementation of the project, relating to the colonization of newly created wetlands by benthic organisms and the comparison of structural and functional characteristics of these systems to existing wetlands.

RESULTS

Preliminary results from benthic collections can be found in Appendix E.

TITLE: The distribution and abundance of passerine birds

PERSONNEL: Donna Rieckmann, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

Daniel J. Matiatos, Wildlife Biologist, USFWS, Rocky Mountain Arsenal.

INTRODUCTION

The diversity of Arsenal habitats range from wetland/riparian to various types of grasslands. This diversity supports numerous passerine species (MKE 1989). The Service has initiated various studies to determine the population status and habitat associations of passerine birds on the Arsenal. This information will allow the Service to mitigate for habitats impacted during Arsenal cleanup. Mitigation, habitat enhancement and habitat management efforts will assure species diversity and richness be maintained during cleanup. The baseline data acquired will contribute to an understanding of long term local population changes.

METHODS

During 1991 the Service initiated a passerine study to monitor the seasonal abundance and habitat associations of passerines on the Arsenal. Seven fixed radius point counts were established in each of seven habitat types. Counts were initiated one hour after sunrise. The number of birds observed within a ten minute period inside and outside a 25 meter radius from a fixed point were recorded. Four surveys a year, one in each season (i.e. winter, spring, summer, fall), were scheduled. However, due to personnel constraints, winter was the only period surveyed during FY91.

A breeding bird survey route was established on the Arsenal through the U.S. Fish and Wildlife Service Office of Migratory Bird Management. This is a 25 mile road transect with 50 stops of 3.0 minutes (Figure 1). The survey is conducted each spring to monitor avian population trends.

A passerine study was initiated by the Denver Museum of Natural History to determine species abundance and habitat associations on the Arsenal (Appendix F). This study will also assess the potential impacts of various cleanup activities on passerine birds.

A christmas bird count has been conducted on the Arsenal by the Denver Audubon Society over the past several years. The Service assisted with the count in 1991 and will continue to assist with future counts.

RESULTS/DISCUSSION

Seventeen species of birds were observed during fixed point radius counts from 14 January through 17 January, 1991 (Table 1). The greatest number of species was recorded in locust thickets or shrubs (Table 2) and the least number of species was recorded in native-perennial grass or cheatgrass (Table 6). From two to nine species were recorded in the six remaining habitats (Tables 3 through 5, 7 and 8). The horned lark was the most widely distributed species occurring in four of seven habitats (Table 9).

Fifty-two birds species were recorded on the breeding bird survey conducted on 1 June 1991. The western meadowlark was the most widely distributed species occurring at 46 of 50 stops followed by the black-billed magpie and the mourning dove (Table 10).

LITERATURE CITED

Morrison-Knudsen Environmental Services, Inc. 1989. Wildlife resources of the Rocky Mountain Arsenal Adams County, Colorado. Prepared for Shell Oil Company Holme Roberts and Owen, Denver, Colorado. Project 1680. 136pp.

