U.S. FISH AND WILDLIFE SERVICE

ROCKY MOUNTAIN ARSENAL NATIONAL WILDLIFE AREA

FISCAL YEAR 1992 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.

February 12, 1993

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 U.S. Fish and Wildlife Service.

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INTRODUCTION

The Rocky Mountain Arsenal (Arsenal), located approximately 10 miles northeast of downtown Denver, was established in 1942 by the U.S. Army (Army) for the purpose of manufacturing chemical and incendiary munitions. These weapons were part of the mobilization effort of World War II. Beginning in 1947, private companies, primarily Shell Oil Company, leased the Arsenal's industrial sites for manufacturing pesticides and herbicides. Chemical weapons production stopped in the late 1960's, and in 1982 Shell closed its factory at the Arsenal.

The Arsenal was listed on the National Priorities List (NPL) in 1987 and 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 of 1986 (SARA).

The Arsenal is 27 square miles, and is largely undeveloped, open grassland. The Arsenal was originally short-grass and sand prairie habitat, dominated by blue grama 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). A variety of grasses and forbs can still be found on the Arsenal including four types of native grasslands. Approximately 20% of the Arsenal is presently native grasslands.

Contamination History

Production of military and commercial chemical products before 1956 resulted in considerable chemical waste by-products (Trautmann 1980). 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. 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, 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 wastes. 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 a potential 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, Shell Chemical Company entered into an agreement with the Army to pay a negotiated rate for each 1,000 gallons of waste produced. The Arsenal began accepting waste for disposal from Lowry Air Force Base and Fitzsimons Army Medical Center in 1966. Solid and slurry waste were often disposed of in the most convenient manner, sometimes without regard or knowledge of its hazardous nature.

In 1968, the U.S. Army Materiel 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.

Fish and Wildlife Resource Background

The Arsenal was designed with substantial buffer zones surrounding chemical production facilities as a means to protect the public if a catastrophic event occurred. These lands have remained largely undeveloped. Vegetation succession, the removal of livestock, and limited human access since 1942 have resulted in wildlife habitat of considerable 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.

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, for 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 expanded the responsibilities of the Service and more accurately defined its role in activities by defining these activities within seven specific tasks (U.S. Government 1991).

Recent legislation enacted by the United States Congress requires the Secretary of the Army and the Secretary of the Interior to enter into a Memorandum of Understanding (MOU) regarding their Departmental roles at the Arsenal. Efforts to create a second revision of the original Conservation Agreement expanding the responsibilities of the Service and more accurately defining roles (in activities at the Arsenal) are underway.

The purpose of the Service's Arsenal Field Office is to centrally manage wildlife resources at the Arsenal. Service responsibilities include managing fish and wildlife resources, conducting the Arsenal's Biological Monitoring Program, mitigating impacts to fish and wildlife habitat in response to remedial activities, and conducting other activities such as providing 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).

The Rocky Mountain Arsenal National Wildlife Refuge Act of 1992

The most significant event since the Service signed the Conservation Agreement with the Army in 1989 was the recent passage of federal legislation establishing the Arsenal as a National Urban Wildlife Refuge (Rocky Mountain Arsenal National Wildlife Refuge Act of 1992, H.R. 1435) (Arsenal Refuge Act). This legislation allows the Department of the Interior to "manage that real property as if it were a unit of the National Wildlife Refuge System...". This legislation does not, in any way, relieve the Army or other parties of their obligation to cleanup the Arsenal per CERCLA.

The refuge was established for the following purposes:

> **(1)** To conserve and enhance populations of fish, wildlife and plants within the refuge, including populations of waterfowl, raptors, passerines, and marsh and waterbirds.
> **(2)** To conserve species listed as threatened or endangered under the Endangered Species Act and species that are candidates for such listing.

NAME & TITLE	HIRE DATE	LAST DAY
GROM, SINDI M. Park Ranger	04/05/92	09/19/92
GUERRERO, DANIEL J. Office Automation Clerk	08/23/92	
HASTINGS, BRUCE C. Fish & Wildlife Biologist	02/11/90	
HETRICK, MELINDA S. Fish & Wildlife Biologist	06/15/92	
JAMES, SHERRY L. Park Ranger	08/12/90	
JAMIEL, DAVID A. Park Ranger	02/11/90	
JOHNSON, LINDA S. *Office Automation Clerk	04/22/91	10/05/91
KRAMPETZ, FREDERICK J. *Wildlife Biologist	12/03/90	
LANGELIER, LISA Refuge Operations Specialist	10/30/89 **returned 01/26/92**	04/19/91
LANGER, GREGORY J. Fish & Wildlife Biologist	11/19/89	
LONG, DEBORAH J. Education Specialist	08/16/92	
MAHLIK, DOAK O. *Biological Aid (Intermittent)	05/10/91	05/09/92
MALONE, LARRY K. Deputy Coordinator	05/06/90	
MATIATOS, DANIEL J. *Wildlife Biologist	11/13/89	
McLAURIN, SEDRICK M. *Biological Aid (Summer hire)	06/24/91	08/15/92
MIESNER, JOHN F. Fish & Wildlife Biologist	06/17/90	
MOORHEAD, CAROL ANN Wildlife Biologist	04/07/91	09/26/92

NAME & TITLE	HIRE DATE	LAST DAY
MURPHY, LISA A. Student Coop Trainee, Biological Sciences	06/16/92	07/92
PATRICK, DARRYL A. *Biological Technician	04/08/91	10/05/91
PELTIER, SCOTT J. Wildlife Biologist	06/02/91	
PLUMPTON, DAVID L. *Fish & Wildlife Biologist (Intermittent)	02/18/92	
RODRIGUEZ, RUBY P. Office Assistant	10/30/89	
ROEHM, GERALD W. Fish & Wildlife Biologist	07/26/92	
ROY, RICHARD R. Fish & Wildlife Biologist	07/12/92	
SEERY, DAVID B. *Wildlife Biologist	03/03/91	
SHUPE, RONALD D. Refuge Manager	12/29/91	
STEVENS, PATRICIA D. Toxicologist	03/25/90	
STEVENSON, JACK G. Park Ranger	12/30/91	07/25/92
TORTOSO, ARLENE C. Micro-Biologist	05/19/91	
URSINI, ANNETTE M. Budget Assistant	07/30/89	
WHITTAKER, DONALD G. *Fish & Wildlife Biologist (Intermittent)	11/18/91	
ZINK, ERIC C. *Biological Aid (Intermittent)	07/24/90	05/09/92

SPECIAL HIRING PROGRAMS

During FY92 the Arsenal Field Office participated in several special hiring programs. Programs included the Youth Conservation Corps (YCC), University Cooperative Education Program, and a special Equal Employment Opportunity (EEO) program.

Regina Garcia began work 8 June as a YCC participant and ended her term with the Service 8 August 1992. Regina's duties included assisting the clerical staff with answering phones, making photo copies, filing, and computer operations. She assisted at the Visitor Center with visitor information and assistance.

During FY92 the Arsenal Field Office participated in the Cooperative Education Program. Rory Carpenter, a student from Grambling University in Louisiana, began work 6 September. Rory's primary responsibilities included assisting with the environmental education and other public use programs. Rory also assisted biologists with raptor research.

During 1991, the Field Office was asked to participate in a nationwide Service EEO program to promote the interest of minorities in fish and wildlife careers. Sedrick McLaurin was hired as a GS-4 Biological Aid under this program during FY91 and was rehired on 10 May, and working until 15 August 1992. Sedrick's duties included assisting the Activities Coordination Section with vehicle and grounds maintenance.

SAFETY

The Service Health and Safety program at the Arsenal Field Office continued to be high priority in FY92. Although three individuals acted as station health and safety officer throughout FY92, the duty has been permanently assigned to one person. Monthly Health and Safety (H&S) committee meetings were conducted on the third Thursday of each month. The committee consisted of supervisors from each section, the alternate health and safety officer, and the health and safety officer. The H&S officer led safety discussions at the beginning of each weekly staff meeting. Monthly H&S films were shown during some staff meetings, as well as demonstrations of the proper use of personal and vehicle safety equipment. Two H&S evacuation drills were conducted following the guidelines of the Service Emergency Response Plan. A H&S report was submitted to the Region 6 Safety officer each month of FY92.

The H&S officer participated in all Army safety meetings and contractor meetings to ensure close coordination between Army and Service activities. The Service received quarterly office safety

TASK 1 - CONSERVATION

TITLE: Bald Eagle Investigations

INTRODUCTION

In 1986 a wintering bald eagle communal roost, classified as essential habitat under the Northern States Bald Eagle Recovery plan (U.S. Fish and Wildlife Service 1983), was discovered on the east side of the Arsenal (Environmental Sciences and Engineering, Inc. 1988). As a result the Service initiated an intensive three year study to ascertain the impacts of Arsenal cleanup, construction of the new Denver International Airport, and highway development in the northeastern metropolitan area on the wintering eagle population. This study was completed in 1990 and a final report summarizing results and stating recommendations for management and continued monitoring was finalized in December 1992 (U.S. Fish and Wildlife Service 1992). The Service has continued to monitor the wintering bald eagle population since the completion of the study to evaluate changes in activity, contaminant levels, and population levels associated with changes in available habitat and increased human activity. This section summarizes Service monitoring activities conducted during the winter of 1991-1992.

METHODS

During the winter of 1991-1992 eagles were captured using variations of the "Lockhart Method" (Harmata 1984). All captured eagles were weighed, aged, photographed, and a series of morphological measurements taken (Table 2).

Contaminants

A blood and fat sample was collected from each eagle for organochlorine and trace element analysis. Blood was collected form the bracellis vein on the ventral side of the wing. After swabbing with alcohol, a 10 cc syringe with a 24 gauge needle was used to acquire blood samples. Fat tissue was collected from the back of the bird slightly lateral to the dorsal midline of the synsacrum as described by Enderson and Berger (1968). A 2 cm incision was made to acquire a 1 gm sample. Nitrofurazone, a topical antibacterial, was applied to the incision. The incision was stitched with Gut 3-0 chromic (3.9 metric) surgical suture.

Trace elements were analyzed by Research Triangle Institute of Research Triangle Park, North Carolina, a contract laboratory for Patuxent Wildlife Research Center. Only blood was analyzed for metal constituents. Lead, arsenic, and selenium were determined

using Graphite Furnace Atomic Absorption Spectroscopy. Other trace elements were determined with Inductively Coupled Plasma Emission Spectroscopy (ICP) with a preconcentration to pH 6. Precision and accuracy of the analysis were confirmed with procedural blanks, duplicate analysis, recoveries of spiked material, and reference material analysis. Detection limits are listed in Table 3.

Organochlorines were analyzed by Mississippi State University State Chemical Laboratory at Mississippi State University, a contract laboratory of Patuxent Wildlife Research Center. Fat samples analysis was conducted using the Micro Method, a modified version of the method described in Manual of Analytical Methods for the Analysis of Pesticides in Humans and Environmental Samples, EPA-600/8-80-083, June 1980, Section 5, A(2). This method is necessary when sample size is small (under 4 grams). Determinations were made by gas chromatograph. Blood samples were analyzed by electron capture gas chromatograph using a modified version of the method described in the same manual, Section 5, A(3)(a). Precision and accuracy of the analysis was confirmed with procedural blanks, recoveries of spiked material, and reference material analyses. Detection limits are reported in Table 4.

Both methods used for whole blood analyses were consistent with previous analytical work performed on eagles at the Arsenal.

Seven additional blood samples were analyzed from bald eagles captured on the Arsenal during the winter of 1990-91. Fat samples were not taken from these birds.

Habitat use, distribution, and population trends Arsenal-wide

Habitat use, distribution, and population trends were evaluated by recording the number of bald eagles observed along a raptor road survey conducted from August 1991 through May 1992 (see methods Raptor Population Trends and Habitat Use section, pg 22).

Roost counts trends

Evening counts of bald eagles using the Arsenal communal roost were initiated on 15 October 1991 and discontinued on 31 March 1992 after no eagles were recorded during four consecutive surveys. Counts were conducted every other night through the survey period following methods described by the U.S. Fish and Wildlife Service (1991). All captured eagles were wing notched to enable the Service to monitor nightly roost fidelity.

RESULTS AND DISCUSSION

Contaminants

Twenty-one blood samples (20 bald eagles, 1 golden eagle) were analyzed for trace metals and organochlorine pesticides (1990 - 1992). Additionally, eleven fat samples were collected from bald eagles during the winter of 1991-92. One additional fat sample was collected from the Service's captive red-tailed hawk. This fat sample was collected prior to eagle trapping to become familiar with the surgical technique and to monitor wound recovery success. Because of the small amount of fat collected from each eagle, determination of organochlorine pesticides was the only analysis performed.

All bald eagles (100%) had detectable levels of mercury in their blood; the golden eagle did not (Table 3). Mercury concentrations found in bald eagles ranged between 0.09-1.85 ppm. Concentrations found between 1987 and 1990 were 0.10-4.20 ppm (U.S. Fish and Wildlife Service 1992b). The maximum mercury concentration in blood from eagles (10 bald and 9 golden eagles) at Ouray National Wildlife Refuge and Pelican Lake, Utah was 1.07 ppm (Stephens et al. 1992). Two of the highest concentrations (1.85 and 1.27 ppm) were found in hatch year eagles. Wiemeyer et al. (1989) found higher concentrations in blood samples of adult bald eagles than in those of nestlings and hatch year birds which corresponds to the known accumulative nature of mercury. Although little is known regarding the effects of mercury in blood on the health of bald eagles, the concentrations reported here do not currently appear to be cause for concern.

Fifteen of twenty bald eagles (75%) had detectable levels of lead in their blood (0.07-0.67 ppm). This frequency and range is comparable to levels found between 1987 and 1990 at RMA (82%, below detection-0.60 ppm)(U.S.Fish and Wildlife Service 1992b). The maximum lead concentration in blood from eagles (10 bald and 9 golden eagles) at Ouray National Wildlife Refuge and Pelican Lake, Utah was 0.18 ppm (Stephens et al. 1992). Four of the five eagle with non-detectable levels were hatch year birds. The golden eagle had 0.11 ppm in it's blood. Wiemeyer et al. (1988) considered lead concentrations in blood >0.7 ppm to be indicative of significant lead exposure. Although no eagles at RMA were above this level, eight bald eagles, including two hatch year birds, were above the level considered slightly elevated (>0.20 ppm) (Bloom et al *in* Wiemeyer et al. 1988) and three of these were approaching the 0.07 ppm level.

All eagles had detectable levels of selenium in their blood. Concentrations ranged from 0.36 to 0.98 ppm. In previous years (1987-90), selenium was detected in 49 of 50 (98%) bald eagle blood samples with the highest concentration being 2.97 ppm (U.S. Fish and Wildlife Service 1992b). The maximum selenium concentration in the blood from one of ten bald eagles at Ouray

National Wildlife Refuge and Pelican Lake, Utah was 1.15 ppm (minimum 0.27 ppm) (Stephens et al. 1992).

Arsenic was not detected in any eagles sampled between 1990 and 1992. In previous years (1987-90), arsenic was detected in 18 of 35 (51%) bald eagle blood samples, with the highest concentration being 0.79 ppm (U.S.Fish and Wildlife Service 1992b). Arsenic was also not detected in any of the 18 eagle blood samples analyzed from Ouray National Wildlife Refuge and Pelican Lake, Utah (Stephens et al. 1992).

HCB, oxychlordane, heptachlor epoxide, alpha chlordane, trans-nonachlor, DDE, dieldrin, cis-nonachlor, DDD, and PCBs were found in the eleven fat samples (100%) taken. Endrin and DDT were found in one (9%) and two (18%) fat samples, respectively. PCBs, DDE, and dieldrin were found in one (5%), seventeen (81%), and two (10%) blood samples, respectively.

Seven birds which had DDE in their fat (0.70-20.0 ppm) also had DDE in their blood (0.1-0.6). One bird that had dieldrin in its fat (1.6 ppm) also had dieldrin in its blood (0.1 ppm). The eagle that had PCBs in its blood did not have a fat sample taken, however, all eagles with both blood and fat samples taken did not have PCBs detected in their blood although it was detected in their fat.

Overall, detectable DDE concentrations (81%) in blood ranged from 0.01-0.09 ppm. Concentrations found in bald eagles sampled between 1987 and 1990 ranged from below detection (62%) to 0.28 ppm (U.S. Fish and Wildlife Service 1992b).

The detectable dieldrin concentrations (10%) were 0.01 ppm in each of two samples. Concentrations found in bald eagles sampled between 1987 and 1990 ranged from below detection (78%) to 0.07 ppm (U.S.Fish and Wildlife Service 1992b).

Only one PCB concentration (5%) of 0.33 ppm was detected. Between 1987 and 1990, concentrations ranged from below detection (90%) to 0.71 ppm (U.S.Fish and Wildlife Service 1992b).

Habitat use, distribution, and population trends

No notable differences were observed in bald eagle distribution during 1991-1992 when compared to the previous three winters (U.S. Fish and Wildlife Service 1991). Bald eagle occurrence along the Arsenal road survey was greatest along survey legs 8,9,14,15, and 23 (Fig. 1). Legs 8 through 15 are chiefly comprised of wetland habitats and associated riparian woodlands along Lakes Ladora, Lower Derby, and First Creek. These wetland habitat communities are commonly occupied by bald eagles (Stalmaster 1987, Johnsgard 1990). The substantial number of eagles observed along leg 23 may be due to the availability of

prairie dogs in this area, and the associated high number of ferruginous hawks which use the area which eagles kleptoparasitize. The number of eagles observed along the road survey during 1991 was not substantially different than numbers observed during the last two winters (U.S. Fish and Wildlife Service 1992) (Table 5). Eagle numbers remain slightly lower than numbers observed during the 1988-1989 winter (Table 5).

Roost counts

The peak number of bald eagles observed on the Arsenal roost was 30 during 1991-1992 (Fig. 2). This is fewer than the high count of 38 individuals observed on the roost during 1990-1991 (U.S. Fish and Wildlife Service 1991). The peak was observed on 1 January 1992 which is within the period when high numbers were observed during the past five winters (U.S. Fish and Wildlife Service 1991). Most wintering populations reach their peaks during January (Stalmaster 1987). The percent of sub-adults using the Arsenal roost increased during 1991-1992 when compared to 1990-1991 (Fig. 3). However, the percent of sub-adults using the roost remains considerably less than that observed during the 1986-1987 and 1987-1988 winters (Fig. 3). This may indicate stabilization of possible growth in the wintering population (Stalmaster 1987). Sub-adults comprise a greater percentage of eagles observed on the Arsenal roost early and late in the season (Fig. 4). Some studies indicate that sub-adult birds migrate earlier in autumn (Southern 1963). However, studies in the San Luis Valley, Colorado, found adults more numerous in early winter (Harmata 1983). The ratio of sub-adults to adults approached 1:1 during mid-winter (Fig. 4).

Table 2. Sex and age of bald and golden eagles captured at Rocky Mountain Arsenal, winters of 1990-91 and 1991-92.

ID#	Date Captured	Species	Sex	Age	Blood Sample	Fat Sample
139	12-14-90	Bald	M	ATY	Y	N
140	12-15-90	Bald	F	ASY	Y	N
141	01-27-91	Bald	M	ASY	Y	N
142	01-27-91	Bald	M	ASY	Y	N
143	01-27-91	Bald	M	HY	Y	N
144	01-27-91	Bald	M	SY	Y	N
145	01-27-91	Bald	M	HY	Y	N
33223	12-09-91	Bald	F	HY	Y	Y
33224	12-09-91	Bald	M	SY	Y	Y
33225	12-11-91	Bald	M	ASY	Y	Y
33226	12-11-91	Golden	M	ASY	Y	N*
33227	12-12-91	Bald	F	HY	Y	Y
33228	01-13-92	Bald	F	HY	Y	Y
33229	01-13-92	Bald	F	ATY	Y	Y
33230	01-13-92	Bald	F	HY	Y	Y
33231	01-13-92	Bald	M	ASY	Y	N*
33232	01-13-92	Bald	F	ASY	Y	Y
33233	01-13-92	Bald	M	ASY	Y	Y
33234	01-14-92	Bald	F	HY	Y	Y
33235	01-14-92	Bald	M	ASY	Y	N*
33236	01-14-92	Bald	M	SY	Y	Y

* No fat identified by palpation.
HY-hatching year; ASY-after second year; ATY-after third year; SY-second year

Table 3. Trace element concentrations (ppm, wet weight) in whole blood of bald and golden eagles captured at Rocky Mountain Arsenal, winters of 1990-91 and 1991-92.

ID#	Moisture	Al	As	B	Ba	Be	Cd	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Se	Sr	V	Zn
139	77.1	BDL	BDL	1.74	BDL	BDL	BDL	BDL	0.82	577.1	0.53	80.4	BDL	BDL	0.17	0.21	0.85	0.08	BDL	5.82
140	78	BDL	BDL	0.65	BDL	BDL	BDL	BDL	0.54	510.4	0.23	77.9	BDL	BDL	0.21	0.14	0.55	BDL	BDL	6.51
141	77	BDL	BDL	1.02	BDL	BDL	BDL	BDL	0.53	462.3	0.28	63.3	BDL	BDL	BDL	0.17	0.90	BDL	BDL	4.09
142	78.7	BDL	BDL	0.43	BDL	BDL	BDL	BDL	0.56	475.0	0.09	72.0	BDL	BDL	BDL	0.65	0.56	BDL	BDL	5.73
143	77.5	BDL	BDL	0.74	BDL	BDL	BDL	BDL	0.54	486.0	0.71	63.7	BDL	BDL	BDL	0.23	0.90	BDL	BDL	4.27
144	77.8	BDL	BDL	0.57	BDL	BDL	BDL	BDL	0.51	475.1	0.83	64.6	BDL	BDL	BDL	0.22	0.98	BDL	BDL	5.53
145	78.6	BDL	BDL	0.50	BDL	BDL	BDL	BDL	0.52	447.3	0.92	68.1	BDL	BDL	BDL	0.58	0.69	0.06	BDL	4.09
33223	80.2	BDL	BDL	0.42	BDL	BDL	BDL	BDL	0.45	421.7	1.85	66.9	BDL	BDL	BDL	BDL	0.69	BDL	BDL	3.90
33224	79.4	BDL	BDL	0.57	BDL	BDL	BDL	BDL	0.46	451.1	0.48	68.2	BDL	BDL	BDL	BDL	0.74	BDL	BDL	4.33
33225	78.1	BDL	BDL	0.25	BDL	BDL	BDL	BDL	0.43	420.5	0.70	54.1	0.31	BDL	BDL	0.09	0.91	BDL	BDL	3.88
33226	79.3	BDL	BDL	0.50	BDL	BDL	BDL	BDL	BDL	378.8	BDL	73.3	0.13	BDL	BDL	0.11	0.36	0.06	BDL	4.93
33227	78.4	BDL	BDL	0.72	BDL	BDL	BDL	BDL	0.61	494.6	0.97	73.0	BDL	BDL	BDL	BDL	0.67	BDL	BDL	4.99
33228	78.9	BDL	BDL	0.47	BDL	BDL	BDL	BDL	0.48	485.3	1.27	61.6	BDL	BDL	0.50	BDL	0.63	BDL	BDL	5.06
33229	77.6	BDL	BDL	0.77	BDL	BDL	BDL	BDL	0.54	535.4	0.69	74.6	BDL	BDL	0.22	0.13	0.65	0.09	BDL	5.87
33230	79	BDL	BDL	0.68	BDL	BDL	BDL	BDL	0.55	478.8	0.59	69.9	BDL	BDL	0.17	0.13	0.62	BDL	BDL	4.58
33231	78	BDL	BDL	0.87	BDL	BDL	BDL	BDL	0.50	468.6	0.31	62.7	BDL	BDL	BDL	0.31	0.56	BDL	BDL	3.72
33232	80.4	BDL	BDL	0.53	BDL	BDL	BDL	BDL	0.46	423.4	1.16	58.2	BDL	BDL	BDL	0.10	0.67	BDL	BDL	3.88
33233	77.6	BDL	BDL	1.01	BDL	BDL	BDL	BDL	0.55	508.5	0.81	68.8	BDL	BDL	BDL	0.07	0.68	BDL	BDL	5.53
33234	79.5	2.77	BDL	0.97	BDL	BDL	BDL	BDL	0.49	469.5	0.89	65.4	BDL	BDL	BDL	BDL	0.92	0.10	BDL	4.74
33235	78.3	BDL	BDL	0.50	BDL	BDL	BDL	BDL	0.50	449.2	0.63	61.2	BDL	BDL	BDL	0.20	0.60	BDL	BDL	4.49
33236	77.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.49	517.4	1.56	70.5	BDL	BDL	BDL	0.67	0.71	BDL	BDL	4.33
Detection Limit		1.63	0.10	0.16	1.63	0.03	0.03	0.16	0.16	3.26	0.02	3.26	0.13	0.16	0.16	0.06	0.07	0.06	0.16	0.33

Table 4. Organochlorine concentrations (ppm) in whole blood and fat of bald and golden eagles captured at Rocky Mountain Arsenal, winters of 1990-91 and 1991-92.