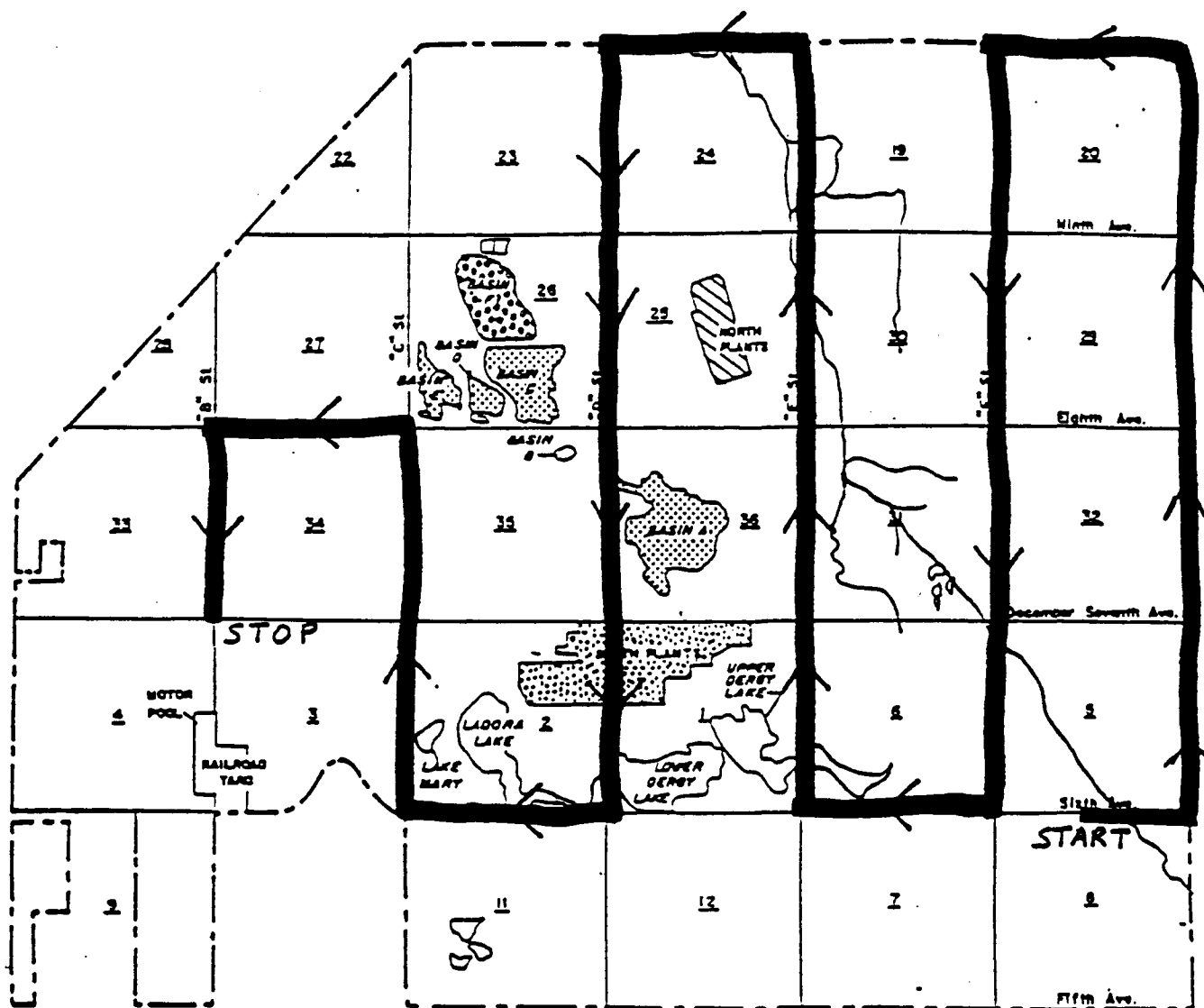


Figure 1. Breeding bird survey route established on the Rocky Mountain Arsenal in FY 91.

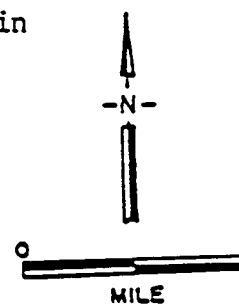


Table 1. Species list recorded during winter fixed-radius point counts on the Rocky Mountain Arsenal (RMA), January 14-17, 1991.

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Downy Woodpecker (Picoides pubescens)
Northern Flicker (Colaptes auratus)
Horned Lark (Eremophila alpestris)
Black-billed Magpie (Pica pica)
American Crow (Corvus brachyrhynchos)
Black-capped Chickadee (Parus atricapillus)
Townsend Solitaire (Myadestes townsendi)
Northern Shrike (Lanius excubitor)
European Starling (Sturnus vulgaris)
American Tree Sparrow (Spizella arborea)
Song Sparrow (Melospiza melodia)
Dark-eyed Junco (Junco hyemalis)
Red-winged Blackbird (Agelaius phoeniceus)
Western Meadowlark (Sturnella neglecta)
House Finch (Carpodacus mexicanus)
American Goldfinch (Carduelis tristis)
House Sparrow (Passer domesticus)
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Table 2. Species recorded in locust thickets or shrubs.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Northern Flicker			+				
Horned Lark					7		
Black-billed Magpie			+			4	1
American Crow			*				
European Starling				1		+	
American Tree Sparrow			+		3	+	
House Finch			+	1		2	
American Goldfinch						+	
House Sparrow	1						
Total individuals	1	0	0	2	10	6	1

+ species recorded beyond the 25-m radius but in the habitat type

* species recorded beyond the 25-m radius outside the habitat

Table 3. Species recorded in trees, ornamentals or lawns.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Downy Woodpecker		+	1				
Black-billed Magpie	1	+	+	+			
Black-capped Chickadee		+					
Townsend Solitaire							1
Northern Shrike	*						
Dark-eyed Junco		17					
House Finch	2					+	1
American Goldfinch				+		2	
Total individuals	3	17	1	0	0	2	2

+ species recorded beyond the 25-m radius but in the habitat type

* species recorded beyond the 25-m radius outside the habitat

Table 4. Species recorded in sage or rubber rabbitbrush.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Black-billed Magpie					+		
American Tree Sparrow	38				1	+	+
Western Meadowlark							+
American Goldfinch				+			
Total individuals	38	0	-	0	1	0	0