FWS #	139B	140B	141B	142B	143B	144B	145B
LAB #	835227	835228	835229	835230	835231	835232	835233
MATRIX	Eagle Blood	Eagle Blood	Eagle Blood	Eagle Blood	Eagle Blood	Eagle Blood	Eagle Blood
COMPOUND							
HCB	ND*	ND	ND	0.02	ND	ND	ND
α-BHC	ND	ND	ND	ND	ND	ND	ND
r-BHC	ND	ND	ND	ND	ND	ND	ND
β-BHC	ND	ND	ND	ND	ND	ND	ND
δ-BHC	ND	ND	ND	ND	ND	ND	ND
Oxychlordane	ND	ND	ND	ND	ND	ND	ND
Hept. Epox.	ND	ND	ND	ND	ND	ND	ND
r-Chlordane	ND	ND	ND	ND	ND	ND	ND
t-Nonachlor	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND
PCB's (total)	ND	0.33	ND	ND	ND	ND	ND
o, p'-DDE	ND	ND	ND	ND	ND	ND	ND
α-Chlordane	ND	ND	ND	ND	ND	ND	ND
p, p'-DDE	0.03	0.09	0.03	0.01	0.02	0.01	ND
Dieldrin	0.01	ND	ND	ND	ND	ND	ND
o, p'-DDD	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
cis-nonachlor	ND	ND	ND	ND	ND	ND	ND
o, p'-DDT	ND	ND	ND	ND	ND	ND	ND
p, p'-DDD	ND	ND	ND	ND	ND	ND	ND
p, p'-DDT	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND
OTHER:							
WEIGHT (g)	6.64	8.14	8.61	9.31	7.34	7.04	7.54
MOISTURE (%)	-	-	-	-	-	-	-
LIPID (%)	-	-	-	-	-	-	-

Lower Level of Detection = 0.01 ppm for Tissue, Soil, Etc. 0.05 for Toxaphene and PCBs. For Water, LLD= 0.005 ppm for OCs, Tox , PCBs. # = Confirmed by GC/Mass Spectrometry
*ND = None Detected
**Spike = ____ for ____
***NS = Not Spiked

Table 4. cont.

FWS #	33223B	33223F	33224B	33224F	33225B	33225F	33226B
LAB #	835234	835235	835236	835237	835238	835239	835240
MATRIX	Eagle Blood	Eagle Fat	Eagle Blood	Eagle Fat	Eagle Blood	Eagle Fat	Eagle Blood
COMPOUND							
HCB	ND*	0.07	ND	0.05	ND	0.08	ND
α-BHC	ND	ND	ND	ND	ND	ND	ND
γ-BHC	ND	ND	ND	ND	ND	ND	ND
β-BHC	ND	ND	ND	0.05	ND	ND	ND
δ-BHC	ND	ND	ND	ND	ND	ND	ND
Oxychlordane	ND	0.12#	ND	0.36#	ND	0.24	ND
Hept. Epox.	ND	0.14#	ND	0.33#	ND	0.29	ND
γ-Chlordane	ND	0.06	ND	0.09	ND	ND	ND
t-Nonachlor	ND	0.18#	ND	1.0#	ND	0.38	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND
PCB's (total)	ND	5.6#	ND	24.#	ND	16.	ND
o, p'-DDE	ND	ND	ND	ND	ND	ND	ND
α-Chlordane	ND	0.17#	ND	0.43#	ND	0.32	ND
p, p'-DDE	0.01	3.3#	0.06	20.#	0.01	5.2	0.01
Dieldrin	ND	0.13#	0.01	1.6#	ND	0.46	ND
o, p'-DDD	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
cis-nonachlor	ND	0.19#	ND	0.66#	ND	0.47	ND
o, p'-DDT	ND	ND	ND	ND	ND	ND	ND
p, p'-DDD	ND	0.27#	ND	1.3#	ND	0.51	ND
p, p'-DDT	ND	ND	ND	0.08	ND	ND	ND
Mirex	ND	0.04	ND	0.44#	ND	0.06	ND
OTHER:							
WEIGHT (g)	8.93	0.489	7.38	0.537	8.92	0.173	8.71
MOISTURE (%)	-	-	-	-	-	-	-
LIPID (%)	-	-	-	-	-	-	-

Lower Level of Detection = 0.01 ppm for Tissue, Soil, Etc. 0.05 for Toxaphene and PCBs.
For Water, LLD= 0.005 ppm for OCs, Tox , PCBs. # = Confirmed by GC/Mass Spectrometry
*ND = None Detected
**Spike = ____ for _____
***NS = Not Spiked

Table 4. cont.

FWS #	**** 33226F	33227B	33227F	33228B	33228F	33229B	33229F
LAB #	835241	835242	835243	835244	835245	835246	835247
MATRIX	Eagle Fat	Eagle Blood	Eagle Fat	Eagle Blood	Eagle Fat	Eagle Blood	Eagle Fat
COMPOUND							
HCB	0.01	ND	0.03	ND	0.06	ND	0.08
α-BHC	ND*	ND	ND	ND	ND	ND	ND
r-BHC	ND	ND	ND	ND	ND	ND	ND
β-BHC	ND	ND	ND	ND	ND	ND	ND
δ-BHC	ND	ND	ND	ND	ND	ND	ND
Oxychlordane	0.06	ND	0.08	ND	0.17	ND	0.24
Hept. Epox.	0.09	ND	0.08	ND	0.18	ND	0.23
r-Chlordane	ND	ND	0.03	ND	0.06	ND	ND
t-Nonachlor	0.07	ND	0.09	ND	0.14	ND	0.54
Toxaphene	ND	ND	ND	ND	ND	ND	ND
PCB's (total)	2.3	ND	2.0	ND	4.9	ND	18.
o, p'-DDE	ND	ND	ND	ND	ND	ND	ND
α-Chlordane	ND	ND	0.07	ND	0.15	ND	0.25
p, p'-DDE	0.58	ND	0.70	ND	0.78	0.01	7.2
Dieldrin	0.45	ND	0.26	ND	0.42	ND	0.87
o, p'-DDD	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	0.18
cis-nonachlor	ND	ND	0.08	ND	0.10	ND	0.84
o, p'-DDT	ND	ND	ND	ND	ND	ND	ND
p, p'-DDD	0.01	ND	0.11	ND	0.34	ND	0.04
p, p'-DDT	ND	ND	ND	ND	ND	ND	ND
Mirex	0.02	ND	0.01	ND	0.01	ND	0.12
OTHER:							
WEIGHT (g)	0.411	8.46	0.460	8.47	0.211	8.96	0.187
MOISTURE (%)	-	-	-	-	-	-	-
LIPID (%)	-	-	-	-	-	-	-

Lower Level of Detection = 0.01 ppm for Tissue, Soil, Etc. 0.05 for Toxaphene and PCBs.
For Water, LLD= 0.005 ppm for OCs, Tox , PCBs. # = Confirmed by GC/Mass Spectrometry
*ND = None Detected
**Spike = ____ for _____
***NS = Not Spiked
**** Captive red-tailed hawk fat sample.

Table 4. cont.

FWS #	33230B	33230F	33231B	33232B	33232F	33233B	33233F
LAB #	835248	835249	835250	835251	835252	835253	835254
MATRIX	Eagle Blood	Eagle Fat	Eagle Blood	Eagle Blood	Eagle Fat	Eagle Blood	Eagle Fat
COMPOUND							
HCB	ND*	0.04	ND	ND	0.10#	ND	0.14
α-BHC	ND	ND	ND	ND	ND	ND	ND
γ-BHC	ND	ND	ND	ND	ND	ND	ND
β-BHC	ND	ND	ND	ND	ND	ND	ND
δ-BHC	ND	ND	ND	ND	ND	ND	ND
Oxychlordane	ND	0.10	ND	ND	0.22#	ND	0.31
Hept. Epox.	ND	0.09	ND	ND	0.23#	ND	0.23
γ-Chlordane	ND	ND	ND	ND	0.05	ND	ND
t-Nonachlor	ND	0.08	ND	ND	0.48#	ND	0.73
Toxaphene	ND	ND	ND	ND	ND	ND	ND
PCB's (total)	ND	1.2	ND	ND	7.9#	ND	28.
o, p'-DDE	ND	ND	ND	ND	ND	ND	ND
α-Chlordane	ND	0.05	ND	ND	0.28#	ND	0.23
p, p'-DDE	ND	1.4	0.03	0.01	4.9#	0.02	8.3
Dieldrin	ND	0.62	ND	ND	0.36#	ND	0.49
o, p'-DDD	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
cis-nonachlor	ND	0.07	ND	ND	0.45#	ND	0.40
o, p'-DDT	ND	ND	ND	ND	ND	ND	ND
p, p'-DDD	ND	0.06	ND	ND	0.47#	ND	0.43
p, p'-DDT	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	0.06	ND	0.12
OTHER:							
WEIGHT (g)	8.75	0.497	9.07	9.18	0.503	8.38	0.198
MOISTURE (%)	-	-	-	-	-	-	-
LIPID (%)	-	-	-	-	-	-	-

Lower Level of Detection = 0.01 ppm for Tissue, Soil, Etc. 0.05 for Toxaphene and PCBs.
For Water, LLD= 0.005 ppm for OCs, Tox , PCBs. # = Confirmed by GC/Mass Spectrometry
*ND = None Detected
**Spike = ____ for _____
***NS = Not Spiked

Table 4. cont.

FWS #	33234B	33234F	33235B	33236B	33236F	Blank	Matrix Blank
LAB #	835255	835256	835237	835238	835239	835260	for
MATRIX	Eagle Blood	Eagle Fat	Eagle Blood	Eagle Blood	Eagle Fat	Reagent	Blood
COMPOUND							
HCB	ND*	0.07	ND	ND	0.10	ND	ND
α-BHC	ND	ND	ND	ND	ND	ND	ND
γ-BHC	ND	ND	ND	ND	ND	ND	ND
β-BHC	ND	ND	ND	ND	ND	ND	ND
δ-BHC	ND	ND	ND	ND	ND	ND	ND
Oxychlordane	ND	0.10	ND	ND	0.23	ND	ND
Hept. Epox.	ND	0.15	ND	ND	0.26	ND	ND
γ-Chlordane	ND	0.12	ND	ND	ND	ND	ND
t-Nonachlor	ND	0.48	ND	ND	0.46	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND
PCB's (total)	ND	14.	ND	ND	8.1	ND	ND
o, p'-DDE	ND	ND	ND	ND	ND	ND	ND
α-Chlordane	ND	0.38	ND	ND	0.25	ND	ND
p, p'-DDE	0.01	3.6	0.02	0.01	4.1	ND	ND
Dieldrin	ND	0.45	ND	ND	0.23	ND	ND
o, p'-DDD	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
cis-nonachlor	ND	0.24	ND	ND	0.65	ND	ND
o, p'-DDT	ND	ND	ND	ND	ND	ND	ND
p, p'-DDD	ND	0.78	ND	ND	0.34	ND	ND
p, p'-DDT	ND	ND	ND	ND	0.19	ND	ND
Mirex	ND	0.02	ND	ND	0.19	ND	ND
OTHER:							
WEIGHT (g)	5.07	0.339	9.56	8.91	0.290	-	-
MOISTURE (%)	-	-	-	-	-	-	-
LIPID (%)	-	-	-	-	-	-	-

Lower Level of Detection = 0.01 ppm for Tissue, Soil, Etc. 0.05 for Toxaphene and PCBs.
For Water, LLD= 0.005 ppm for OCs, Tox , PCBs. # = Confirmed by GC/Mass Spectrometry
*ND = None Detected
**Spike = for
***NS = Not Spiked

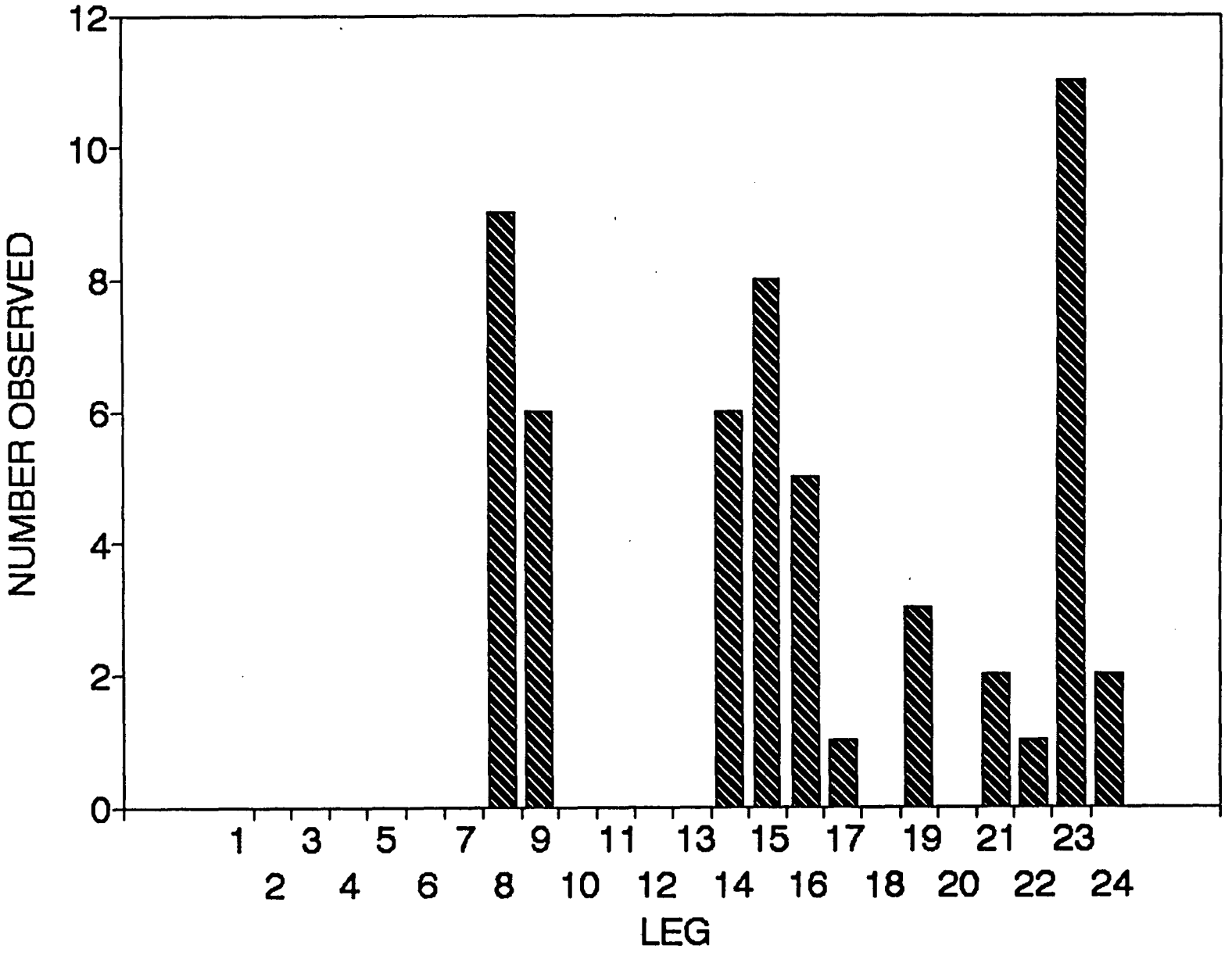


Fig. 1. Distribution of bald eagles along the Arsenal road survey from August 1991 through May 1992.

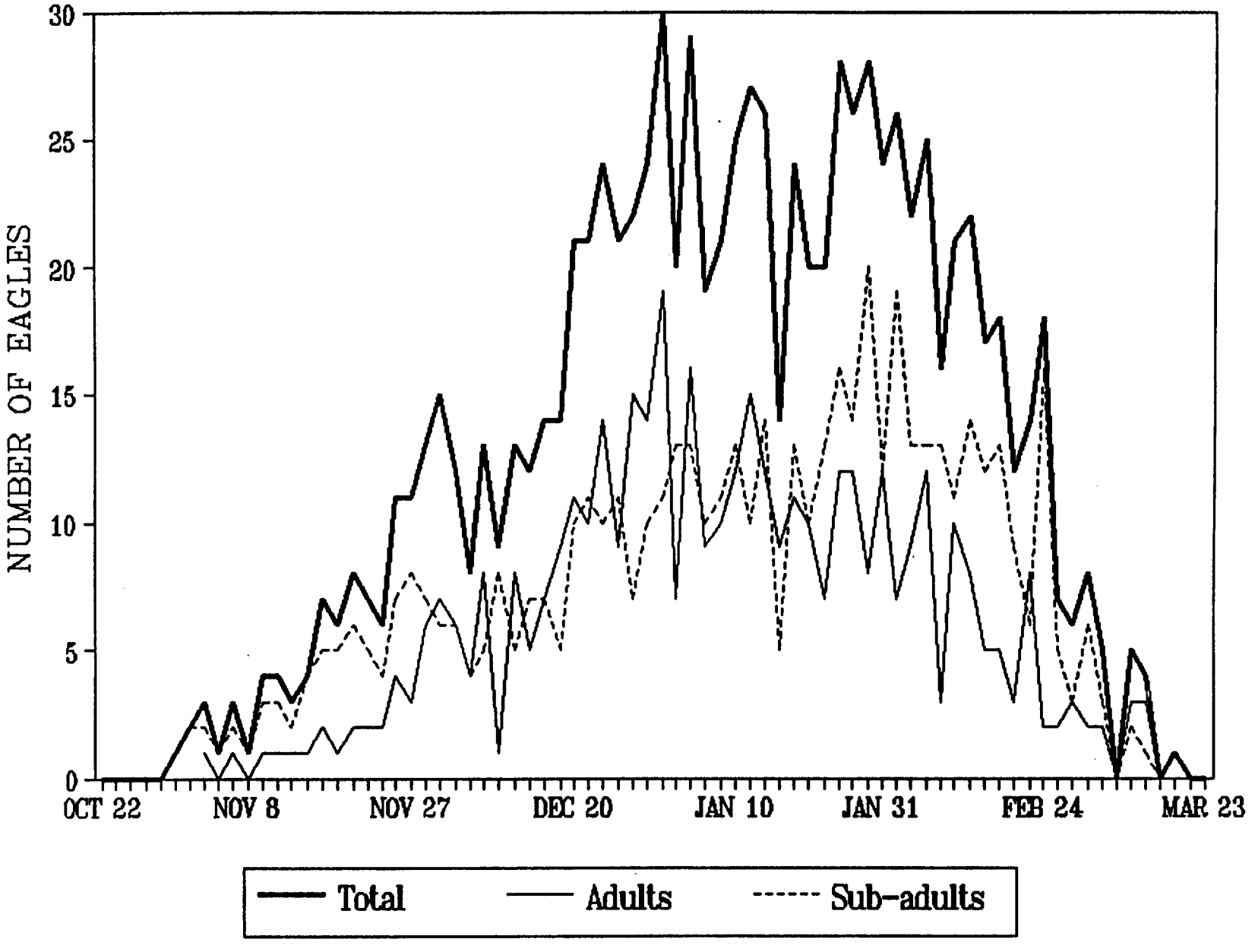


Fig. 2. Number of bald eagles observed during evening counts of the Arsenal communal roost from October 1991 through 1992.

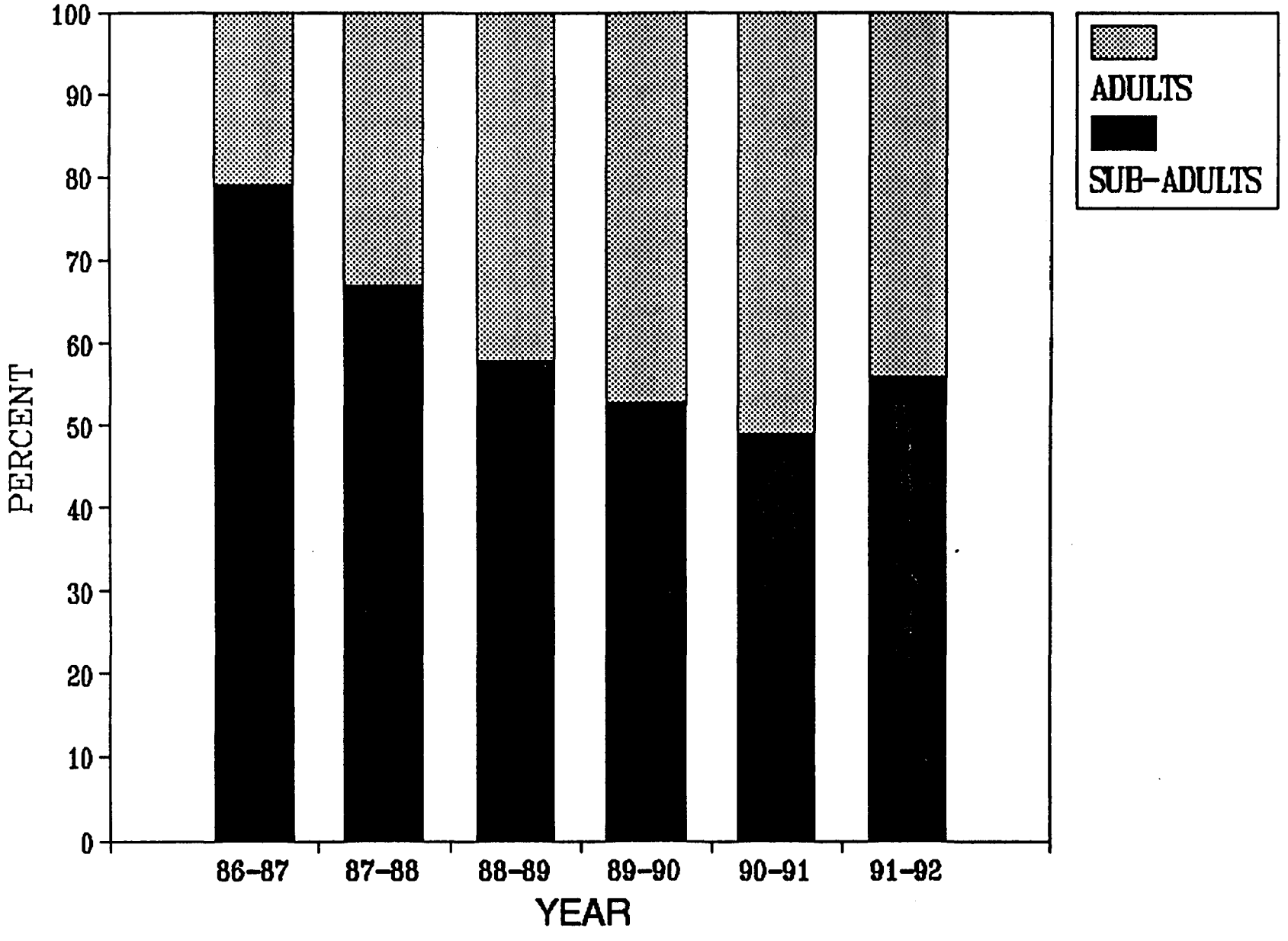


Fig. 3. Percent of adult verses subadult bald eagles observed during evening roost counts conducted during the winters of 1986-1987 through 1991-1992.

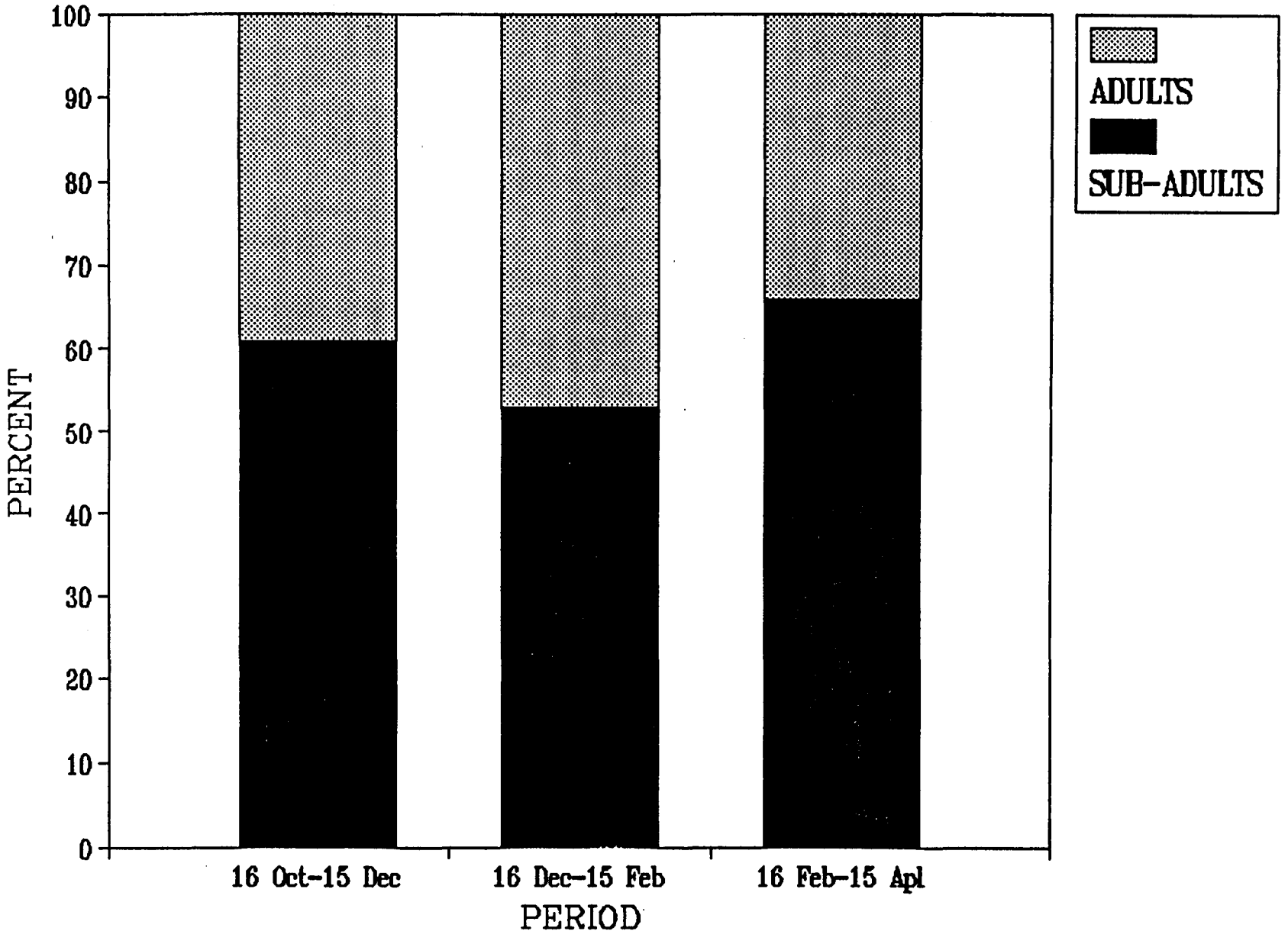


Fig. 4. Percent of adult versus subadult bald eagles observed on the Arsenal communal roost during early, middle, and late 1991-92 winter periods.

TITLE: Raptor population trends and habitat use

INTRODUCTION

The Arsenal supports a large and diverse raptor community (Table 6). The Arsenal contains a mosaic of habitat types including wetland, riparian, and various types and successional stages of grasslands. Inventorying and monitoring raptor populations and habitat use enables the Service to protect these habitats and maintain population diversity and richness during Arsenal cleanup. Baseline and long-term data will facilitate Service habitat management and habitat enhancement/mitigation projects for habitats impacted during Arsenal cleanup. The surveys also provide information for eliminating or minimizing potential exposure of raptors to chemically contaminated areas. The information will allow the Service to effectively place perch and nest structures over the Arsenal to maintain wintering and resident raptor populations.

Roadside surveys were used to monitor bald eagle and other raptor abundance and distribution on the study area, and to provide an index of raptor habitat use versus availability. Road censusing is a cost efficient method for surveying widely distributed raptors and has been used extensively to monitor raptor population trends (Johnson and Enderson 1972, Bauer 1982) and habitat/perch use (Marion and Ryder 1975, Fischer et el. 1984).

The inventory and monitoring of nesting raptors was conducted during the spring and summer of 1992. 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 will allow the Service to protect sensitive raptor nesting areas through the placement of "Sensitive Wildlife Area" signs.

METHODS

A road survey of raptors was conducted weekly or biweekly from August 1991 through May 1992. A 24 mile road survey was driven 2 hours after sunrise on calm days with no precipitation (Fig. 5). Surveys were conducted by a single observer from an automobile driving at 15-20 mph. Only birds observed with an unaided eye were recorded. If birds were not readily identifiable, the vehicle would stop and binoculars or a spotting scope would be used to make an identification. Species, age class, activity, perching substrate, leg (mile) of transect, and a specific location were recorded for each raptor observed.

An index of abundance was calculated for each species during the winter period (October-March) for comparisons with previous years data. A second index was produced for each species observed during the entire survey period (August-May). These indices were created by calculating the mean number of birds observed per survey for 19 and 32 surveys, respectively. An index was also calculated for all raptors combined for the three most common wintering raptor species for each month from August through May. Habitat use by the three most common wintering species was classified by two methods. First, use was evaluated by comparing distributional peaks of raptors along the survey route with existing vegetation maps (Morrison-Knudsen Environmental Services, Inc. 1992) during 32 surveys conducted from October 1991 through May 1992. Second, raptor habitat use and availability estimates were calculated by recording habitat types for perched birds, and estimating habitat availability for seven habitat types using existing vegetation maps and acreage estimates (Morrison-Knudsen Environmental Services, Inc. 1992) (Table 7). Habitat use and availability data were acquired during 23 surveys conducted from October 1990 through March 1991 and 32 surveys conducted from August 1991 through May 1992.

Weekly surveys for breeding raptors were initiated in late March 1992. Breeding pairs/occupied territories of red-tailed hawks and Swainson's hawks were located by noting the behavior of adults during the breeding period (March-June), and systematically searching available nesting habitat. Once occupied territories/breeding pairs were located, the areas were monitored weekly until the nest or territory was abandoned or young fledged.

Thirty-six American kestrel boxes are located on the Arsenal, five along the South Platte River near 112th Street (McIntosh Farm), six at the Riverside Cemetery, and five along the South Platte River near the Metropolitan Sewage District Plant were monitored during 1992 (U.S. Fish and Wildlife Service 1992). Nest box monitoring was initiated on 6 May 1992. All boxes were monitored weekly through May, thereafter only boxes that contained breeding pairs were monitored. These boxes were monitored until they were abandoned by the adults or the young fledged. Young were considered fledged when they reached 80 percent of fledging age. Age was determined on the basis of body size and feather development.

Terminology and definitions used in nest monitoring data analysis are similar to those proposed by Postupalsky (1974) and Steenhof (1987).

Other raptor projects included:

Four ferruginous hawk nesting platforms and four barn owl nest boxes were constructed and placed during 1992 (Fig. 6).

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

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

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 continued (Appendix B).

RESULTS

Raptor Population Trends and Habitat Use

Population

Ferruginous hawks were the most frequently observed raptor during the winter period (October-March) followed by red-tailed hawks, rough-legged hawks, and bald eagles (Table 8). A mean of 20.9 raptors was observed per survey during this period (Table 8). A mean of 20.5 raptors was observed per survey during the entire survey period (August-May) with red-tailed hawks followed by ferruginous hawks and burrowing owls the most common species observed.

Red-tailed hawk numbers increased substantially from August through October and dropped from October through January (Fig. 7). Numbers increased from January through March followed by a decline through May. Ferruginous hawk numbers increased from August through January and decreased from January through May (Fig. 7). Rough-legged hawks followed a similar pattern, increasing from November to peak numbers observed in January and declining through March (Fig. 7). Mean total raptors observed from August through April ranged from 18 to 26 (Fig. 8). Mean total raptors decreased to 11 during May.

Ferruginous hawks, rough-legged hawks, and bald eagles comprised 60.5 percent of the observed raptor population during the winter period. These species comprised only 37.7 percent of the observed population during the entire survey period (Table 8). Swainson's hawks, burrowing owls, and American kestrels comprised 6 percent of the observed population during the winter period, and 31.3 percent of the observed population during the entire survey period (Table 8). No substantial differences were noted for other species.

Habitat use

Distributional peaks

Red-tailed hawks were most frequently observed along legs 8, 14, and 15 (Fig. 5). Habitat along these legs consists of wetland habitats with associated riparian vegetation including varying aged stands of cottonwoods along First Creek and Lakes Ladora, Mary, and Lower Derby, and grasslands dominated by crested wheatgrass and cheatgrass/weedy forbs. The greatest number of ferruginous hawks were observed along legs 14, 23, 24 (Fig. 6). Habitat along these legs is grasslands dominated by weedy forbs with lesser amounts of cheatgrass/weedy forbs and native perennial grass. Rough-legged hawks were most commonly observed along legs 5, 15, 19, and 22 (Fig. 7). Habitat along these legs is comprised of cheatgrass/weedy forbs, wetlands, weedy forbs, and native perennial grass.

Habitat use versus availability

Red-tailed hawks were observed in wetland habitats substantially greater than expected based on their availability at the Arsenal. Observations of red-tailed hawks in other habitats was less than expected based on availability (Table 9). Ferruginous hawks occurred in weedy forb habitats much greater than expected, and occurred in crested wheatgrass and other habitat categories notably less than expected based on availability (Table 9). Rough-legged hawks were observed in wetland habitats considerably more than expected and occurred in weedy forbs, crested wheatgrass, and other habitat categories less than expected based on availability (Table 9).

Perch Use

Utility poles followed by cottonwoods were the most frequently used perch substrate by red-tailed hawks (Table 10). Rough-legged hawks used cottonwood trees and utility poles equally (Table 10). Utility poles were the primary perch used by ferruginous hawks (Table 10).

DISCUSSION

Raptor population trends and habitat use

Population Dynamics

The mean number of ferruginous hawks observed increased substantially during 1991 through 1992 when compared to the previous two winters. However, numbers remain considerably lower than those observed during the 1988-1989 winter (U.S. Fish and Wildlife Service 1992). The increase during 1991 through 1992 may be related to an increase in prairie dog distribution and density on the Arsenal. Prairie dog abundance and distribution

hawks and rough-legged hawks occur along survey legs and in habitats comprised primarily of wetland habitat types. This may indicate selection of these habitats due to prey availability, or may be related to the availability of suitable perches. Perch availability per habitat type was not measured. Rough-legged hawk use in weedy forb and cheatgrass/weedy forb habitats is probably related to these same variables. The greater number of ferruginous hawks observed in weedy forb habitat types and along survey legs dominated by weedy forbs may be attributed to the availability of prairie dogs in this habitat type. Approximately 44 percent of prairie dog towns are located within the weedy forbs habitat type (Table 11) (Morrison-Knudsen Environmental Service, Inc. 1992). Also, the use of utility poles by ferruginous hawks increased during 1991-1992 compared to 1990-1991 (U.S. Fish and Wildlife Service 1992). General observations indicate utility poles are the dominant perch in the weedy forbs habitat type and in most areas occupied by prairie dogs. Use of utility poles by red-tailed hawks increased substantially during 1991-1992 which may be related to the increase in prairie dogs. However, habitat use by red-tailed hawks classified by distribution along the road survey did not reveal a corresponding shift in use to these habitat types from 1990-1991 to 1991-1992.

RESULTS

Raptor nest monitoring

Nine breeding pairs of Swainson's hawks were observed on the Arsenal during 1992 (Table 12) (Fig. 8). Nests numbers 1,4, and 5 were also used during 1991, and nest number 6 was used during 1990. Four nests were located in cottonwood trees, 4 in Siberian elm trees, and one in a green ash tree. The number of breeding pairs and the total number fledged was substantially greater than that observed during 1990 and 1991 (U.S. Fish and Wildlife Service 1992) (Table 13). There was no substantial difference in the number fledged per breeding pair between 1992 and 1991, but a notable decrease was observed compared to 1990 (Table 13). The number of young fledged per successful nest increased compared to 1991 but was less than that observed during 1990 (Table 13). The mean number fledged per occupied territory was greater than that observed during 1990 and 1991 (Table 13). One fledgling was observed from the single breeding pair of red-tailed hawks located on the Arsenal during 1992 (Fig. 9).

Twenty-four breeding pairs of American kestrels were monitored at the Arsenal (Table 14) and 11 at off-post sites (Tables 15 and 16). There were no active boxes located along the South Platte River near the Metropolitan Sewage District Plant. There was no substantial differences between Arsenal and off-post sites in most American kestrel productivity indices (Table 17). The mean number of young observed per active box was notably higher at off-post sites combined, and the number fledged per all boxes was less at off-post sites combined (Table 17). Percent nest success

decreased at both Arsenal and off-post sites during 1992 compared to 1991 (Table 17) (U.S. Fish and Wildlife Service 1992). The number fledged per breeding pair and number fledged per successful nest at both Arsenal and off-post sites deceased somewhat in 1992. The decrease in the number fledged per breeding pair was greater at the Arsenal (Table 17) (U.S. Fish and Wildlife Service 1992).

DISCUSSION

Raptor nest monitoring

The substantial increases in the number of breeding pairs of Swainson's hawks may be the result of increased nest search efforts and monitoring consistency, increases in prey populations, or increases in prey availability through habitat modifications. Nest searches and monitoring was conducted by the same observer throughout 1992 which may have increased monitoring consistency and data quality. The increase in breeding pairs of Swainson's hawks may be attributed to increases in prairie dog abundance and distribution on the Arsenal. Fluctuations in prey populations may have dramatic effects on local populations of breeding raptors (Newton 1979). Vegetative cover can also affect the availability of prey to raptors (Wakeley 1978, Bechard 1982, Garton et al. 1989). Consequently, the number of breeding pairs an area can support may be affected (Bechard 1980, Bechard 1982). Arsenal cleanup activities, Service habitat restoration projects, and prairie dog management operations may be modifying habitats in ways that affect prey availability.

The mean number fledged per breeding pair, mean number fledged per successful nest, and the mean number of young per nest of Swainson's hawks on the Arsenal was slightly greater than other studies in Colorado (Olendorff 1973) and elsewhere (Dunkle 1977, Fitzner 1978, Schmutz 1985) (Table 18).

Although no substantial differences were observed in most American kestrel productivity indices between Arsenal and off-post sites, the differences that did occur may be related to variations in sample size. Also, the differences may be attributed to dissimilar habitats. All the off-post sites were located in riparian habitats, and 94 percent of the 16 boxes were attached to cottonwood trees with the remaining 6 percent attached to utility poles. Whereas, approximately 41 percent of the Arsenal boxes are located in tree groves primarily surrounded by grasslands, 41 percent were located in riparian habitats, and 18 percent were located in grasslands. Twenty-three percent of the Arsenal boxes were on utility poles and 67 percent were on trees. The decrease in the number fledged per breeding pair and successful nests at both Arsenal and off-post sites may be attributed to different weather patterns during the springs of 1991 and 1992. Weather can affect the suitability of foraging sites for breeding raptors (Stinson 1980).

Table 5. Raptors observed along the Arsenal road survey during the winter period and the entire survey period of 1991-92.

	1991-92 (Oct-Mar)				1991-92 (Aug-May)			
Species	N	AVG	%	RANGE	N	AVG	%	RANGE
Red-tailed hawk	96	(5.1)	24.2	(1-17)	154	(4.8)	23.5	(0-17)
Rough-legged hawk	68	(3.6)	17.1	(0-9)	68	(3.6)	10.4	(0-9)
Ferruginous hawk	119	(6.3)	30.0	(0-16)	126	(3.9)	19.2	(0-16)
Bald eagle	**53**	**(2.8)**	**13.4**	**(0-7)**	**53**	**(2.8)**	**8.1**	**(0-7)**
Golden eagle	14	(0.7)	3.5	(0-2)	14	(0.7)	2.4	(0-2)
American kestrel	24	(1.3)	6.0	(0-13)	93	(2.9)	14.2	(0-13)
Unknown buteo	11	(0.6)	2.8	(0-2)	16	(0.5)	2.4	(0-2)
Northern harrier	5	(0.3)	1.3	(0-2)	5	(0.3)	0.7	(0-2)
Merlin	3	(0.2)	0.8	(0-1)	3	(0.2)	0.5	(0-1)
Prairie falcon	4	(0.2)	1.0	(0-1)	4	(0.2)	0.6	(0-1)
Swainson's hawk	--	(----)	----	----	22	(0.7)	3.4	(0-5)
Burrowing owl	--	(----)	----	----	90	(2.8)	13.7	(0-17)
Total raptors	397	(20.9)	----	(15-32)	648	(20.3)	----	(9-32)

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

Table 6. 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)
Northern Goshawk (Accipiter gentilis) *
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)

* Species first documented during FY 92.

Table 8. Raptors observed along the Arsenal road survey during the winter period and the entire survey period of 1991-92.

	1991-92 (Oct-Mar)				1991-92 (Aug-May)			
Species	N	AVG	%	RANGE	N	AVG	%	RANGE
Red-tailed hawk	96	(5.1)	24.2	(1-17)	154	(4.8)	23.5	(0-17)
Rough-legged hawk	68	(3.6)	17.1	(0-9)	68	(3.6)	10.4	(0-9)
Ferruginous hawk	119	(6.3)	30.0	(0-16)	126	(3.9)	19.2	(0-16)
Bald eagle	53	(2.8)	13.4	(0-7)	53	(2.8)	8.1	(0-7)
Golden eagle	14	(0.7)	3.5	(0-2)	14	(0.7)	2.4	(0-2)
American kestrel	24	(1.3)	6.0	(0-13)	93	(2.9)	14.2	(0-13)
Unknown buteo	11	(0.6)	2.8	(0-2)	16	(0.5)	2.4	(0-2)
Northern harrier	5	(0.3)	1.3	(0-2)	5	(0.3)	0.7	(0-2)
Merlin	3	(0.2)	0.8	(0-1)	3	(0.2)	0.5	(0-1)
Prairie falcon	4	(0.2)	1.0	(0-1)	4	(0.2)	0.6	(0-1)
Swainson's hawk	--	(----)	----	----	22	(0.7)	3.4	(0-5)
Burrowing owl	--	(----)	----	----	90	(2.8)	13.7	(0-17)
Total raptors	397	(20.9)	----	(15-32)	648	(20.3)	----	(9-32)

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

Table 10. Percent perch use by raptors along the Arsenal road survey during the winter of 1991-92.

	Perch Type *									
Species	UP	CW	SE	GD	AS	WP	RO	LC	OP	MN
Red-tailed Hawk	58.3	35.9	1.0	1.0	1.0	1.4	0.0	0.0	1.9	1.0
Ferruginous Hawk	76.1	6.8	3.4	2.3	6.8	0.0	0.0	0.0	2.3	1.1
Rough-legged Hawk	42.4	45.8	10.2	1.7	0.0	0.0	0.0	0.0	0.0	0.0

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

Table 11. Vegetation classification within prairie dog towns on the Arsenal.

Classification	Acreage	Percent
Weedy Forbs	747.24	43.9
Cheatgrass/Weedy Forbs	464.12	27.2
Native Perennial Grass	288.32	16.9
Crested Wheatgrass	47.97	2.8
Shrubland/Succulents	61.76	3.6
Other	94.36	5.5
Total	1703.77	99.9

Table 12. Nest specific Swainson's hawk productivity on the Arsenal during 1992.

Nest	Number of Young Observed	Number Fledged
1	*	
2	3	3
3	3	3
4	*	
5	3	3
6	3	3
7	1	1
8	3	1
9	1	1
Total	17	13

* Nests lost due to wind during the late incubation or early brooding period.

Table 13. Swainson's hawk productivity on the Rocky Mountain Arsenal for 1990, 1991, and 1992.

	1990	1991	1992
Number of Breeding Pairs	2	4	9
Number of Nestlings Observed	0	6	17
Total Number Fledged	5	6	13
Mean fledged Per Breeding Pair	2.5 (2-3)	1.5 (1-2)	1.6 (0-3)
Mean Fledged Per Successful Nest	2.5 (2-3)	1.5 (1-2)	2.1 (1-3)
Mean Fledged Per Occupied Territory	1.0 (0-3)	0.7 (0-2)	1.6 (0-3)

Numbers in perentheses represent ranges.

Table 14. Nest specific American kestrel productivity at the Arsenal during 1992.

Box No.	Minimum Number * Eggs	Minimum Number Young Hatched	Number Young Fledged
RMA 3	5	3	3
RMA 4	5	0	0
RMA 9	0	0	0
RMA 10	5	4	4
106	5	5	5
107	5	4	4
108	0	0	0
110	0	0	0
111	0	0	0
112	5	4	4
114	0	0	0
118	3	0	0
119	0	0	0
121	5	5	5
122	5	5	4
123	5	0	0
124	0	0	0
125	0	0	0
126	0	0	0
129	0	0	0
130	0	0	0
131	4	4	4
132	5	0	0
133	5	2	2
135	5	5	4
137	2	0	0
138	4	0	0
139	5	3	2
140	5	2	2
141	4	0	0
142	5	0	0
143	5	5	2
144	2		2
146	5	5	4
147	5	0	0
149 **			
150	0	0	0
Total	109	58	51

* Zero values indicate inactive nest boxes.

** Nest box was not monitored to prevent potential disruption to nesting swainson's hawk.

Table 18. Swainson's hawk productivity on the Arsenal during 1992 compared with other sites in Colorado (Olendorff 1973), Wyoming (Dunkle 1977), Washington (Fitzner 1978), and Alberta (Schmutz 1985).

	Site *				
	1	2	3	4	5
Sample Size	9	95	31	39	439
Mean Clutch	2.4	2.3	2.2		
Mean Fledged Per Breeding Pair	1.6	1.2	1.2	1.2	1.5
Mean fledged Per Successful Nest	2.1	1.2	2.1	1.8	2.0

* 1= Arsenal, 2= Northeastern Colorado (1973), 3= Wyoming (1977), 4= Washington (1978), 5= Alberta (1985)

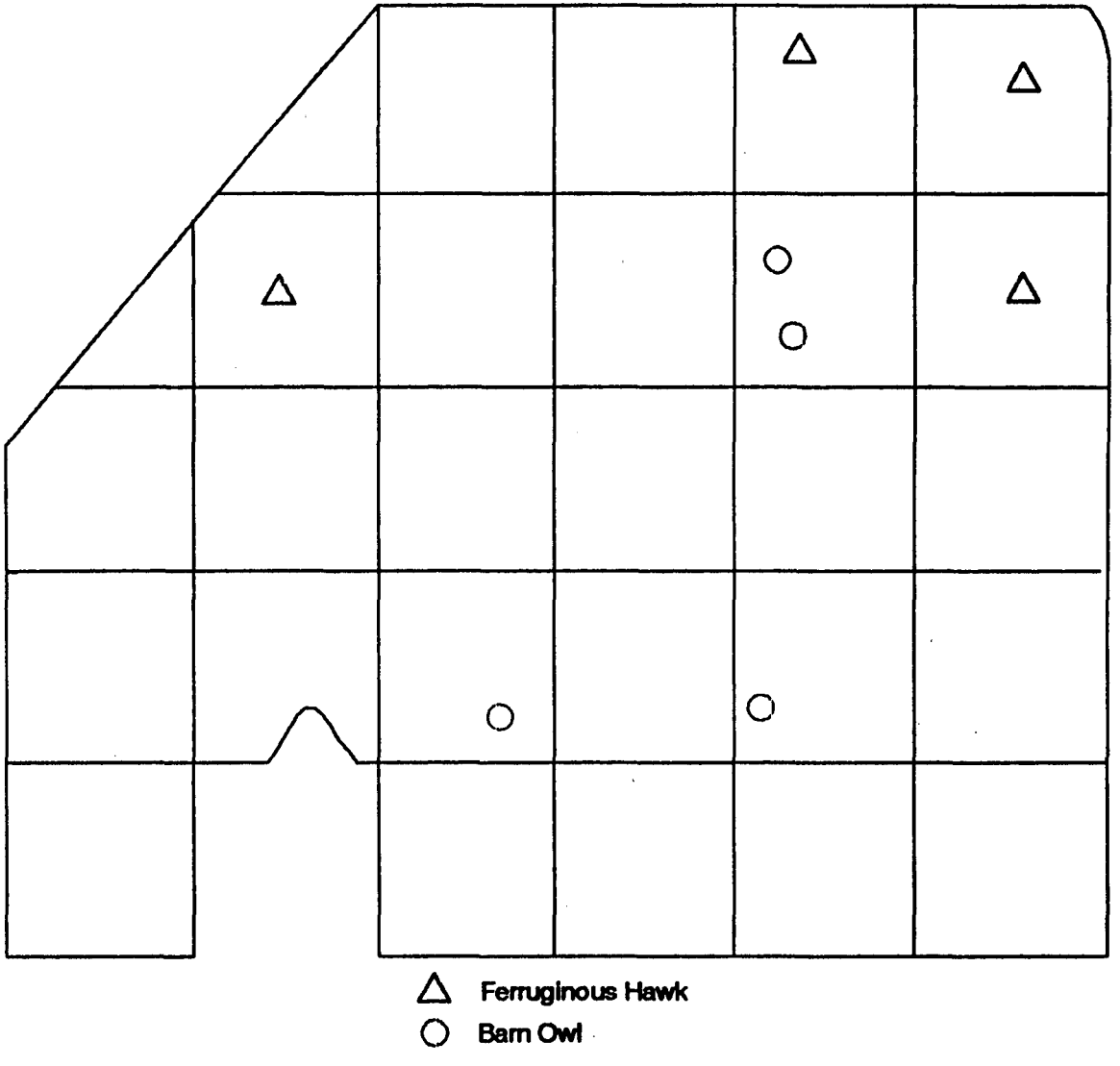


Fig. 6. Ferruginous hawk and barn owl nesting structures established on the Arsenal during 1992.