+ species recorded beyond the 25-m radius but in the habitat type

- not sampled

Table 5. Species recorded in wetland/riparian.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Downy Woodpecker		1					
Northern Flicker						+	
Black-billed Magpie					+	+	+
European Starling	+	+	+		+		
American Tree Sparrow			+				
Song Sparrow	1						
Red-winged Blackbird							1
House Finch			+			+	+
Total individuals	1	1	0	0	0	0	1

+ species recorded beyond the 25-m radius but in the habitat type

Table 6. Species recorded in native-perennial grass or cheatgrass.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Horned Lark	4				+	2	+
Total individuals	4	0	0	0	0	2	0
+ species recorded beyond the 25-m radius but in the habitat type							

Table 7. Species recorded in weedy forbs/cheatgrass.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Horned Lark				+		+	+
Western Meadowlark						+	+
Total individuals	0	0	0	0	0	0	0
+ species recorded beyond the 25-m radius but in the habitat type							

Table 8. Species recorded in crested wheatgrass.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Black-billed Magpie							+
Horned Lark	+	+				+	
Total individuals	0	0	0	0	0	0	0
+ species recorded beyond the 25-m radius but in the habitat type							

Table 9. Species and habitat association at Rocky Mountain Arsenal (RMA), winter 1991.

Species	WR	Habitat type				SR	TR	ST	OTHER
		WF	NP	CW					
Downy Woodpecker	X						X		
Northern Flicker	X							X	
Horned Lark		X	X	X				X	
Black-billed Magpie	X			X		X	X		
American Crow									X
Black-capped Chickadee						X			
Townsend Solitaire						X			
Northern Shrike									X
European Starling	X							X	
American Tree Sparrow	X				X			X	
Song Sparrow	X								
Dark-eyed Junco						X			
Red-winged Blackbird	X								
Western Meadowlark		X			X				
House Finch	X					X	X		
American Goldfinch					X	X	X		
House Sparrow								X	

WR=Wetland/Riparain
 WF=Weedy forbs/Cheatgrass
 NP=Native perennial grass
 CW=Crested Wheatgrass
 SR=Sage/Rabbitbrush
 TR=Trees/ornamentals/lawn
 ST=Shrubs/locust thickets

Table 10. Results of the breeding bird survey conducted on the Rocky Mountain Arsenal on 1 June 1991.

SPECIES.....	TOTAL...	STOPS OBSERVED
PIED-BILLED GREBE	1	1
WESTERN GREBE	7	1
DOUBLE-CREST CORMORANT	13	8
GREAT BLUE HERON	13	11
CANADA GOOSE	27	3
MALLARD	4	3
BLUE-WINGED TEAL	1	1
GADWALL	1	1
SWAINSON'S HAWK	10	9
RED-TAILED HAWK	6	4
AMERICAN KESTREL	18	14
RING-NECKED PHEASANT	41	25
NORTHERN BOBWHITE	3	1
AMERICAN COOT	5	3
KILLDEER	3	1
ROCK DOVE	90	8
MOURNING DOVE	96	33
GREAT HORNED OWL	4	2
BURROWING OWL	5	3
DOWNY WOODPECKER	2	2
RED-SHAFTED FLICKER	2	2
WESTERN KINGBIRD	45	22
EASTERN KINGBIRD	17	7
HORNED LARK	28	11
BARN SWALLOW	5	5
BLACK-BILLED MAGPIE	84	35
ROCK WREN	1	1
HOUSE WREN	10	7
MARSH WREN	1	1
AMERICAN ROBIN	26	9
EUROPEAN STARLING	173	21
WARBLING VIREO	1	1
YELLOW WARBLER	14	7
COMMON YELLOWTHROAT	8	7
BLACK-HEADED GORSBEAK	1	1
RUFIOUS-SIDED TOWHEE	1	1
CASSIN'S SPARROW	1	1
LARK SPARROW	2	2
LARK BUNTING	92	14
GRASSHOPPER SPARROW	25	13
SONG SPARROW	5	2
RED-WINGED BLACKBIRD	86	8
WESTERN MEADOWLARK	349	46
YELLOW-HEADED BLACKBIRD	6	1
BREWER'S BLACKBIRD	2	1

Table 10. Con't.

SPECIES.....		TOTAL...	STOPS OBSERVED
COMMON GRACKLE	45		17
BROWN-HEADED COWBIRD	2		2
ORCHARD ORIOLE	1		1
BULLOCK'S ORIOLE	49		21
HOUSE FINCH	6		2
AMERICAN GOLDFINCH	7		2
HOUSE SPARROW	37		10

TOTAL SPECIES = 52			

STATION EQUIPMENT AND FACILITIES

Communications Equipment

During FY91, the Clerical Section was placed under the supervision of the Administration Section. Primary responsibilities of this section are answering all incoming phone calls, including calls arranging tours, proof reading and finalizing out-going mail, and monitoring the base station radio for calls.