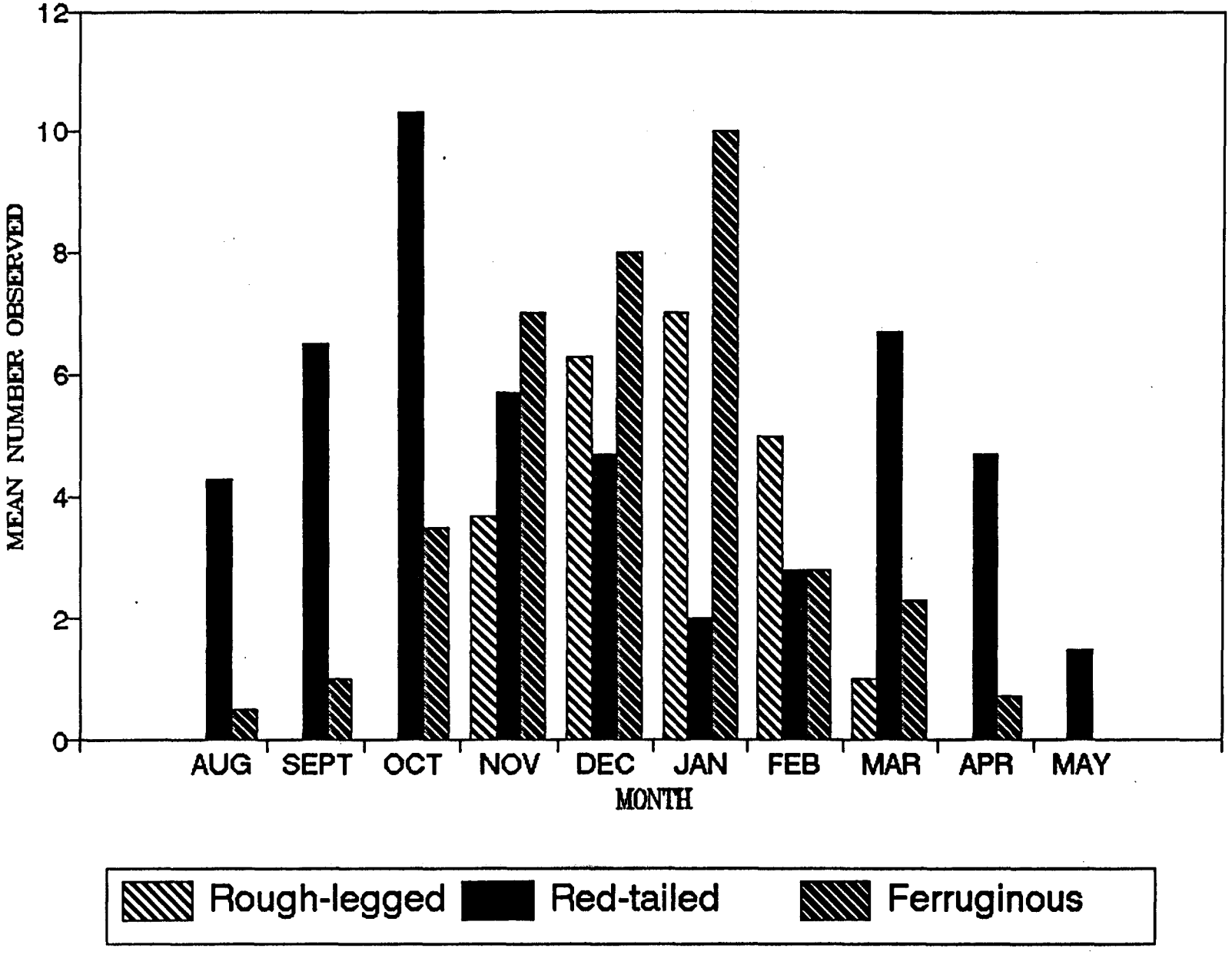


Fig. 7. Mean number of rough-legged, red-tailed, and ferruginous hawks observed on the Arsenal road survey from August 1991 through May 1992.

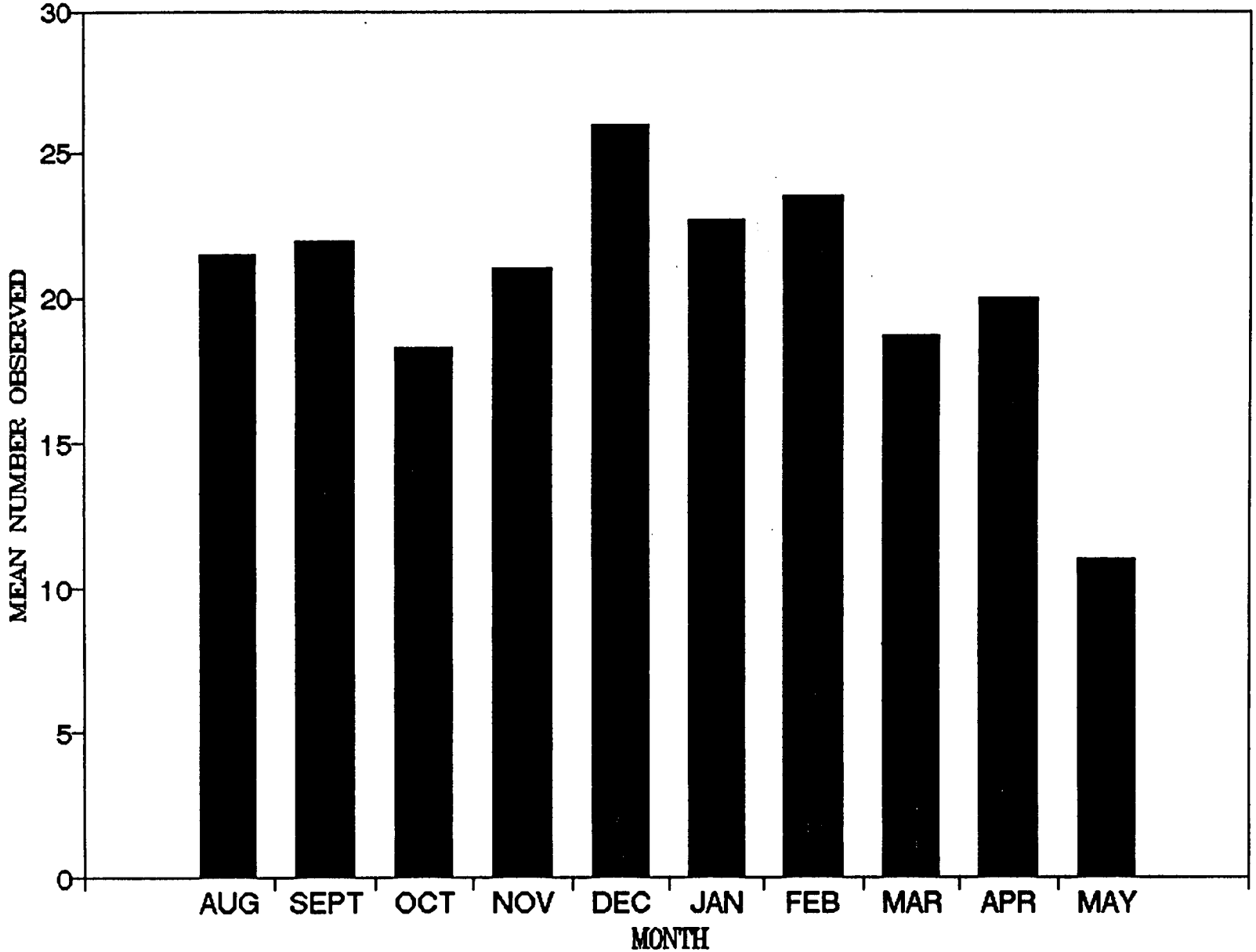


Fig. 8. Mean number of all raptors observed per month on the Arsenal road survey from August 1991 through May 1992.

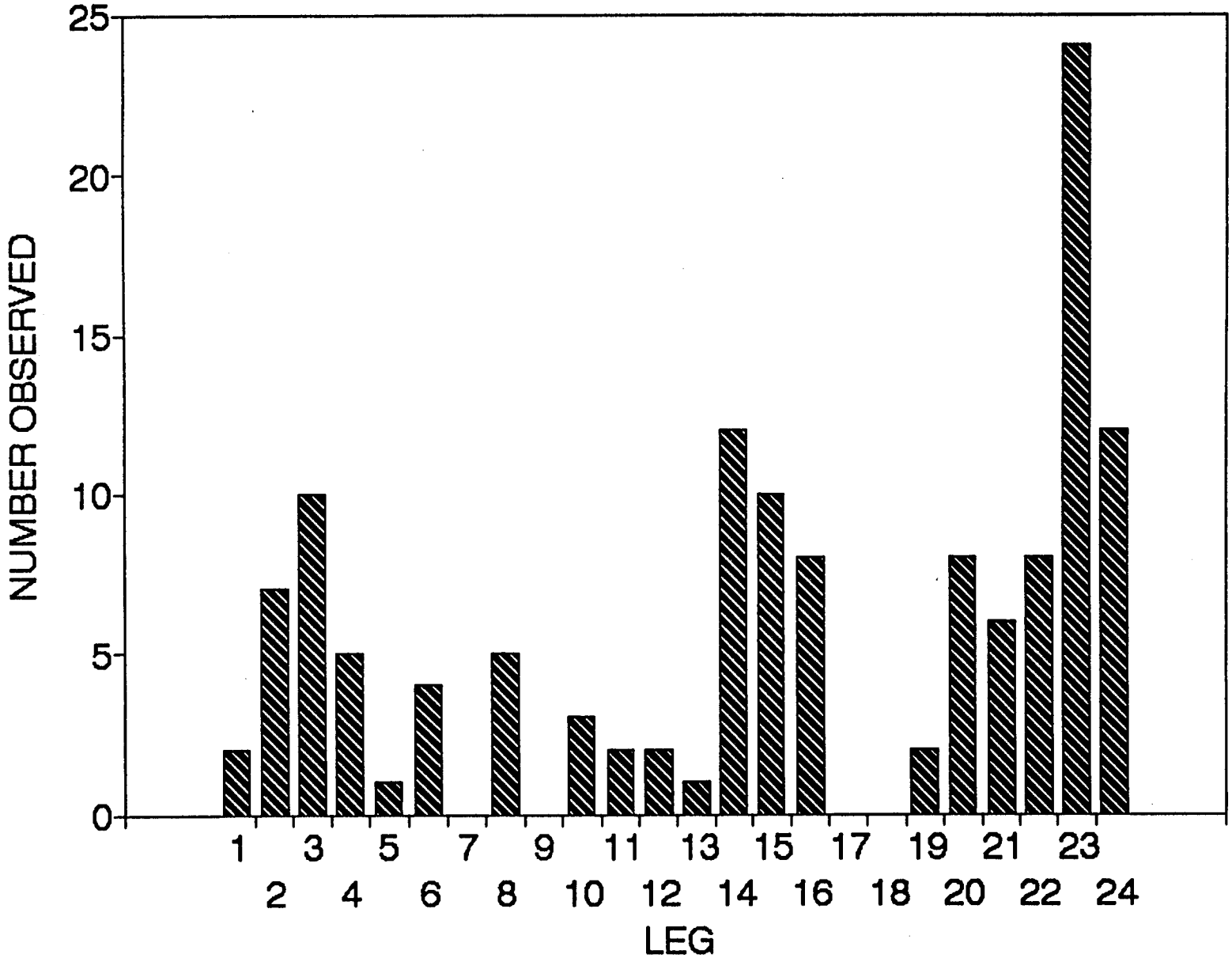


Fig. 10. Distribution of ferruginous hawks on the Arsenal road survey from August 1991 through May 1992.

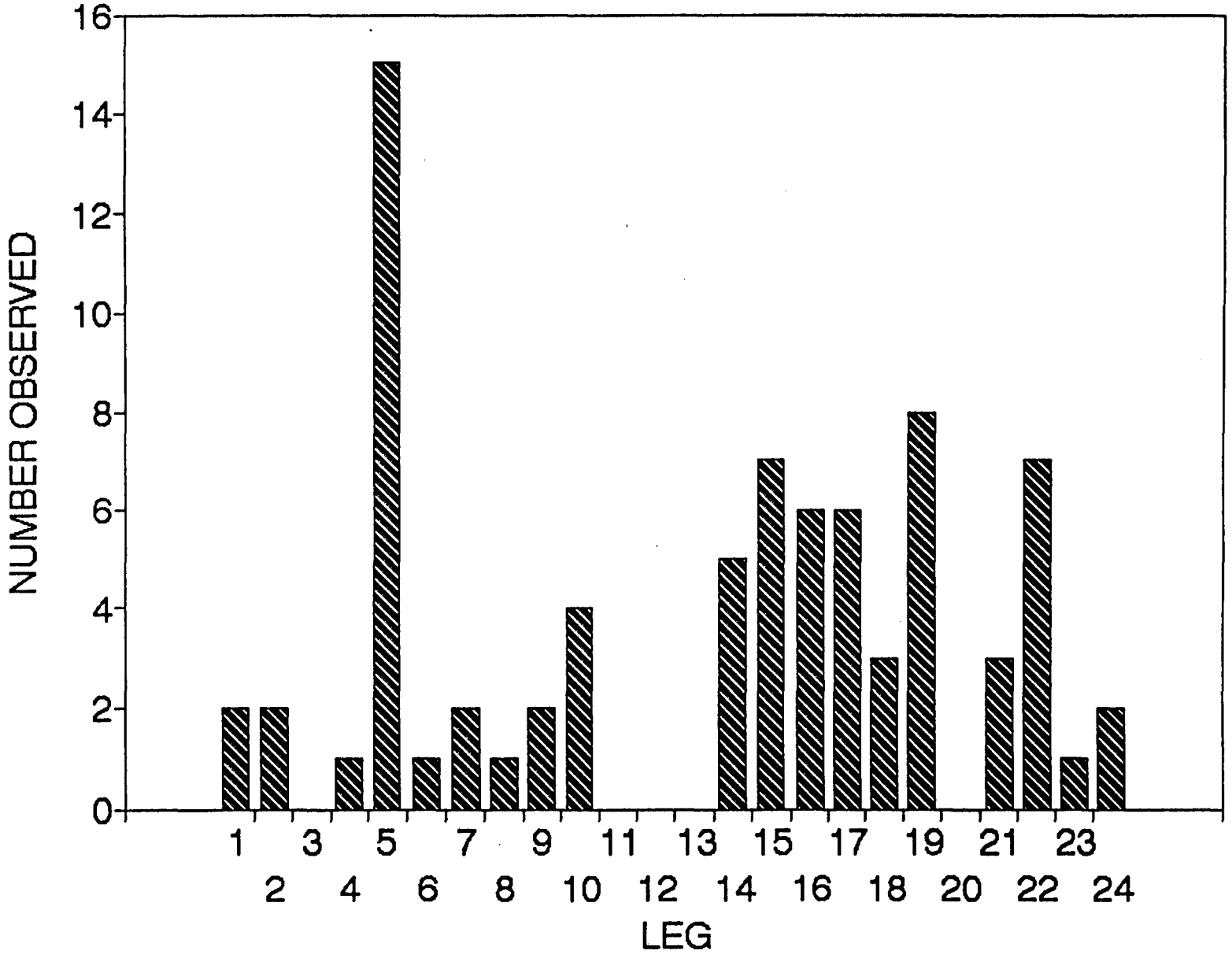


Fig. 11. Distribution of rough-legged hawks on the Arsenal road survey from August 1991 through May 1992.

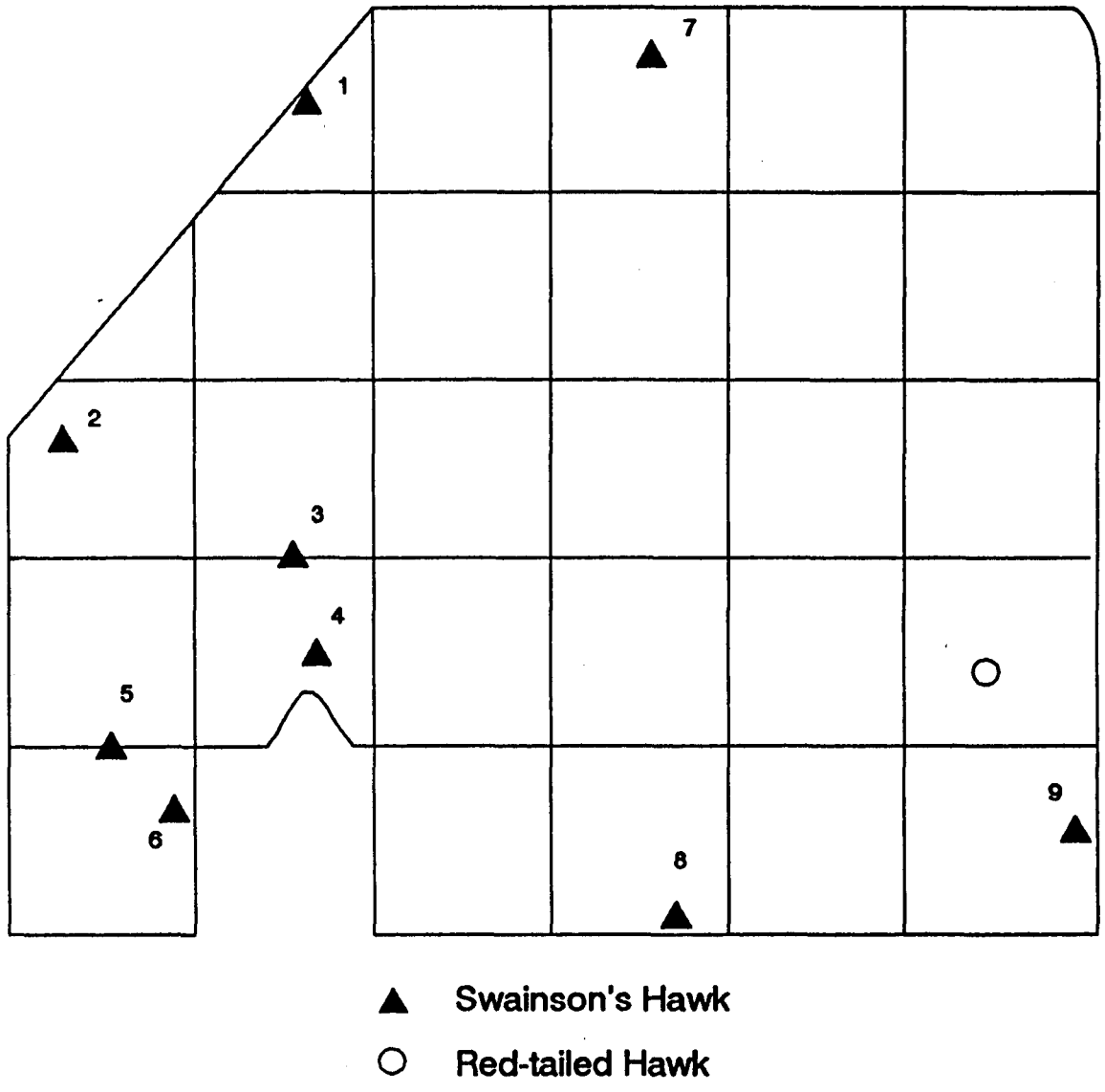


Fig. 12. Breeding pairs of Swainson's hawks and Red-tailed hawks on the Arsenal during 1992.

Title: Owl nesting trends and habitat use.

INTRODUCTION

Great horned owls (Bubo virginianus) are often found nesting on the Arsenal. To a lesser degree, long-eared owls (Asio otus) and an occasional pair of barn owls (Tyto alba) nest here as well. Eastern screech owls (Otus asio) are suspected of nesting here, but no actual nest cavities have been identified to date. Great-horned owl and long-eared owl nesting data were collected on the Arsenal during the winters and springs of 1990 and 1991, and reported in the FY91 Annual Progress Report (U.S. Fish and Wildlife Service 1991). A limited effort was made to locate nesting screech owls during those same years. As Arsenal cleanup operations proceed, human activities may encroach on nesting sites and habitat disturbances may occur. The purpose of this study is to determine distribution and abundance of nest sites and to quantify reproductive success. The information collected will be important for habitat management decisions, mitigating nesting areas if impacted by cleanup activities, and future plans to enhance wildlife viewing opportunities. Survey efforts conducted in 1992 are reported on, and reproductive success of great-horned and long-eared owls in 1990, 1991, and 1992 are compared.

METHODS

Night surveys were conducted to locate territories of great horned owls, long-eared owls, and eastern screech owls from 6 February through 19 February 1992 using prerecorded broadcast owl tapes. Owl calling was conducted after sunset on Arsenal roads covering distances of 5 to 11.1 miles for periods of 2 to 3 hours. An effort was made to undertake the surveys on clear, calm nights (winds $\leq$ 3 mph). However, conditions often changed as the evening progressed. Thus, surveys were often conducted under less than ideal weather conditions. After driving along predetermined survey routes, the vehicle was stopped at intervals of 0.5 miles. If Stapleton air traffic noise interfered with listening, the observer drove to the next 0.5 mile station. Owl calls were played on a Tandy compact cassette recorder model number 26-1208A according to the following procedure (Morrell et al. 1991): At each station, the observer stopped the vehicle and listened for unsolicited owl calls for 2 minutes, then taped calls were played for 5 minutes. A broadcast consisted of 6 sets of a 20-second owl call, with each set separated by 40-second pause intervals. Immediately after the final 20 second broadcast, 5 minutes were spent listening for owls. When an owl was heard and identified, the date, time, and locations were recorded on a survey data sheet.

Day surveys were conducted to locate breeding pairs of great horned owls and long-eared owls from 4 February through 29 April

1992. Occupied great horned owl nests were monitored from 7 March through 19 June 1992. Occupied long-eared owl nests were monitored from 8 April through 19 June 1992.

Daylight searches were conducted from vehicles and on foot. Great horned owl and long-eared owl nests were located by searching areas where an owl was heard in response to a broadcast tape on a previous night, searching nest sites known from previous years, and searching potential habitat. The areas around stick nests were examined for the presence of fresh pellets and whitewash as indicators of owl activity. Except in restricted access areas, all trees were checked in the Arsenal's southern tier sections 1 through 9, 11 and 12, and sections 20, 24, 25, 30, and 31 in the northern tier. Potential nest sites were located on 8 1/2" X 11" aerial photographs of Arsenal square mile sections, and occupied nests were permanently marked on 8 1/2" X 11" mylar overlays. Surveys and monitoring were conducted on a weekly basis and the results recorded on an observation data form. Nests were not entered to avoid disturbances. Thus, data were not collected on clutch size or on the number of eggs hatched in 1992. Brood size was determined from the number of nestlings seen in the nest while observing from a safe distance with binoculars and a spotting scope. Nest trees were identified and recorded. Universal Transverse Mercator (UTM) coordinates of successful nests were extrapolated from 7.5 minute topographical maps and recorded for future reference.