The following radios and related equipment were purchased during FY91:

<u>QT</u>	<u>Equipment</u>	<u>Price</u>
25	LPV4141-A-02 Portable Radios w/keyboard, antenna and battery	\$14332.50
25	LAA0325 1hr. Desktop chargers	1102.50
25	LAA0205 Microphones	945.00
25	LAA0435 Carry Cases	708.75
25	LAA0411 & LAA0424 Full Radio Cover w/Belt loop	393.75
3	Motorola Cellular #8000 Ultra Classic Portable Telephone	2640.00
3	Motorola Hang-up cup	75.00
3	Motorola battery eliminator	240.00
3	Post mount	120.00
1	Base station UHF 40 watt w/Powerline Protection	4016.00
1	20' Slip-up antenna mast kit	49.00
1	4.5 Gain Repeater Antenna	68.00
1	GE Remote Control, Model RCDISM	399.00

All regular telephones used by the Service on the Arsenal are the property of the U.S. Army.

Computer Systems

Computers are used for virtually all memo and report writing, as well as for storage and analysis of project data by all staff. Standard computer training received by all employees include WordPerfect 5.1 and DOS. Other computer training such as Freelance and dBase IV is arranged for specific employees on an as needed basis.

The following computers and related equipment were purchased in FY91:

<u>QT</u>	<u>Equipment</u>	<u>Price</u>
3	Dell 386 Desktop Computers	\$11055.00
1	Gateway 2000-486 Microcomputer	3240.00
1	CompuAdd 316 notebook size computer	1969.15

1	Ricoh Daisy Wheel Printer	1140.00
1	Hewlett-Packard LaserJet III Printer	1878.25
1	Buffalo Buffer Switch	498.39
2	Auto Switch Boxes	138.00
2	Alps Allegro 500 Dot Matrix Printers	600.00
1	Hewlett-Packard Paint Jet Graphics Printer	2443.00

This list does not include the software purchased with each computer system. Computer systems and software are upgraded annually.

Field Station Equipment

Since the establishment of a Service Field station at the Rocky Mountain Arsenal in 1989 considerable equipment has been purchased to support Service activities at the Arsenal. The following list includes only equipment purchased during FY91.

OFFICE EQUIPMENT

Base station/radios	22640.00
Map files	2255.00
Fax Machine	1901.00
Typewriters	1464.00
Bookcases	1150.00
Drafting Table/Chair	704.00
Mobile map files	643.00
Snowplow/ATV	403.00
Answering machine	344.00
Calculators	180.00
Display rack	130.00

FIELD EQUIPMENT

Traffic Counters	1304.00
Dart Gun	827.00
"A" Wood Barricades	750.00
Locking Freezers	417.00
Rain Gear	351.00
Super Blind	254.00
Dollies	247.00
Tools	170.00
Micro Cassette Recorders	101.00
Wet/Dry Shop Vac	90.00

PUBLIC USE EQUIPMENT

Canon T-90, Accessories	5701.00
Portable Exhibits	2879.00
50" Projection TV	2421.00
Slide Mgmt System	1733.00

Fishing rods	986.00
Folding Machine	931.00
Audio Viewer	843.00
Coffee Stations	769.00
Planimeter	592.00
VCR'S	570.00
Video Security Cabinet	560.00
Cassette Recorder	486.00
Vacuum	356.00
Polaroid Camera	211.00
Mobile Table	99.00

LABORATORY EQUIPMENT

Dissolved Oxygen Meter	752.70
BOD Bottle Probe w/o stirrer	184.86
Probe Cable (2)	241.80
Drying Oven	159.00
Analytical Electronic Balance	2264.85
Hach Spectrophotometer w/pour-thru cell kit	3027.65
Oxygen Field Probe (2)	301.08
Jouan Centrifuge	4720.00
Corning Meter Module w/3 sensors	695.00
Zenon Water Purifier	1788.35
Westinghouse Refrigerator/Freezer	371.00
Eveready Thermometer	200.48
Seerite Tracing Light Box (2)	460.00
Incubator-Model 2015-Low Temp.-BOD	7043.16
Fume Hood-48" Wide-Superstructure	2310.40
Olympus Microscope w/4 objectives & 2 oculars	2937.60
Olympus Microscope w/base illuminator & focusing mount	940.10
Olympus Illuminator w/transformer	368.20
Fan-1/3 horsepower, 1 phase, T/E	741.12

LIST OF APPENDICES

Appendix A

Natural Resources Conservation Committee Notes

Appendix B

Mitigation Task Plan

Appendix C

Implementation of the Vegetation Management Plan for
the Bald Eagle Management Area of Rocky Mountain
Arsenal.

Appendix D

Activities Policy and Procedures for Roacky Mountain
Arsenal.

Appendix E

Graduate Research Reports

Appendix F

Denver Museum of Natural History Reports