RESULTS AND DISCUSSION

Broadcast Calling

Prerecorded tape playing had limited success due to air traffic noise from nearby Stapleton Airport which made listening difficult along many routes. Further, the cassette recorder and tapes produced a low quality broadcast. Greatest success was in calling eastern screech owls which were heard in response to the tapes on three occasions. A long-eared owl was heard on one night in section 6, S.E. 1/4, but was thought to be hunting rather than in a nesting territory. A pair of calling great-horned owls was located on the night of 12 February in section 6, N.E. 1/4, but without the aid of the broadcast equipment. Daytime searches were much more productive in locating nesting owls.

GREAT HORNED OWLS

Distribution, Abundance, and Reproduction

A total of 13 great horned owl territories were located on the Arsenal during the period of 12 February through 29 April 1992. Eleven successful nests were located during the period of 7 March through 29 April (Fig. 13, Table 19). Two owl pairs monitored

throughout the breeding season were considered nonbreeders as no nests were observed in their territories.

Mean number of nestlings (Table 20) was 2.6 per breeding attempt (range 2-4). Table 21 summarizes the number of owlets contained in each nest. Houston (1971) reported that an above average year in Saskatchewan consisted of an average number of young $\geq$ 2.3 per nest, $\geq$ 5% with 4 young, and < 12% with only 1 young. According to this definition, the Arsenal had an above average year for great-horned owl production. Young were observed in the branching stage (away from the nest) from 28 April through 9 June. Eleven breeding pairs were successful (100%). At least 21 of 29 nestlings fledged (72.4%). Although monitoring efforts were more intensive and consistent in 1992 than in previous years, nests were not visited daily. Without constant observation, fledging is often difficult to determine. The actual number fledged was probably higher.

The number of breeding attempts reached a low of 8 in 1991, but peaked at 11 in 1990 and 1992 (no net change). After a decline in successful nests from 10 in 1990 to 5 in 1991, the number rose again in 1992, to 11 (net gain 10%). Caution is advised by Mayfield (1961, 1975), Marks (1986), and Steenhof and Kochert (1982), however, in calculating successful nests since the number can be inflated by overlooking early nest failures. Bent (1938) states that great-horned owls begin egg laying in January or February. Austing et al. (1966) indicated that egg laying usually begins around the middle of February on the Massachusetts latitude, with progressively earlier nesting dates as one moves southward. Since the first great horned-owl nest was not found until 7 March, the number of breeding attempts may have been underestimated. However, the total number of nestlings observed since the initiation of this study was highest (29) in 1992. The number fledged per successful nest has remained constant during the 3 year study with a range of 1.9 to 2.1. This compares favorably to fledgling rates found by Petersen (1979) in Wisconsin.

Breeding Chronology

Based on Bent (1938), Burton (1984), and Johnsgard (1988), great-horned owls require 66-77 days from incubation to fledging (Table 22). The approximate dates on which eggs were laid was calculated by backdating from fledging dates determined by activities of young owls outside the nest. Thus, great horned owl eggs were laid as early as 25 February and as late as 5 April (Table 23). Egg laying occurred at 6 nests in late February, at 1 nest in early March, and at 2 nests in mid-March. The outcome of 2 nests is unknown.

A more accurate assessment of egg dates could be made by entering the nests and checking eggs, but the risk of abandonment or the reduction in reproductive success is present with such undertakings (Steenhof 1987, Steenhof & Kochert 1982).

Nest Tree Selection

Great horned owls selected 4 tree species for nesting on the Arsenal (Fig. 14): plains cottonwood (Populus sargentii), Siberian elm (Ulmus pumila), white poplar (Populus alba), and juniper (Juniper sp.). Cottonwoods (5) and Siberian elm (4) were most frequently selected for nests. White poplar (1) and juniper (1) were selected least frequently. Most great horned owls (90.9%) chose open stick nests, while one pair (9.1%) raised their young in a domed stick nest. These structures presumably were abandoned by hawks or magpies, since great horned owls do not normally build their own nests (Austing and Holt 1966).

LONG EARED OWLS

Distribution, Abundance, and Reproduction

Four long-eared owl territories were located during the period of 16 March through 11 April. Four nests were confirmed during the period of 8 April through 22 April (Fig. 13). Mean number of nestlings was 1.0 (range 1-2) per breeding attempt (Table 24). Young were confirmed in 3 nests (Table 25), resulting in a 75% nesting success rate. Owlets were discovered in the branching stage at 2 nests on 7 May and 10 June, respectively. Fifty percent of the nestlings fledged in 1992 compared to 80% in 1990 and 30% in 1991. The number of breeding attempts increased 100% overall from 1990 to 1992. The number of successful nests increased 50% in 1992 over 1990 and 1991. The total number of observed nestlings decreased 20% from 1990 to 1992 after peaking in 1991. The number fledged per successful nest dropped 66.5% from 1990 to 1992.

It is difficult to spot young long eared owls in the branching stage. Marks (1986) emphasized the need for repeated visits to the nesting area to search for branchers in order to make an accurate determination of the number of fledglings produced. Branchers generally have a high survival rate (Marks 1986).

Breeding Chronology

Johnsgard (1988) reported that long-eared owls require 45-52 days from incubation to branching and 55-66 days from incubation to fledging. The egg laying date was approximated by backdating from the time when owlets were found in the branching stage. Thus, long eared-owl eggs were laid as early as 17 March and as late as 26 April (Table 26). Fledging dates were estimated by counting forward from branching dates. A more accurate

assessment of egg dates could be accomplished by entering the nests, but there is great risk of nest abandonment.

Nest Tree Selection

Long-eared owls selected thickets of New Mexican locusts (Robinia neomexicana) for nesting sites (Fig. 14). This support Marks (1986) findings that nesting long-eared owls are found in dense vegetation and clumps of trees.

Open stick nests were selected by 50% of the pairs in 1992 whereas the other 50% chose domed stick nests. Typically, long-eared owls utilize abandoned nests of hawks and corvids rather than building their own (Marks 1986, Burton 1984).

BARN OWLS

Nesting barn owls have been reported on the Arsenal during 1990 and 1991. Surveys to locate barn owls were not conducted in 1992, however, a pair nested unsuccessfully in the North Plants.

Table 19. UTM coordinates of great-horned (GHOW) and long-eared owl (LEOW) nests on Rocky Mountain Arsenal in FY92.

Nest Number	Section Number	Species	Y Axis	X Axis
1	4	GHOW	4407420	508540
2	3	GHOW	4406840	511460
3	1	GHOW	4406830	513220
4	12	GHOW	4406760	514490
5	12	GHOW	4405790	514320
6	6	GHOW	4407030	515390
7	6	GHOW	4408300	516310
8	30	GHOW	4410130	516070
9	24	GHOW	4412290	514720
10	12	LEOW	4405470	514380
11	11	LEOW	4406450	512520
12	11	LEOW	4406020	512580
13	11	LEOW	4406440	512640
14	11	GHOW	4405230	513010
15	5	GHOW	4406870	516690

Table 20. Reproductive success of great horned-owls nesting on the Rocky Mountain Arsenal in FY90, FY91, and FY92.

	Year		
	1990	1991	1992
Breeding attempts	11	8	11
Successful nests	10	5	11
Nestlings observed	21	22	29
Nestlings fledged	21	11	21
Nestlings per breeding attempt	1.9	2.8	2.6
Fledged per breeding attempt	1.9	1.4	1.9
Fledged per successful nest	2.1	2.2	1.9

Table 21. Number of great-horned owl nests containing 1, 2, 3, and 4 nestlings on the Rocky Mountain Arsenal in FY92.

Nests with:	Number of successful nests	(%)
1 young	0	0.0
2 young	5	45.5
3 young	5	45.5
4 young	1	9.0
Total	11	100.0

Table 22. Breeding chronology of great-horned owls, long-eared owls, and eastern screech owls.

Species	Egg Laying	Incubation	Fledging
Great horned owl	February or as early as January [a]	26-35 days [b,c]	35-42 days [c]
Long eared owl	Mid-March to Mid-May [c]	25-26 days [c]	Branching: 20-26 days Actual fledging: 30-40 days [c]
Eastern screech owl	Mid-March to early June [d]	26 days [b,c]	30-32 days [c]

[a] Bent 1938
[b] Burton 1984
[c] Johnsgard 1988
[d] Van Camp and Henny 1975

Table 23. Estimated dates of egg laying and fledging for 9 great-horned owl nests located on Rocky Mountain Arsenal in FY92.

Nest	Eggs Laid [a]	Fledged [b]
1	2/26-3/8	5/12
2	3/25-4/5	6/9
3	3/7-3/18	5/22
4	2/25-3/7	5/11
5	2/27-3/9	5/13
6	2/26-3/8	5/12
7	2/25-3/7	5/13
8	3/18-3/29	6/2
9	2/27-3/9	5/13

[a] Determined by backdating 66-77 days from fledging date.

[b] Best estimation.

Table 24. Reproductive success of long-eared owls nesting on the Rocky Mountain Arsenal in FY90, FY91, and FY92.

	Year		
	1990	1991	1992
Breeding attempts	2	5	4
Successful nests	2	2	3
Nestlings observed	5	10	4
Nestlings fledged	4	3	2
Nestlings per breeding attempt	2.5	2.0	1.0
Fledged per breeding attempt	2.0	0.6	0.5
Fledged per successful nest	2.0	1.5	0.67

Table 25. Number of long-eared owl nests containing 1 and 2 nestlings on the Rocky Mountain Arsenal in FY92.

Nests with:	Number of successful nests	(%)
1 young	2	66.7
2 young	1	33.3
Total	3	100.0

Table 26. Estimated dates of egg laying, branching, and fledging for 2 long-eared owl nests located on Rocky Mountain Arsenal in FY92.

Nest	Eggs Laid [a]	Branched [b]	Fledged [c]
1	3/17-3/24	5/7	5/17-5/21
2	4/19-4/26	6/10	6/20-6/24

[a] Determined by backdating 45-52 days from branching date.

[b] Best estimation.

[c] Added 10-14 days to branching date.

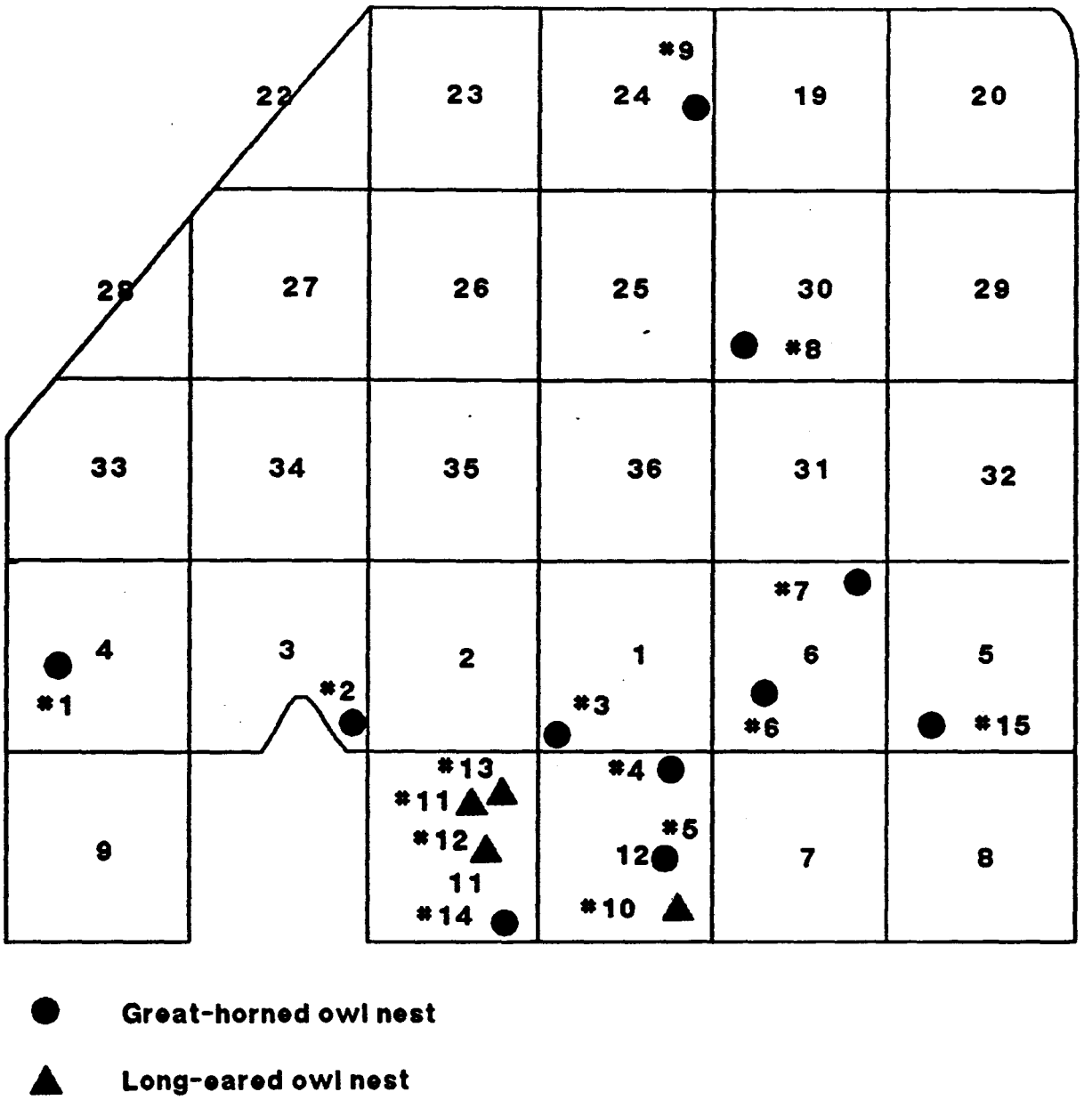


Fig. 13. Location of great horned and long-eared owl nests on the Arsenal in FY92.

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

INTRODUCTION

Since the sylvatic plague epizootic of 1988-89 reduced the population of black-tailed prairie dogs (Cynomys ludovicianus) on the Arsenal by an estimated 95% (Ebasco 1989; U.S. Fish and Wildlife Service 1989), the Service has been working to re-establish prairie dogs to former levels. Prairie dogs form the primary prey base for a variety of predators on the Arsenal, including the endangered bald eagle (Haliaeetus leucocephalus). Therefore, it was deemed crucial that their population levels be restored to pre-plague levels as soon as possible. The focal point of this effort has been through prairie dog relocations into areas of former occupation with the assistance of several private organizations. From 1989 to 1991, the Service relocated 5229 prairie dogs to the Arsenal from off-post sources (U.S. Fish and Wildlife Service 1992). In 1991, prairie dog distribution totaled 555.56 hectares, with an estimated mean density of 25.87 prairie dogs per hectare (U.S. Fish and Wildlife Service 1992). The purpose of this continuing study has been to determine changes in the distribution and abundance of prairie dogs on the Arsenal, and to assess future prairie dog management objectives.

METHODS

Distribution

Prairie dog distribution was mapped using the same methodology as in 1991 (U.S. Fish and Wildlife Service 1992). Black and white aerial photographs (8 1/2" by 11" with a scale of approximately 1 inch equals 660 feet) were used as a field reference guide. An 8 1/2" by 11" piece of frosted mylar was placed over each section photo and the boundaries of prairie dogs towns were then delineated in the field. Only active prairie dog towns were included in the survey. Upon completion of the field mapping, the area of each town was determined using an electronic planimeter.

Abundance

Methods used to estimate population parameters were the same as those used in the 1991 survey (U.S. Fish and Wildlife Service 1992), and are based on the methodology developed by the National Ecology Research Center (NERC) in Fort Collins to evaluate black-footed ferret habitat (Biggins et al. 1989). Visual counts were conducted to determine population densities and burrow transects (counting active and total burrows) to ascertain burrow densities and relative activity levels. Both of these methods are used to determine overall fitness of a population. Values will be compared to other black-tailed prairie dog populations.

Additionally, between-year data comparisons were made, since the methodology and observers were the same in both years.

Nine of the 10 study plots from 1991 were used for 1992, (one plot was not used for a second year due to prairie dog trapping at the site) and three new study plots were added (Fig. 15). Study plots were selected on a representative, rather than a random basis, due to certain site characteristics needed to conduct visual counts. Site characteristics included visibility of the entire study plot from a single location, vegetation height, size of prairie dog town, and topographic relief. The plots were established using a surveyors transit and geodimeter, and corners marked with six foot lengths of 1/2 inch PVC tubing. Pin flags were set out at regular intervals along the sides of the plots to determine whether prairie dogs were in or out of the plot during counts.

Visual counts and burrow transects were conducted on each study plot (n=12) from 2 June to 2 July, 1992. Visual counts were performed for three consecutive days on each plot, starting approximately 1/2 hour after sunrise and continuing (with 15 minutes between counts) until prairie dog numbers began to decrease, usually by mid-morning. The highest number of prairie dogs recorded during the three days of visual counts was used to determine the density of each plot (highest count/area). All plots were summed and divided by the number of plots (n=12) to determine the mean uncorrected density. A visual correction factor (observability index) for black-tailed prairie dogs developed at NERC (uncorrected density/.566) was used to estimate the mean population density. The observability index corrects for the number of prairie dogs not above ground during the counts and observer error. This density was multiplied by the total area occupied by prairie dogs to ascertain the prairie dog population estimate for 1992.

Burrow transects were conducted on the same study plots using prescribed methods developed by Biggins et al. (1989) at NERC. Rol-a-tape measuring wheels with three-meter conduit attached were used to determine the area on each plot sampled (e.g. a 200 meter-wide plot would yield a series of 600 square meter strips sampled). The number of active and total burrows found on each strip transect were tabulated and all transects totaled for each plot. Active burrow densities were then calculated for each study plot and the mean calculated. Biggins and Hanebury (unpublished data) determined that there is a significant relationship between active burrow densities and visual counts for black-tailed prairie dogs. This is best described by a regression line through the origin, with $r = +0.65$. Minitab (Student Edition) was used to calculate the linear correlation coefficient of active burrows/visual counts for black-tailed prairie dogs at the Arsenal.

RESULTS AND DISCUSSION

Distribution

A total of 663.24 hectares (1638 acres) of active prairie dog towns were mapped during February and April, 1992 (Fig. 16, Table 27). This represents an increase of 19.4% over the 1991 distribution. Fifty-seven percent of the increase in area is attributable to 1991 relocation areas (Sections 19, 20 and 23), therefore 46.2 hectares (43%) of the increase came from natural expansion. The only areas showing decreases in prairie dog distribution were those affected by clean-up/construction activities in Sections 25, 35 and 8. In fact, the mitigated areas in Sections 25 (borrow pit) and 8 (BEMA habitat) were completely re-colonized by prairie dogs by the end of FY92. Some of the areas showing no increase in prairie dog distribution (Sections 34, 4, 3, 2, 6 and 12), may lack additional suitable habitat for prairie dog expansion.

Table 27. Areas of prairie dog town areas on Rocky Mountain Arsenal (in hectares).

Section	1991	1992	% Change
22	12.56	19.80	+ 57.6
23	5.65	9.46	+ 67.4
19	69.59	99.53	+ 43.0
20	19.55	52.13	+166.6
28	3.83	8.34	+117.7
27	16.40	21.90	+ 33.5
26	5.48	5.48	0.0
25	20.64	16.86	- 18.3
30	35.55	37.47	+ 5.4
29	78.92	85.14	+ 7.8
33	4.28	6.24	+ 45.8
34	.127	.127	0.0
35	85.74	84.60	- 1.3
31	13.26	14.31	+ 7.9
32	65.12	76.01	+ 16.7
4	4.19	4.19	0.0
3	8.37	8.37	0.0
2	8.31	8.31	0.0
6	6.71	6.71	0.0
5	38.70	44.19	+ 14.2
9	37.03	37.11	+ 0.2
11	8.13	8.54	+ 5.0
12	5.79	5.79	0.0
8	1.63	.13	- 92.0
7	0.00	2.50	-----
Total	555.56	663.24	+ 19.4

dog burrows for fleas. On 4 September the Service received notice from CDC that our flea samples had tested positive for the causative agent for plague (Yersinia pestis). Efforts to control and monitor the epizootic were increased, and dusting completed of the recommended areas. By the end of September, the epizootic was under control and affected areas were mapped (Fig. 17). An estimated 55 hectares of prairie dog towns were lost to plague. Fifteen hectares of this area have since been re-established as active prairie dog towns through relocation efforts.

Prairie dogs continue to make a strong recovery following the plague epizootic of 1988-89, despite the plague epizootic in 1992. From an estimated population of over 68,000 in 1987 to a low of less than 3,500 in September 1989 (based on Clippinger 1987), prairie dogs have reached a population of over 20,000 in only three years.

Black-tailed prairie dog densities on the Arsenal are comparable to (and in some cases exceed) densities found in other studies (Biggins et al. 1989; King 1955; Koford 1958; Lewis et al. 1979; Tileston and Lechleitner 1966). The densities found at 7 of the 12 visual count plots exceeded the densities found by other researchers in northern Colorado (32 prairie dogs/ha, Tileston and Lechleitner, 1966). Total burrow densities found on the Arsenal (106/ha) are also comparable to those reported by other investigators including Koford (1958) 6-116/ha, King (1955) 125/ha, Knowles (1982) 101-104/ha, and Tileston and Lechleitner (1966) 104/ha.

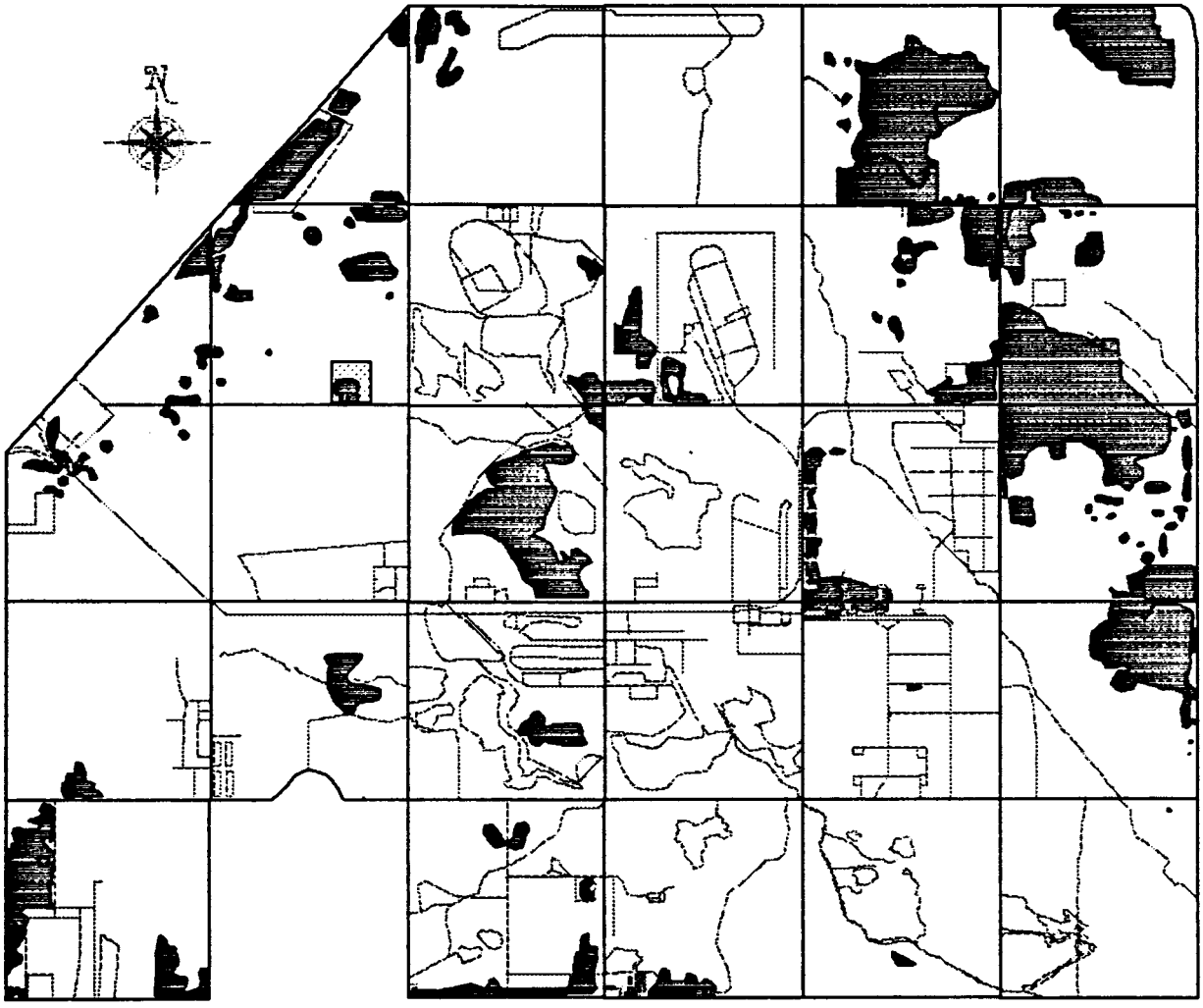


Fig. 15. Prairie dog distribution at the Arsenal, May 1992.

the Denver International Airport and U.S. Post Office site throughout the year.

Table 30. Prairie dog trapping/relocations at Rocky Mountain Arsenal during FY92.

On-post trapping	Number
Bldg. 111 - east	45
North Boundary	57
Northwest Boundary	70
SQI site	48
Borrow Pit (Sect. 25)	9
sub-total	229
Off-post relocators	
Prairie Dog Rescue	277
Urban Wildlife Rescue	58
Loveland Prairie Dog Action	81
Dog-Gone	11
Bob Alm	11
sub-total	438
Total	667

The Service trapped nuisance prairie dogs from a number of on-post locations where their presence may have interfered or conflicted with clean-up related activities. The Service was able to re-establish active prairie dog towns at the two sites in Section 27 affected by plague, with 48 released on the Auger plot (as part of a prairie dog relocation experiment) and 62 released at the Section 27 north site.

Table 31. Prairie dog relocation areas at Rocky Mountain Arsenal during FY92.

Relocation areas	Number
Sect. 23 NW	83
Sect. 19 S	384
Sect. 20 NE	41
Sect. 27 Auger	120
Sect. 27 North	39
Total	667

Dispersals

Five previously released prairie dogs were recaptured during trapping efforts. At the Northwest Boundary Containment System (section 22) two prairie dogs were trapped that had been released into section 27. One was a female adult that was originally released at a graduate study plot on 9 September 1990, and re-trapped on 4 November 1991. This prairie dog dispersed a distance of about 1/4 mile and was re-released at the Auger site. The other prairie dog trapped at the Northwest Boundary was also an adult female originally released 17 June 1991 at the section 27 (north) release site and re-trapped 25 February 1992. This animal dispersed over 1/2 mile and was re-released at the section 20 (north) release site. Two prairie dogs were captured at the North Boundary Containment System (section 23) that had originally been released at the section 19 (north) release site during September, 1990. Both prairie dogs (one male and one female) were re-captured on 6 July 1992, and had travelled over 1 1/2 miles and were re-released at the section 19 (south) release site. The last prairie dog re-captured during trapping was an

adult male originally released 10 May 1992 at the section 23 (northwest) release site. This animal was re-captured on 20 July 1992 at the SQI site and returned to section 23 (northwest). This same prairie dog was re-captured a second time at the SQI on 14 September 1992 and released to the Auger site in section 27. This prairie dog dispersed a total distance of 2 miles (one mile per dispersal). It was captured during the first day of mark/recapture at the Auger site on 5 October 1992.

Management Objectives

Black-tailed prairie dogs at Rocky Mountain Arsenal play a vital role in maintaining diverse wildlife populations, including a large number of resident (coyotes, badgers and red-tailed hawks), breeding (Swainson's hawks) and wintering (bald eagles and ferruginous hawks) predators. Their manipulations of shortgrass prairie through selective feeding and burrowing behavior provide habitat for a wide range of wildlife species, from burrowing owls (Athene cunicularia) to prairie rattlesnakes (Crotalus viridis viridis). However, these same attributes that provide for such a complex wildlife habitat, can also lead to conflicts with human activities. This is especially evident at the Arsenal, where the level of cleanup and related construction projects has increased dramatically in the last few years. This increase in human activity coincides with an expanding prairie dog population, which necessitates aggressive management efforts. Trapping nuisance prairie dogs from areas of conflict and installing barriers (vegetative, human-made, or a combination) to prevent re-colonization will be the primary concern of future prairie dog management. A map is currently being developed to locate potential conflict areas and sites where installation of barriers may be necessary to prevent further conflicts.

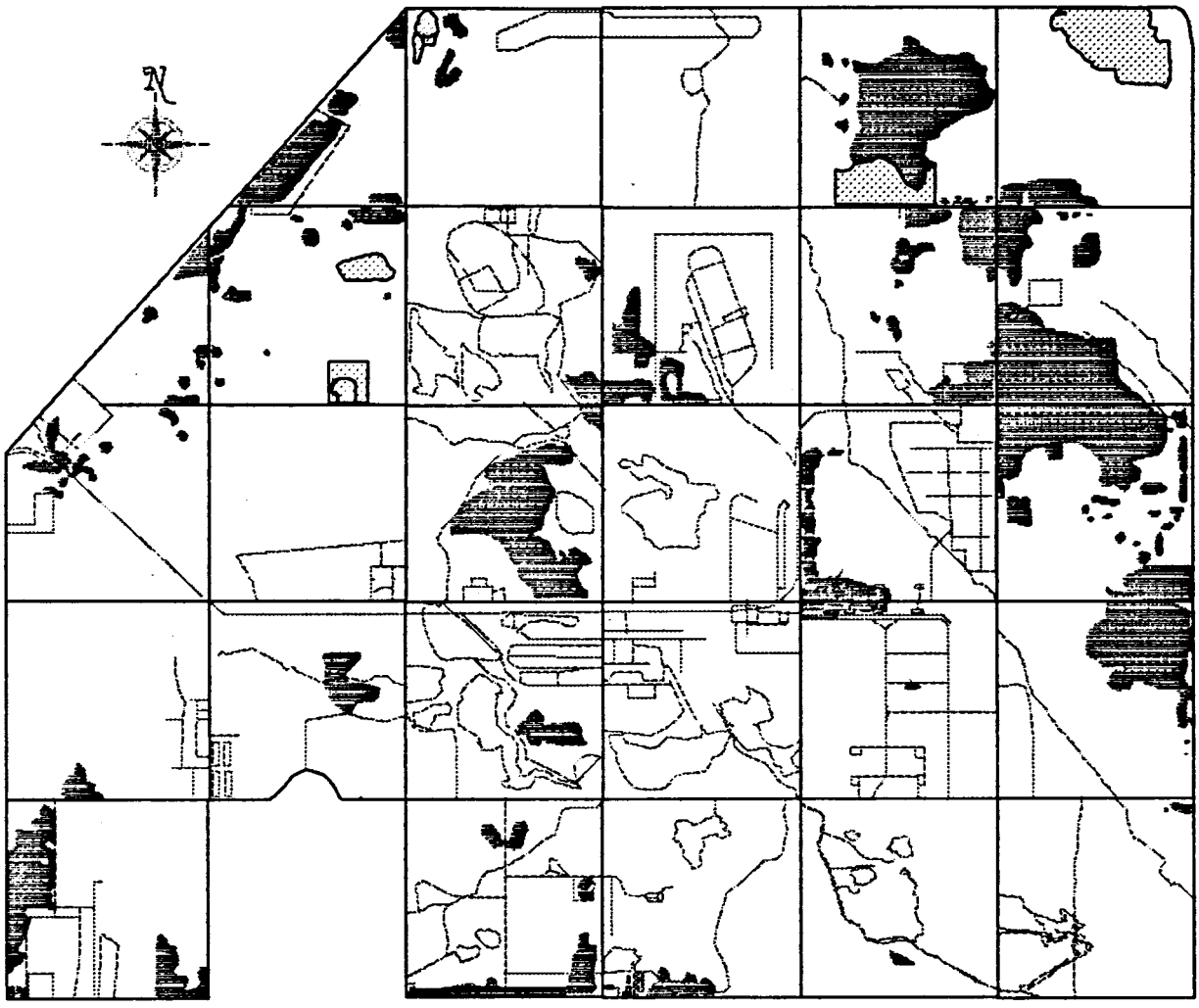


Fig. 18. Prairie dog relocation sites at the Arsenal during FY92.

Phase Two

The second phase of mark/recapture was completed during two weeks of September. During week one, 26 of 46 prairie dogs (n=48, with 2 known mortalities) were recaptured (56.5% survival). During week two, 21 of 46 prairie dogs were recaptured (45.6% survival). Figure 22 shows dispersals (>30 meters) of 26 prairie dogs captured during mark/recapture effort. The dispersals showed similar results as in phase one, with all prairie dogs moving to natural burrows. There was a marked difference in the number of males versus females recaptured (based on proportion of population). Of 11 adult males released, all but one was recaptured during the two week trap effort (91% recaptured). Of the 32 adult females released, 16 were recaptured during the two weeks (50%). Program CAPTURE yielded an estimated population mean of 30 (SE 2.37) for week one. Week two results were an estimated mean of 25 (SE 2.52). The average daily probability of capture (p-hat) was .467 during week one and .420 for week two, which explains the good precision of the population estimate. In addition, it was found that about 30% of the prairie dogs were using augered burrows at least some of the time. By the end of the mark/recapture experiment several of the augered burrows showed evidence of modifications by prairie dogs, including mounding. In at least two of the augered burrows residency by burrowing owls was confirmed. This evidence indicates that augered burrows, especially adjacent to active prairie dog towns, may expedite expansion of prairie dogs into areas of former occupation. Evidence also suggests that prairie dogs will not stay in simple (one opening-straight burrow) burrow systems, but may prefer more complex systems (Stromberg 1978, Egoscue and Frank 1984). Results may be improved by providing augered burrows with more than one opening.

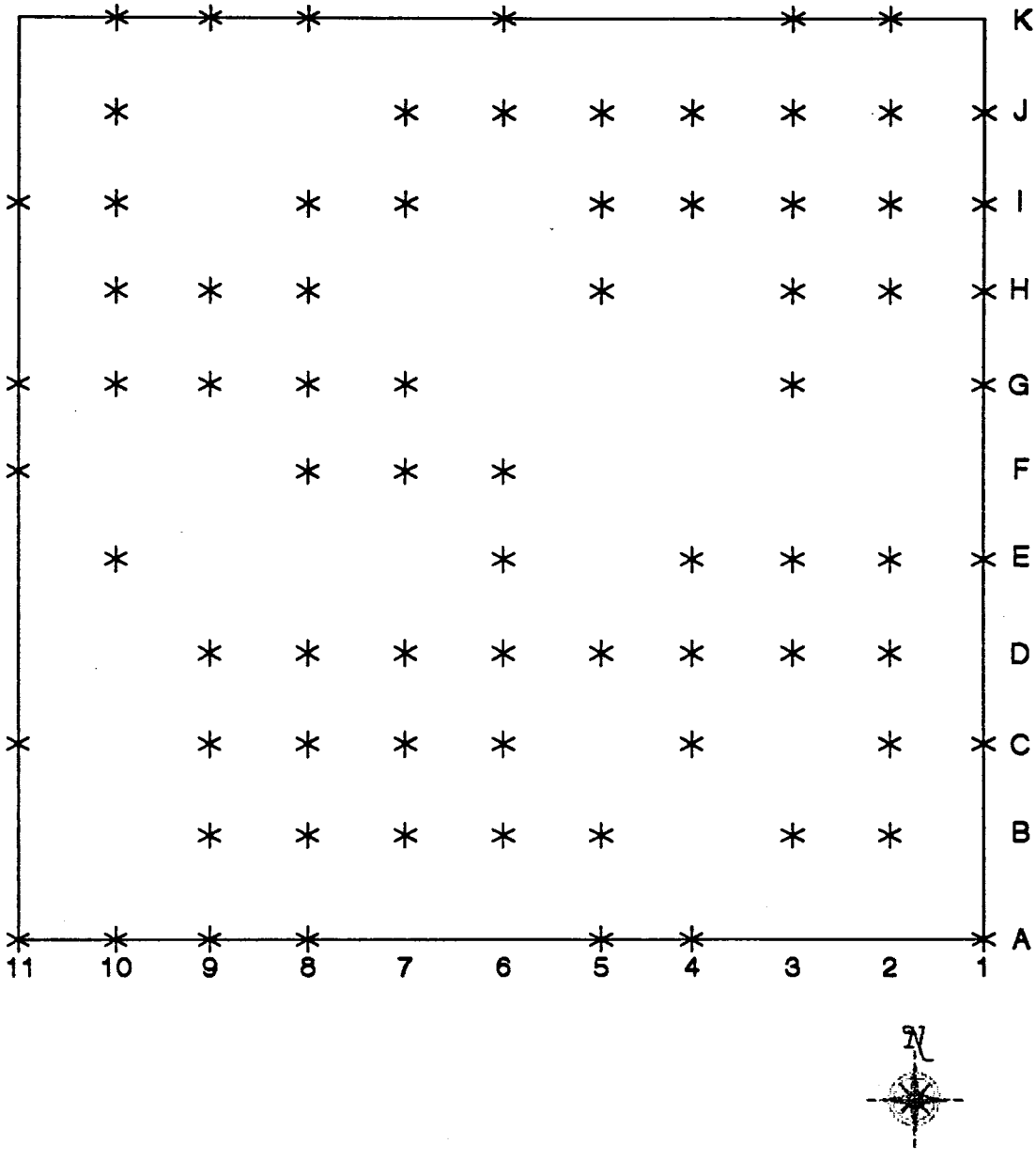


Fig. 19. Prairie dog release points (n=77) at the auger site, 13 September through 18 November, 1991.

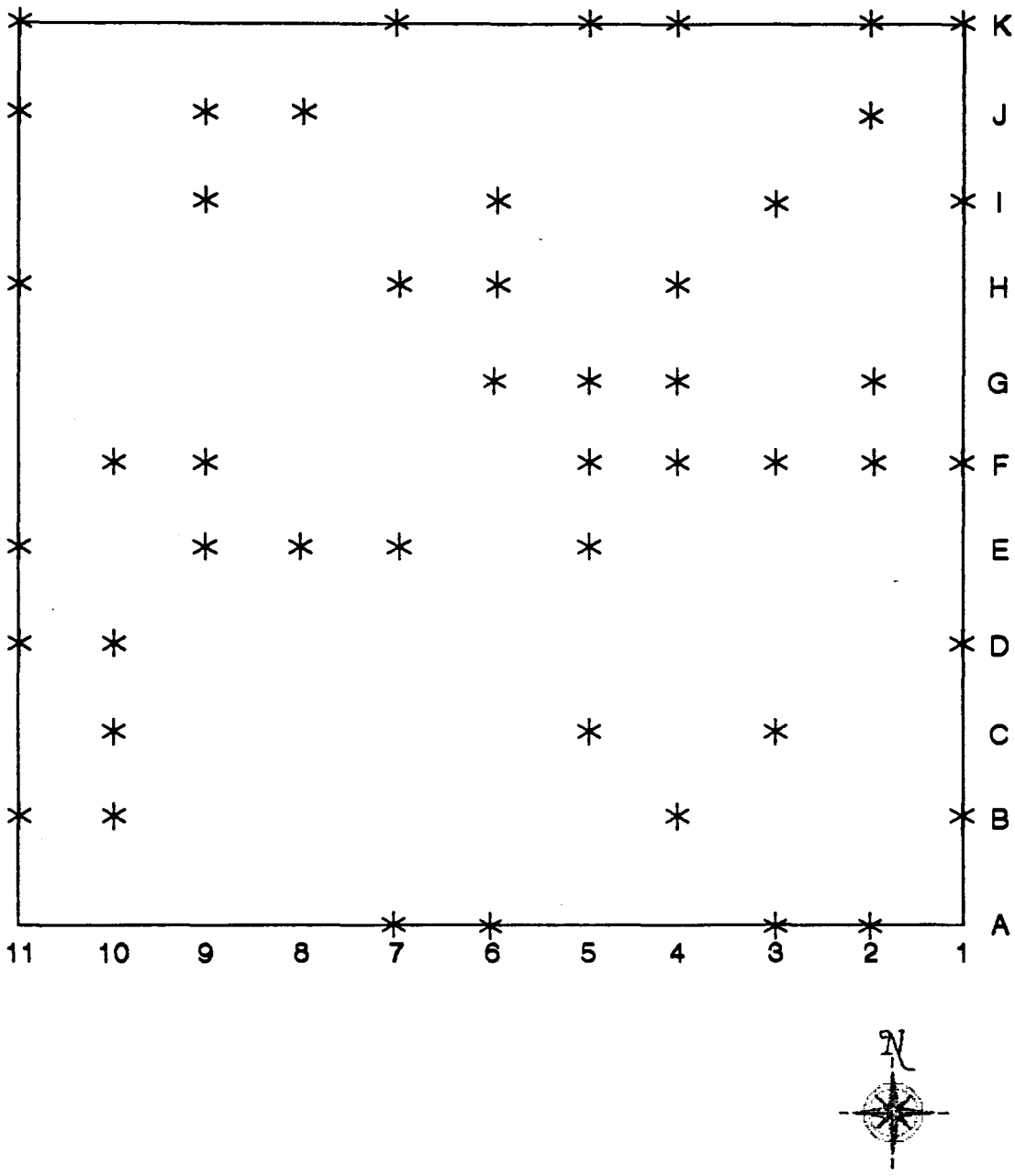
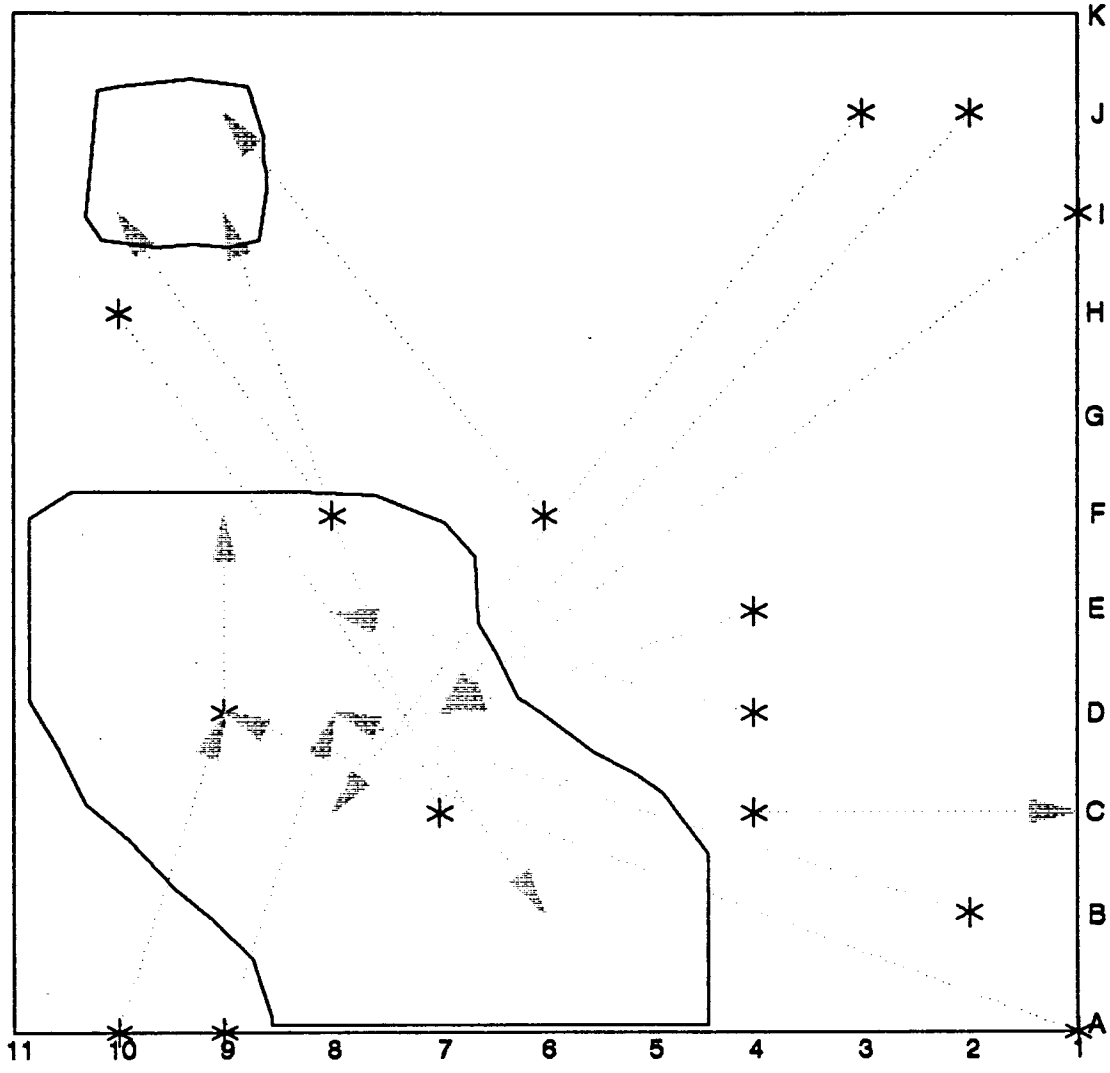


Fig. 20. Prairie dog release points (n=48) at the auger site, 14 - 22 September, 1992.



n = 15

mean = 158 meters

std dev = 68 meters

range = 60 - 251 meters

Fig. 21. Prairie dog dispersals (>30 meters) at the auger site, 25 November through 18 December, 1991. (*) denote release points and ↑ denote dispersal. Outline delineates active prairie dog town.

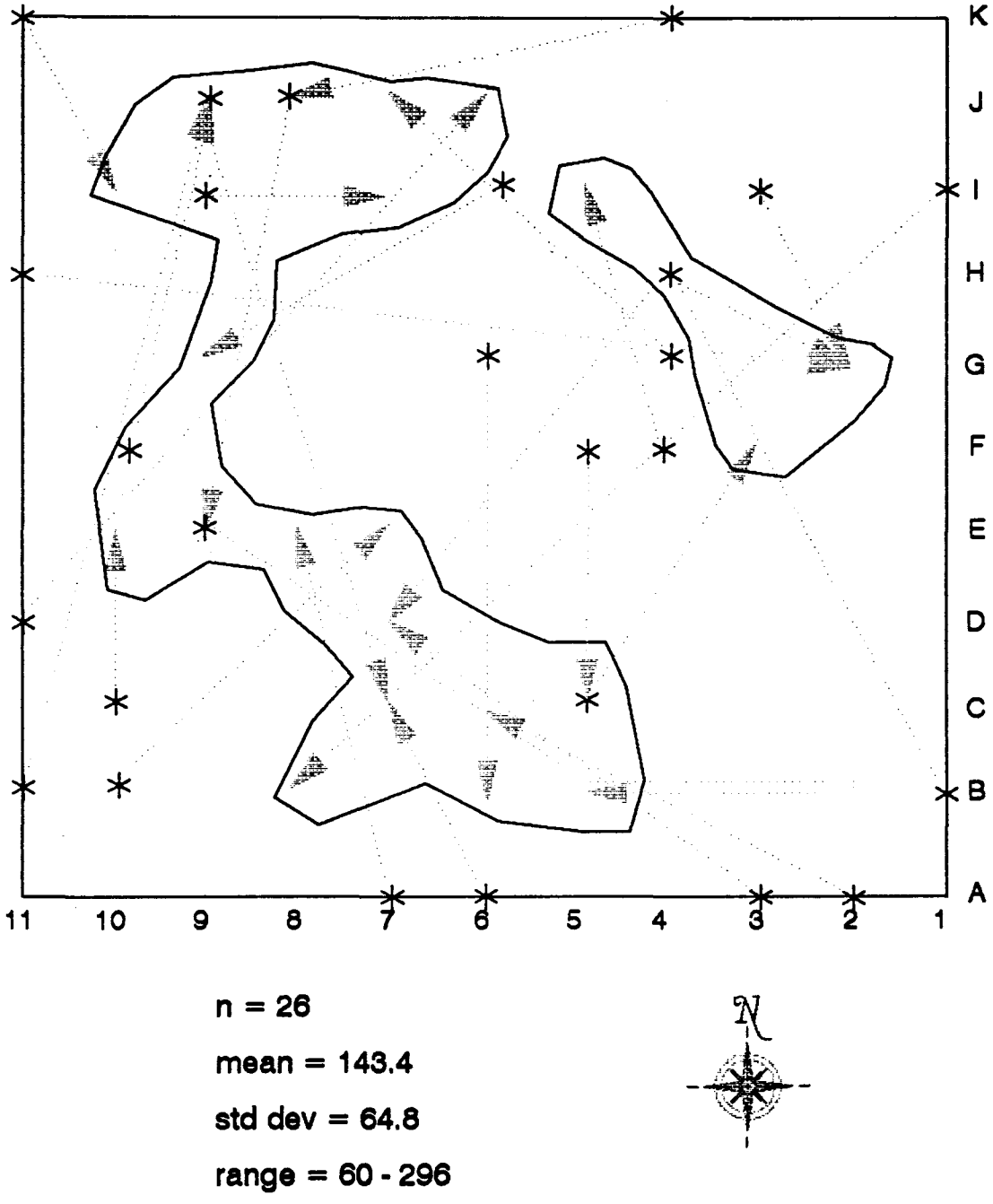


Fig. 22. Prairie dog dispersal (>30 meters) at the auger site, 5 - 22 October, 1992. (*) denote release points and ↑ denote dispersal. Outlined area delineates active prairie dog town.

TITLE: Waterfowl Population Trends and Habitat Use

INTRODUCTION

Monitoring waterfowl population trends enables the Service to identify the important habitats for various waterfowl species and determine periods of use by these species. The Arsenal contains several wetland types that support a diverse waterfowl community (U.S. Fish and Wildlife Service 1992). Waterfowl are a secondary prey item of wintering eagles on the Arsenal and waterfowl management contributes to the quality of habitat for wintering eagles. Information also facilitates habitat management and mitigation for waterfowl habitats that may be impacted during Arsenal cleanup. This information also supports 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 twenty-one fixed observations points two to four times a month (Fig. 23), from August 1991 through May 1992. An index of abundance per habitat type was computed by combining the data acquired from the 21 observation points into seven areas representing similar habitats or the same wetland. An index of abundance over time was computed by calculating the mean number observed per month for Canada geese, for each of the five most numerous duck species, and all duck species combined.

RESULTS AND DISCUSSION

The mean number of ducks observed peaked in November during the fall migratory period and in March during the Spring migratory period (Fig. 24). Canada goose numbers also peaked in November during the fall period, but peaked in February during the spring migratory period (Fig. 25).

The five most numerous duck species followed the same seasonal pattern. Numbers increased during migratory periods and decreased during mid-winter ice-over periods. However, American wigeons and ring-necked ducks were considerably more numerous during the fall migratory period, and green-winged teal were more numerous during the spring migratory period (Fig. 26). No substantial differences were noted for mallards and gadwalls (Fig. 26).

Duck species observed in all habitat types included mallards, gadwalls, redheads, and green-winged teal (Table 32). Canada geese and American coots were also found in all habitat types (Table 32).

Mallards were the most common duck species observed followed by gadwalls, American wigeons, and green-winged teal (Table 32). However, Canada geese occurred in greater numbers than any other waterfowl species (Table 32).

The four most numerous duck species observed on the Arsenal were dabbling ducks. The Upper Derby Lakes possess the most appropriate water depths and habitat characteristics (Bellrose 1976, U.S. Fish and Wildlife Service 1988) for dabbling ducks throughout the year. Consequently, these lakes accounted for 51.5 percent of the waterfowl observed (Table 32).

The greatest number of species was observed on Lake Ladora followed by the Upper Derby Lakes and Havana ponds (Table 32). Lake Ladora had a mean depth of approximately seven feet and was mostly comprised of open water which is preferred habitat for most diving duck species (Bellrose 1976). As a result Lake Ladora provides habitat for both diving and dabbling ducks which may account for the greater number of species observed.

Table 32. Number of waterfowl observed per area during surveys conducted on the Arsenal from August 1991 through May 1992.

	Number Observed							
Species	1	2	3	4	5	6	7	Total
Gadwall	74	69	499	87	77	619	287	1712
Canvasback		5	46		7	2		60
Redhead	29	12	149	13	241	37	10	491
Ring-Necked	60	1	874		133	25	24	1117
Com. Goldeneye			5	22	23	4		54
Cin. Teal	7	1	21		3		10	42
Bufflehead			3	1	12		4	20
G-W-Teal	17	1	777	12	3	254	163	1227
Am.Wigeon			1196		34			1230
Lesser Scaup		1	147	11	119	199	6	483
N. Shoveler			52	4	6	2	66	130
N. Pintail	4		565		2	1	39	611
Com. Merganser	2			32	27	26		87
Mallard	116	19	1256	10	77	619	287	2384
B-W-Teal	14	5	473	8	108	153		761
Wood Duck		1						1
Ruddy Duck			1		18			19
Am. Coot	4	95	275	53	1667	2	11	2097
N.W.F.Goose			1					1
C. Goose	235	727	693	241	592	113	103	2704
Total Ducks	323	115	6064	200	890	1941	896	10429

1= First Creek Cooridor; 2= Lake Mary; 3= Upper Derbies; 4= Lower Derby; 5= Ladora; 6= Havanna Ponds; 7= New Wetlands Sects. 7 and 8.

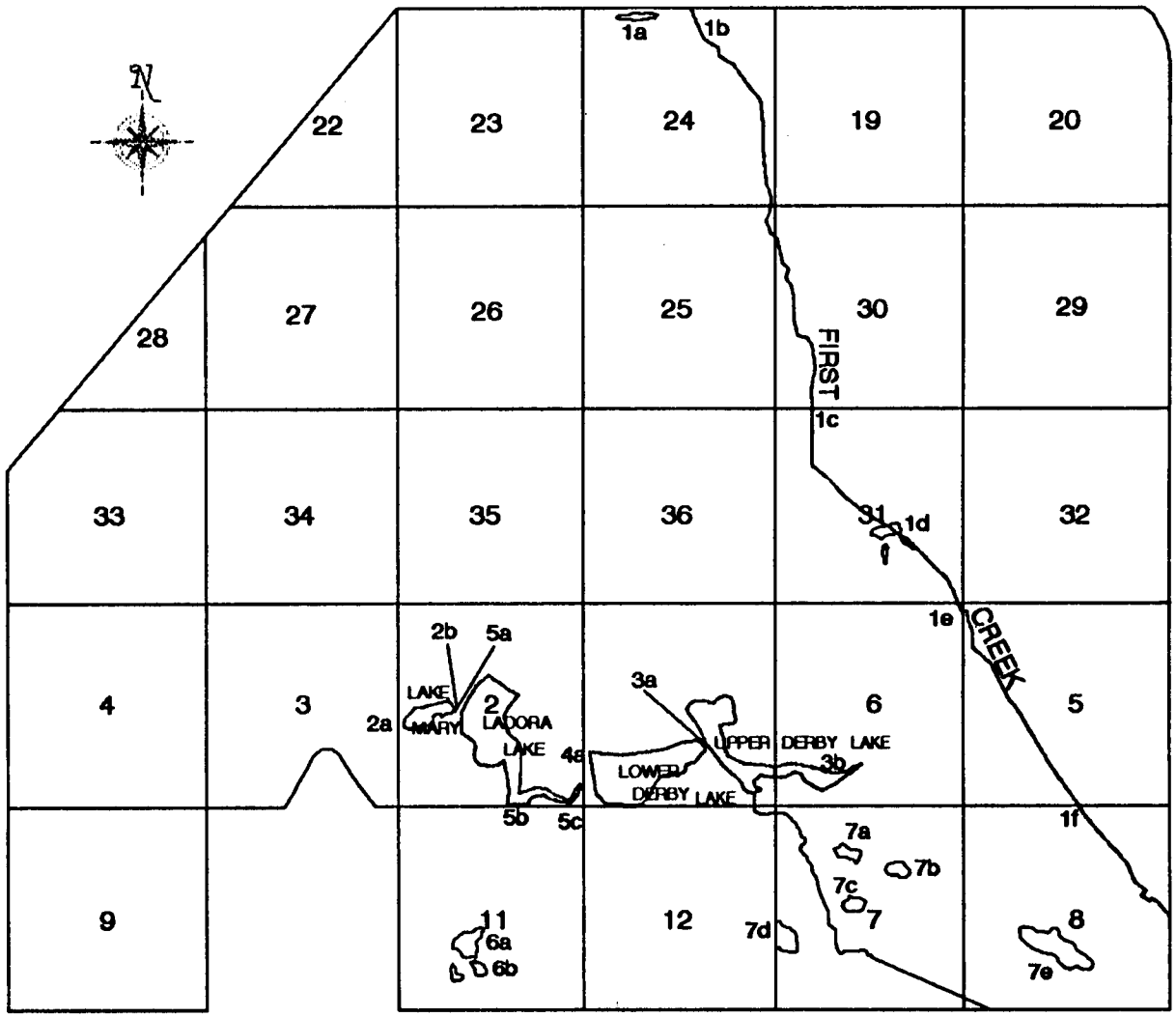


Fig. 23. Waterfowl survey locations used on the Arsenal from August 1991 through May 1992.

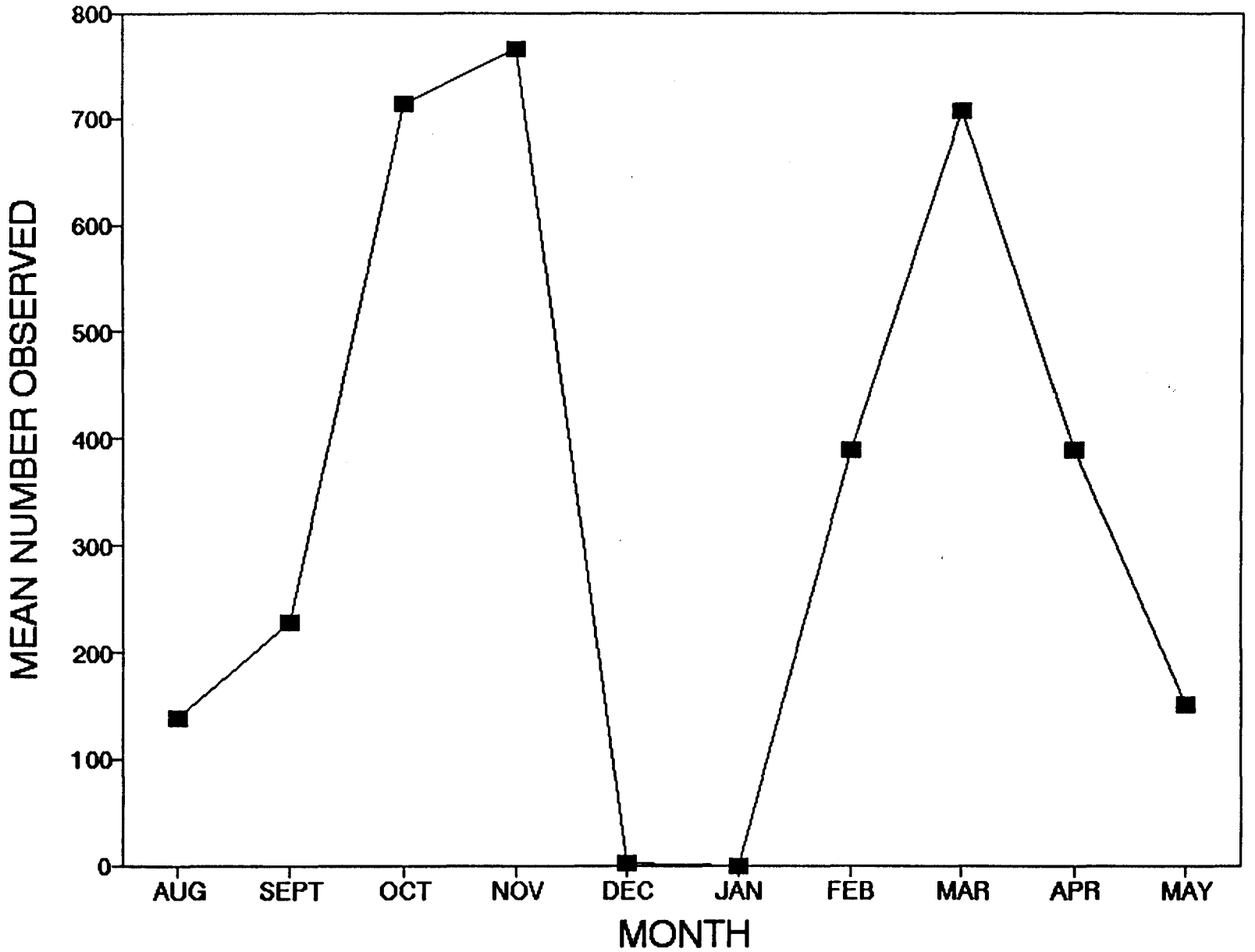


Fig. 24. Mean number of ducks observed per month on the Arsenal from August 1991 through May 1992.

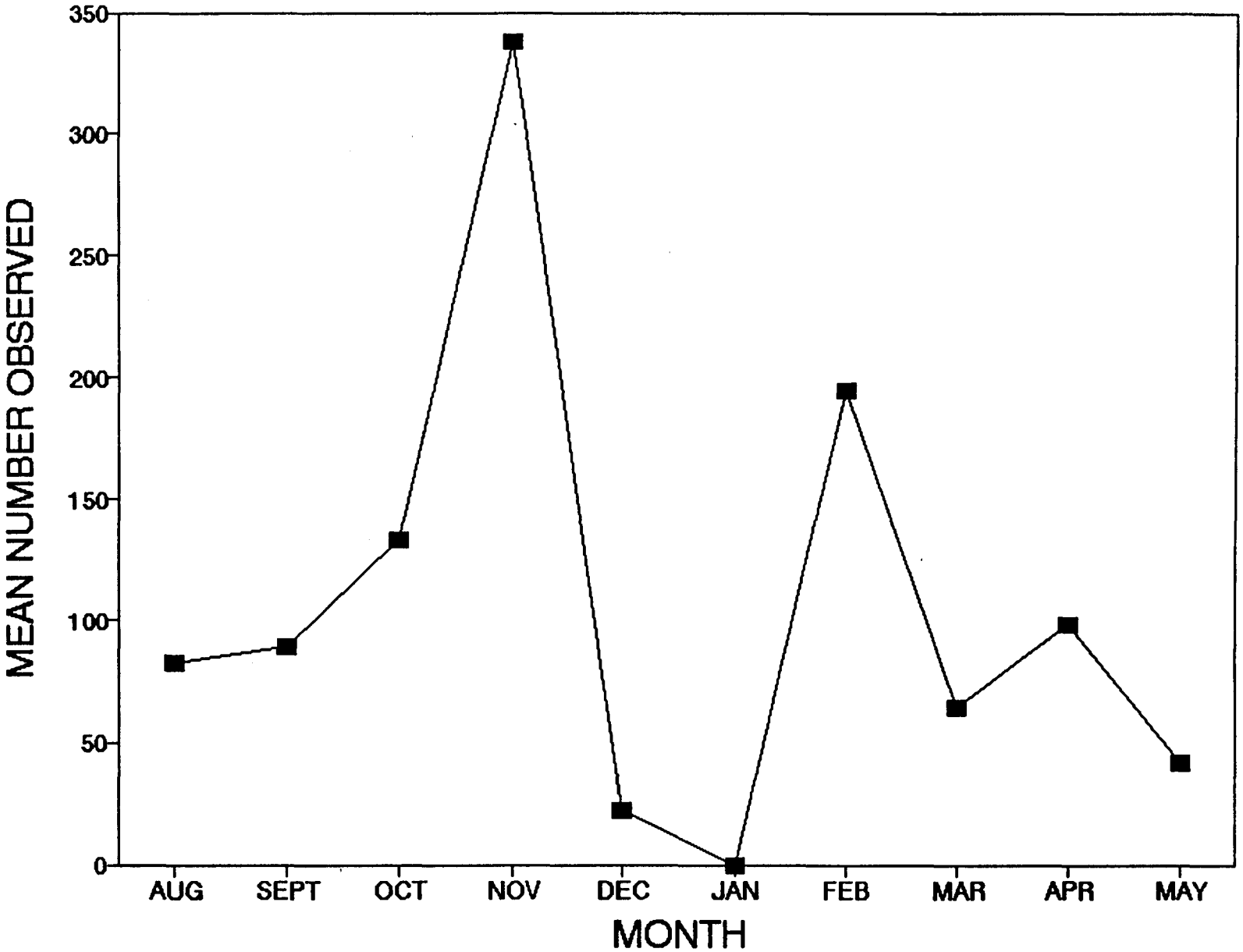


Fig. 25. Mean number of Canada Geese observed per month on the Arsenal from August 1991 through May 1992.

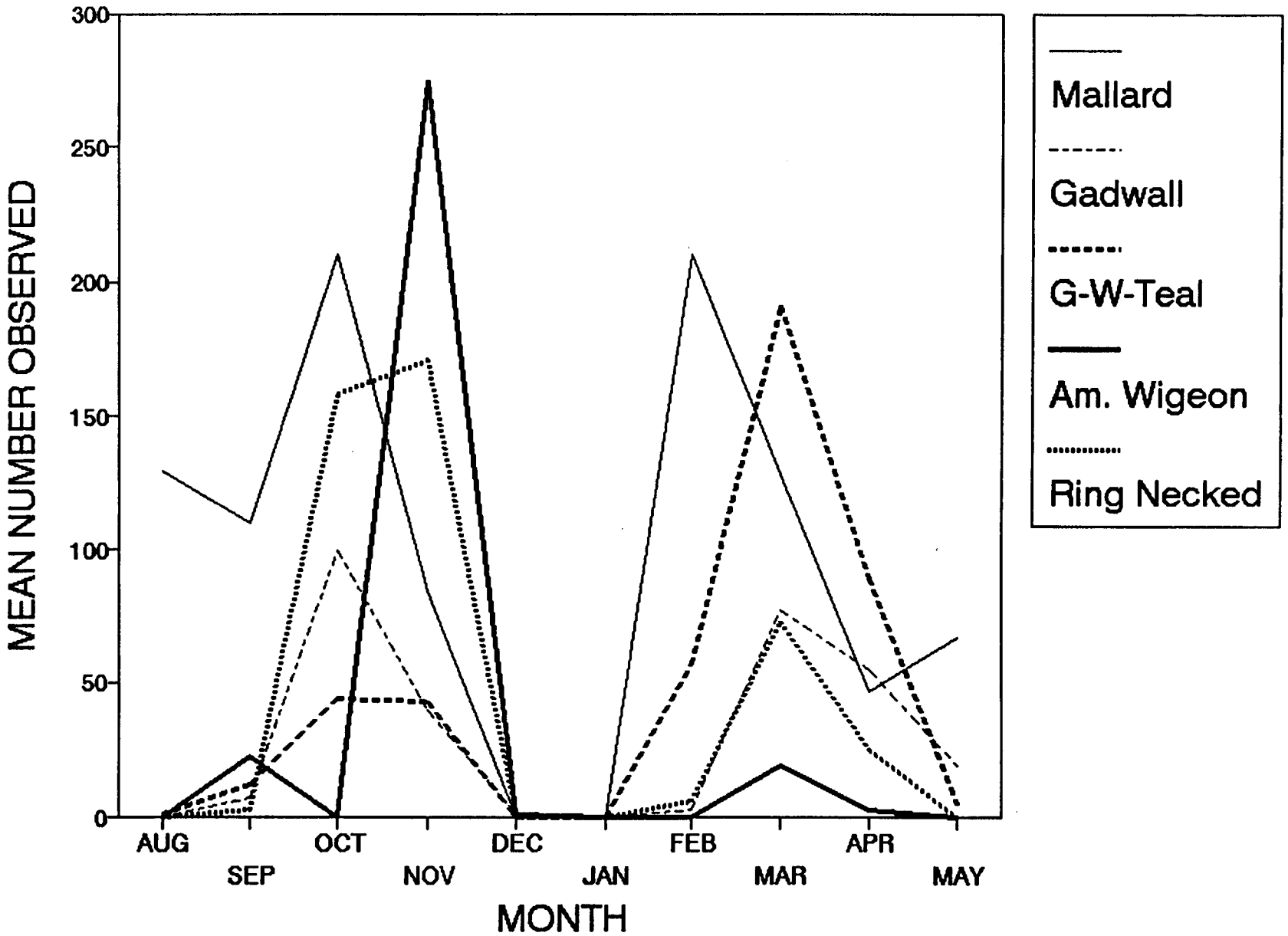


Fig. 26. Mean number observed per month of the five most common duck species on the Arsenal from August 1991 through May 1992.

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

INTRODUCTION

The Arsenal supports a relatively large population of deer, estimated in 1990 at 350 mule deer and 150 white-tailed deer. After the perimeter fence was erected in 1989, the deer population was considered to be a closed population. Management of a closed, non-harvested population, requires substantial information on demographics, especially recruitment and mortality. Additional information on inter- and intraspecific relationships of the sympatric mule and white-tailed deer populations is crucial in developing long-range monitoring and management techniques. A study was initiated in May 1990 to determine patterns of coexistence between mule deer (Odocoileus hemionus) and white-tailed deer (O. virginianus) on the Arsenal. This work was developed under a Cooperative Agreement between the Service and the Cooperative Fish and Wildlife Research Unit at the University of Wyoming. Specific objectives of this study and the initial findings are included in Appendix A.

With the large increases in the mule deer population from 1989 to 1991, it has become necessary to address the problem of over-population. Since hunting and relocation are not viable techniques for population control on the Arsenal, other methods of regulation are needed. A study to investigate fertility control was developed through a Cooperative Agreement between the Service and the Colorado Division of Wildlife (CDOW). This project is a 6 - 7 year project with the first 4 years being conducted at the CDOW deer pens in Fort Collins. Completion of the second year of study occurred in FY92. A series of preliminary reports, entitled Regulation of mule deer population growth by fertility control: laboratory, field, and simulation experiments discuss specific objectives and initial findings (Appendix C).

METHODS

A detailed methodology for both of these studies is included in their respective reports (Appendix A and C).

RESULTS AND DISCUSSION

Most of the field work for the University of Wyoming deer study has been completed. Remaining work includes monthly trend surveys through May 1993, data analysis, and management recommendations. Preliminary population estimates now stand at 660 mule deer and 135 white-tailed deer, based on the latest trend surveys. These estimates indicate that the mule deer population has doubled in the last four years and the white-tailed population has fluctuated little over the same time period.

TITLE: Pronghorn antelope reintroduction study at the Arsenal.

INTRODUCTION

Pronghorn antelope (Antilocapra americana) inhabit a variety of open habitats in western North America. Historically, pronghorn distribution extended eastward to the 95th meridian, westward to Washington, Oregon, and California, south into Mexico and north into Canada. In Colorado, pronghorn formerly ranged over the entire plains east of the foothills and in many of the mountain parks and river valleys in the mountainous portion of the state. The four major habitat types used by pronghorn in Colorado include the shortgrass plains, mountain brush grass, mountain brush, and the intermountain desert (Hoover et al. 1959). In 1990, the pre-hunt pronghorn population in Colorado was approximately 58,000 animals (Duvall 1990).

The Arsenal presently has no pronghorns. Prior to purchase by the Army in 1942, pronghorns were seen in the northeastern portion of the Arsenal, north of 7th Avenue and east of "D" Street, and in the South Plants area between Lake Ladora and the boiler plant (Ray Telfer, pers. comm.). More recently a horn sheath was found in the northeastern portion of the Arsenal (Mike Lockhart, pers. comm.), and field dog trial people reported seeing pronghorn on the Arsenal near the northeastern boundaries approximately five to seven years ago (Jim Fyke, pers. comm.). Thus, it is apparent that pronghorn were once an integral component of the shortgrass prairie ecosystem on the Arsenal and could be beneficial in the maintenance of that ecosystem in the future. The objectives of this feasibility study were to determine the suitability of the Arsenal as a pronghorn reintroduction site and to develop a plan to relocate pronghorn to the Arsenal.

METHODS

A feasibility study was initiated in 1990 to determine the suitability of the Arsenal as a pronghorn reintroduction site. Several criteria developed by Hoover et al. (1959) and O'Gara and Yoakum (1990) for translocating pronghorn were addressed using several sources of information. Vegetation information was obtained from Morrison-Knudsen Environmental Services (1989), with the remainder of the information provided by Service personnel and Army documents. Additionally, two experts in pronghorn relocation conducted an on-site inspection of the Arsenal, and provided valuable comments.

Newly acquired information was incorporated into the results of the initial feasibility study to derive a viability rating for the Arsenal. In addition, Service personnel attended the 15th Biannual Pronghorn Workshop, where valuable biological, behavioral and reintroduction information was obtained.

All information was used in developing a comprehensive relocation proposal.

RESULTS AND DISCUSSION

The results of the feasibility study indicate that the Arsenal is a viable pronghorn relocation site. The viability index developed by Howard et al. (1983) and used by the Bureau of Land Management in New Mexico (1986) to rate potential translocation sites is:

$$1.082 + (0.106)(X1) - (0.006)(X2) - (0.068)(X3) - (0.059)(X4)$$

where,

X1 = the number of fall forb species
X2 = ruggedness index
X3 = pasture size in sections
X4 = anticipated average sheep stocking rate (animal units per section where 1 animal unit = 5 sheep)

Based on data collected in 1990 by Service personnel, and updated with current information, the above formula yields a viability index of 9.63. A minimum score of 1.5 is necessary to be considered a viable relocation site. Therefore the Arsenal appears to be a viable relocation site.

The Service has prepared a specific release plan. Army approval for a pronghorn reintroduction is pending.

TITLE: Distribution and abundance of mammalian predators

INTRODUCTION

A number of mammalian predators are known to exist on the Arsenal (coyote, badger, skunk, weasel and shrew) and several additional species may also occur (e.g. mink, raccoon, gray fox, swift fox and/or red fox) (Morrison-Knudsen 1989b). Little is known about the distribution and abundance of these species. With the Arsenal's excellent road system, scent station surveys can be a viable means of determining mammalian predator distribution and abundance. The use of scent stations to determine trends in furbearer populations dates back to the early 1950's. Since that time, the technique has been refined and used for a variety of mammalian predators including coyote (Canis latrans), gray fox (Urocyon cinereoargenteus), red fox (Vulpes vulpes), raccoon (Procyon lotor), bobcat (Lynx rufus) and skunks (Mephitis mephitis) (Linhart and Knowlton 1975, Conner et al. 1983, Wood 1959, Sumner and Hill 1980, and Morrison et al. 1981). The Service has used scent station studies in other areas for many years as a practical means of determining trends in carnivore populations (Roughton and Sweeny 1982). In the western states the emphasis has primarily been on investigating predator control efforts aimed at reducing coyote populations (Linhart and Knowlton 1975).

The objectives of this study are to 1) determine species occurrence and distribution of mammalian predators, 2) determine habitat use, seasonal variation and population trends over time, and 3) develop management strategies aimed at preserving critical habitat for mammalian predators.

METHODS

Scent station study

There are advantages to using scent stations, as well as disadvantages. Advantages of using scent stations include: 1) cost efficiency, 2) repeatability, 3) applicability to large areas of land, 4) apply to more than one species, 5) comparability between years, and 6) statistical analysis. The disadvantages are 1) weather variables affect results, 2) considerable staff time required, 3) a good network of roads required, and 4) potential low visitation rates. The effectiveness and reliability can be influenced by the quality and quantity of scent used, method of presentation, sampling design, and sensitivity of the data analyzed (Roughton and Sweeny 1982).

A scent station study was implemented on the Arsenal according to the recommendations of Roughton and Sweeny (1982) and Conner et al. (1983). During FY92 the Service tested the use of scent

stations, and plans to start the actual study in FY93. The study consists of five survey lines (transects) with 10 scent stations each, spaced at intervals of .32 km. and operated for 1 night per month. Conner et al. (1983) determined that a .32 km interval between scent stations was best for multiple species studies. Operating scent stations for 1 night per month, versus 3 to 5 consecutive nights, will remove the sample bias from repeated visits by individual animals. The transects will be operated for two years, from March to October, in order to compare between-month and between-years. Since the number of transects depend on the size of the study area, five transects will be set up on the Arsenal, for a total of 50 scent stations. All major habitat types present on the Arsenal (Morrison-Knudsen 1989a) will be included in the transects.

Scent stations consist of a 1 meter diameter circle cleared of all vegetation and debris. Each station is prepared by sifting clean, dry dirt over the area to produce a uniform thin layer over the entire station. A cotton ball soaked with Fatty Acid Scent (FAS) (Pocatello Supply Depot, Pocatello, ID) is then placed on a stick in the center of the circle. At each station, date, time, weather conditions and habitat types will be recorded. Beginning two hours after sunrise all scent stations are checked with the aid of a Peterson Field Guide to Animal Tracks (Murie 1974). All tracks present within the station are identified (including small mammals and deer), recorded, and the scent stick removed. All tracks of a single species are recorded as a single individual regardless of the number of tracks present. Stations damaged by rain or other factors, such as human disturbance, are ruled inoperable and will not be used. Any tracks that cannot be identified are recorded as unknown.

Relative abundance will be calculated for each of the species identified during the study. An index of relative abundance is calculated by taking the total number of visits of one species and dividing it by the total number of stations which were operable for a given month, and then multiplying by 100. Visitation rates will be calculated for each species, expressed as the percentage of stations visited by a species per transect night. Analysis of variance procedures will be executed on arcsine transformed visitation rates using General Linear Models Procedure (GLM) of the Statistical Analysis System (SAS) (Helwig and Council 1979). This will allow examination of the effects of year, month, and habitat, with sufficient replicates of habitat types included in the data collection.

Coyote/Badger Study

A recently completed graduate research project examined coyote/badger ecology on the Arsenal. The completed thesis (Hein 1992) evaluated coyote attractants and provided a density estimate. In addition, two supplemental documents report on

coyote home range estimates and badgers distribution and abundance on the Arsenal (Appendix A). The results are summarized here and the methodology described within the documents.

RESULTS AND DISCUSSION

Scent Station

During FY92 five transect lines were delineated (Fig. 27) and preliminary tests of the soil sifter and FAS scent performed. One scent station per transect line was set up as a test during August 1992. Modifications to the sifter were identified and will be incorporated in a new design. The FAS scent performed well, with good visitation rates recorded for all stations. Data collection on all stations is scheduled to begin in March 1993.

Coyote/Badger Study

A graduate research project entitled Evaluations of Coyote Attractants and a Density Estimate on the Rocky Mountain Arsenal was recently completed. This project examined coyote/badger ecology at the Arsenal (Hein 1992). The results indicated relatively high coyote densities (0.71/sq.km., 95% CI = 0.49 to 1.16) as compared with other studies in Wyoming (0.53/sq.km., SD =0.04) (Camenzind 1978), Montana (0.39/sq.km.) (Pyrah 1984) and Texas (0.90/sq.km.) (Andelt 1985). Home ranges for radio-collared coyotes on the Arsenal averaged 6.9 sq.km. (SE = 1.0) for residents and 22.5 sq.km. (SE = 5.4) for transients (Appendix A). Badger density was estimated at a minimum of 0.27/sq.km., based on the number trapped on the Arsenal. This estimate is low compared to a density of 2.6 sq.km. (Lindzey 1971) or up to 5 resident badgers per sq.km. found by Messick and Hornocker (1981). Badger home range calculations were not possible, due to small sample size of telemetry locations.

Coyote visitation rates to three different types of scent stations were found to be comparable to other studies and visits to FAS stations were at a moderate rate. This meets expectations, as FAS is considered a good attractant for a multiple-species study.

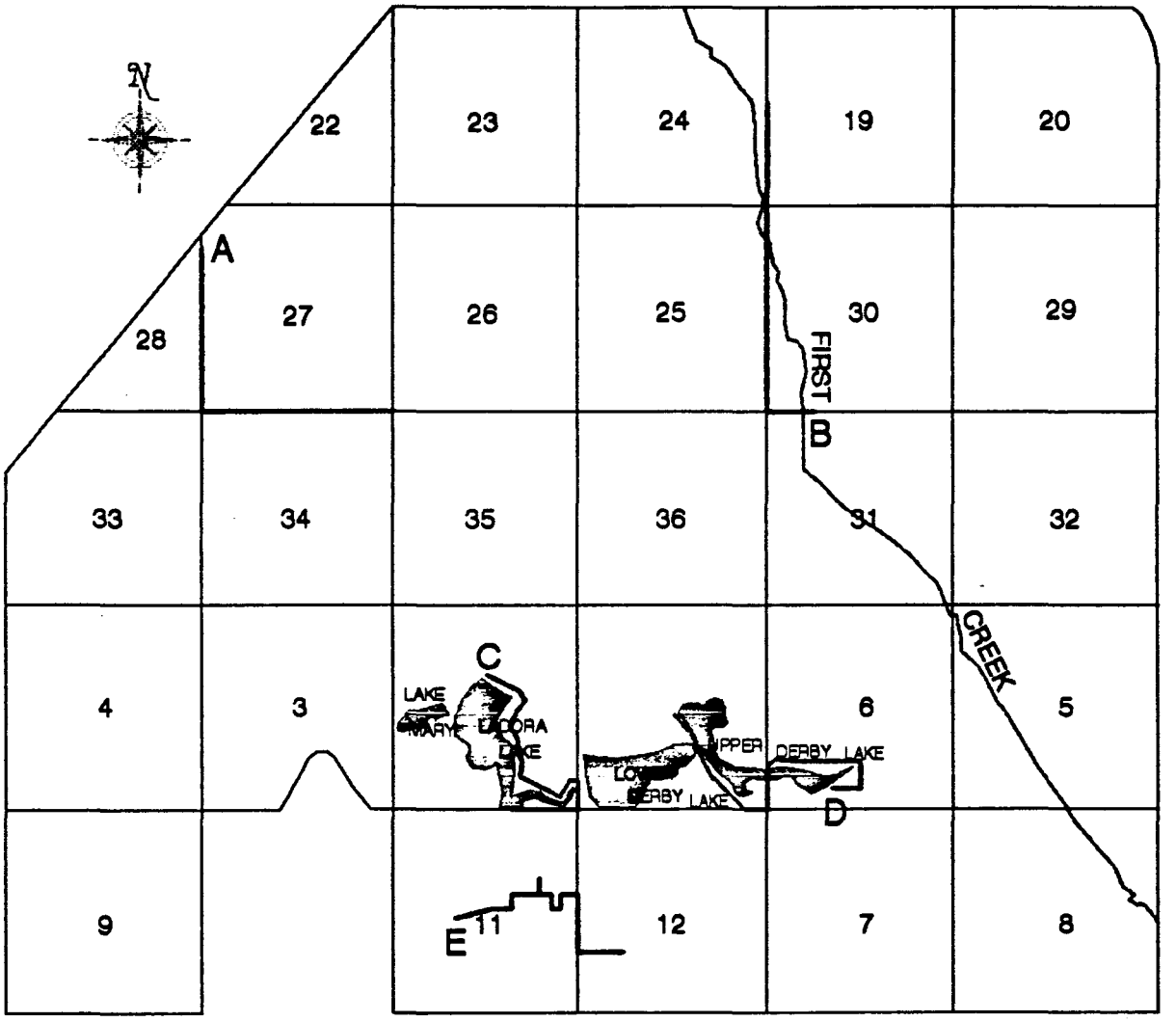


Fig. 27. Mammalian predator scent station transects set up on the Arsenal during FY92.

the second and third most abundant species respectively. Because this was only the second year of data collection, the variation in results was not considered a notable difference. To establish population trends, several more years of survey data must be collected.

Comparison of the 1991 and 1992 Christmas bird counts reveal similar results in both number of species and individuals observed (Table 34). Results of the counts are being used to help formulate a bird checklist for the Arsenal.

Table 33. Rocky Mountain Arsenal Breeding bird survey data from 1 June 1991 and 8 June 1992.

SPECIES OBSERVED	TOTAL		STOPS	
	1991	1992	1991	1992
PIED-BILLED GREBE	1	-	1	-
WESTERN GREBE	7	-	1	-
DOUBLE-CRESTED CORMORANT	13	12	8	7
GREAT BLUE HERON	13	6	11	6
CANADA GOOSE	27	19	3	2
MALLARD	4	5	3	1
BLUE-WINGED TEAL	1	-	1	-
GADWALL	1	-	1	-
SWAINSON'S HAWK	10	2	9	2
RED-TAILED HAWK	6	1	4	1
FERRUGINOUS HAWK	-	1	-	1
AMERICAN KESTREL	18	2	14	2
RING-NECKED PHEASANT	41	14	25	10
NORTHERN BOBWHITE	3	-	1	-
AMERICAN COOT	5	2	3	2
KILLDEER	3	9	1	7
RING-BILLED GULL	-	7	-	1
ROCK DOVE	90	27	8	3
MOURNING DOVE	96	24	33	15
GREAT HORNED OWL	4	4	2	1
BURROWING OWL	5	5	3	3
BELTED KINGFISHER	-	1	-	1
DOWNY WOODPECKER	2	-	2	-
RED-SHAFTED FLICKER	2	-	2	-
WESTERN WOOD-PEWEE	-	1	-	1
WESTERN KINGBIRD	45	69	22	24
EASTERN KINGBIRD	17	5	7	3
HORNED LARK	28	7	11	5
NORTHERN ROUGH WINGED SWALLOW	-	1	-	1
BARN SWALLOW	5	-	5	-
BLACK-BILLED MAGPIE	84	38	35	14
ROCK WREN	1	-	1	-
BEWICK'S WREN	-	1	-	1
HOUSE WREN	10	14	7	9
MARSH WREN	1	-	1	-
AMERICAN ROBIN	26	19	9	12
EUROPEAN STARLING	173	35	21	9
WARBLING VIREO	1	-	1	-
YELLOW WARBLER	14	10	7	7
COMMON YELLOWTHROAT	8	7	7	6
BLACK-HEADED GROSBEAK	1	-	1	-
RUFOUS-SIDED TOWHEE	1	-	1	-
CASSIN'S SPARROW	1	2	1	1
LARK SPARROW	2	-	2	-
LARK BUNTING	92	293	14	30

GRASSHOPPER SPARROW	25	12	13	8
SONG SPARROW	5	-	2	-
RED-WINGED BLACKBIRD	86	100	8	18
WESTERN MEADOWLARK	349	526	46	48
YELLOW-HEADED BLACKBIRD	6	-	1	-
BREWER'S BLACKBIRD	2	278	1	23
COMMON GRACKLE	45	2	17	2
BROWN-HEADED COWBIRD	2	6	2	5
ORCHARD ORIOLE	1	-	1	-
BULLOCK'S ORIOLE	49	13	21	7
HOUSE FINCH	6	-	2	-
AMERICAN GOLDFINCH	7	-	2	-
HOUSE SPARROW	37	39	10	7
TOTAL SPECIES		52	39	

Table 34. Christmas bird count data from the Arsenal on 1 January 1991 and 1 January 1992.

SPECIES	1991	1992
CANADA GOOSE	330	375
MALLARD	66	4
GREEN-WINGED TEAL	2	2
GADWALL	-	2
RING-NECKED DUCK	-	3
COMMON GOLDENEYE	-	2
BALD EAGLE	23	33
NORTHERN HARRIER	5	-
RED-TAILED HAWK	12	5
FERRUGINOUS HAWK	8	10
ROUGH-LEGGED HAWK	7	7
BUTEO SPECIES	-	4
GOLDEN EAGLE	1	-
AMERICAN KESTREL	2	2
MERLIN	1	-
PRAIRIE FALCON	-	1
CHUKAR	-	8
RING-NECKED PHEASANT	1	27
NORTHERN BOBWHITE	-	28
AMERICAN COOT	4	2
RING-BILLED GULL	565	500
ROCK DOVE	41	49
GREAT HORNED OWL	4	2
BURROWING OWL	1	-
DOWNY WOODPECKER	7	2

Table 36. Cumulative number of ring-necked pheasant crow calls recorded per survey date, Rocky Mountain Arsenal, spring 1992.

Date	Cumulative crow calls	$\bar{X}$ (range)
05/02	89	8.9 (0 - 20)
05/05	77	7.7 (1 - 18)
05/07	94	9.4 (1 - 19)
05/09	102	10.2 (1 - 23)
05/12[a]		
05/14	103	10.3 (2 - 19)
05/16[a]		
05/19	99	9.9 (0 - 20)
05/21	125	12.5 (1 - 38)
05/23	64	6.4 (1 - 18)
05/26[a]		
05/28	31	3.1 (1 - 6)
05/30[a]		
06/02	49	4.9 (1 - 12)
06/04[a]		
06/06	61	6.1 (2 - 16)

[a] Inclement weather prohibited a valid survey.

TITLE: The status of reptiles and amphibians

INTRODUCTION

The Service's management objectives for reptiles and amphibians include maintaining current population diversity and abundance, and establishing annual surveys for reptiles and amphibians on the Arsenal.

METHODS

During FY92, the Service formulated a study proposal to verify the list of suspected reptile and amphibian species that inhabit the Arsenal. The two year study fulfills the need for a baseline inventory of herptiles and a method for monitoring the possible effects of cleanup activities on habitats occupied by this group.

The general vicinities for trap sites were selected based on available vegetation and soil maps (Morrison-Knudsen 1992). Ground truthing of specific sites will be done in spring 1993 prior to initiation of field work.

RESULTS AND DISCUSSION

The species list of the Biota Remedial Investigations Report (Morrison-Knudsen Environmental Services, Inc. 1989) was updated in August 1992 by the Service to include 21 reptiles and 7 amphibians, none of which are presently threatened or endangered. Table 38 lists the updated version of herptiles suspected on the Arsenal. The list is a culmination of personal sightings and field guide range maps for both the United States and Colorado (Hammerson 1986, Morrison-Knudsen 1989, Stebbins 1985). Necessary materials for the project have been purchased, traps constructed, and sites selected for commencement of the study in spring 1993.

During FY92, Service personnel recognized the water control structures on the new wetlands as potential hazards to amphibians dispersing from the ponds. The steep vertical walls offered no escape route for various wildlife including small mammals and hundreds of Woodhouse toads. Floating ramps were constructed to prevent trapping animals in the water control structure.

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

INTRODUCTION

In 1990 a Cooperative Agreement between the Service, the Army, the National Fish and Wildlife Foundation, and the Denver Museum of Natural History was initiated to determine the distribution, abundance, and/or habitat association of non-predatory small mammals on the Arsenal and then physically disrupt a part of this habitat as it currently exists. The information gained will be used to quantify the response of small mammals to physical habitat disturbance associated with contamination cleanup activities. Field work continued in 1992. Completion of the project is expected in 1993.

METHODS

During FY92, the Service continued to provide oversight for the small mammal study. Live trapping was accomplished to determine small mammal community structure and species' habitat preferences. Two experimental procedures were initiated by the Denver Museum of Natural History (DMNH) in 1992: plowing and restoration with a native grass seed mixture, and habitat alteration by reduction in cover by mowing or enhancing of cover by adding a layer of straw.

RESULTS

Trapping sessions at each vegetation type occurred in June and October. A total of 2,400 summer trap nights produced 616 captures of 334 individual animals yielding an overall capture rate of 26%. A total of 2,100 fall trap nights produced 173 captures of 106 individual animals yielding a capture rate of 8.2%. The two experimental procedures were accomplished during FY92, however, statistical analysis has not been performed on this data to date.

A more detailed description of both methods and results is describes in Appendix B.

established in 1977 through 1991 were repeated in 1992. To minimize fish mortality, standardized gill net sets were shortened from overnight to four hour night sets.

Electrofishing population assessment was continued during 1992. 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. During 1991 and 1992, all captured pike and largemouth bass larger than 250 mm were implanted with a PIT tag on the left side of the abdomen, just behind the pelvic fin.

FISH POPULATION MANAGEMENT

Ladora Northern Pike Study -- To determine the total number of pike in Lake Ladora and the number of times per year each pike was caught, pike were caught in trap nets (fyke-nets) and tagged with white Floy "cinch-up" tags during March of 1990 and portable integrated transponder (PIT) tags during 1991 and 1992. Floy tags were individually numbered and labelled "Please Release". However, poor tag return information from anglers during 1990, and algae growth problems, caused Floy tags to be replaced with PIT tags.

Scale samples for age determination were collected from all largemouth bass and pike captured using methods described by Carlander (1982). Relative weight (condition index) was calculated by dividing the weight of the fish by the standard weight of a fish times 100 (Anderson 1980). For example, a 600 gram pike whose standard weight is 600 grams would have a condition factor of 100% or an appropriate weight. Weights above 100% represent plump fish, weights below 100% represent lean fish.

The mouth condition of Lake Ladora largemouth bass and northern pike were evaluated to determine detrimental effects of sport angling. The 1990 and 1991 pike and largemouth bass mouth condition study was continued in 1992. Mouth condition was evaluated prior to the 1992 fishing season. Pike and largemouth bass were caught in trap nets during March of 1992. Mouth condition was evaluated 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).

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 on 9 April 1992. Brood cutthroat trout were also added to Lake Mary on 5 May 1992. Mosquito fish (Gambusia affinis) were stocked in several impoundments to control mosquito larvae numbers during the summer of 1992.

The Colorado State University fisheries study is on-going. Lake basin reconstruction recommendations will be generated for use in the event the lakes are remediated. Work conducted in FY92 is summarized in Appendix A.

Aquatic vegetation conflicted with children and handicapped fishing programs, therefore, areas near the fishing docks were cleared of vegetation.

Due to excessive turbidity levels, twenty tons of organic matter (hay) were purchased and spread in Lower Derby Lake during April of 1992. Methods to determine appropriate quantities of hay to produce flocculation and precipitation of suspended sediments was described by Boyd (1979). The hay was distributed using a mulch blower.

AQUATIC RESOURCES SAMPLING PROGRAM

To develop baseline water chemistry characteristics of the lakes, several new aquatic standardized locations were developed in April 1991. These standardized sites will be resampled in the summer of 1994.

Water chemistry parameters: dissolved oxygen, pH, conductivity, temperature (profile), and secchi disc (water clarity) were measured once per month beginning in April 1992. Two standardized sampling locations were established on Lakes Mary and Ladora, and three sites on Lower Derby Lake. Detailed methodology and results are located in the Water Quality report.

RESULTS AND DISCUSSION

ANGLER DATA

The Arsenal fishing season extended from 15 April to 14 October 1992. Roving creel clerks contacted 123 Arsenal anglers during 1992. Service employees and Arsenal volunteers collected the creel survey data.

During 1992 the length of an angler day ranged from 1.65 to 3.1, and averaged 2.4 hours per lake. Manfredo (1991) determined that Arsenal anglers average 12.5 days of fishing each year. Based upon the sale of 656 permits and a average of 2.4 hours per angler day, it was estimated that Arsenal anglers expended a minimum of 19,680 hours fishing at the Arsenal in 1992. The distribution of angler use on the Arsenal lakes was 10% for Lower Derby (1,968 hours), 58% for Ladora (11,414 hours) and 32% on Mary (6,298 hours). Assuming 150 fishable surface acres of water, the Arsenal supports only 131 hours of fishing pressure per acre. Many Denver metropolitan impoundments support greater than 500 hours per acre fishing pressure during a season (Dumont 1991). However, two adults per family were allowed to fish on

one permit at the Arsenal in 1991 and 1992, therefore, the true total fishing pressure cannot be estimated.

Lake Mary anglers caught an average of 3.22 fish per hour averaging 170 mm in length. Bluegill represented 92% of the catch, largemouth bass 5% of the catch, and trout and channel catfish provided 3% of the angler catch in 1992.

Lake Ladora anglers caught an average of 1.32 fish per hour in 1992, compared to an average of 1.54 per hour in 1991. Largemouth bass represented 59% of the fish caught. Northern Pike represented 36% of the catch. Bluegills represented 5% of the fish caught from Ladora during 1992.

Lower Derby Lake anglers caught 1.84 fish per hour in 1992. Largemouth bass represented 88% of the fish caught. Northern pike represented 12% of the fish caught with 58% of the pike exceeding 635 mm in length. Although tiger muskie were not recorded during a creel survey, some anglers reported catching tiger muskie 457-508 mm. Many anglers may not be capable of distinguishing tiger muskie from northern pike, therefore, survey results of pike catch rates and total lengths may not be accurate.

Across all three lakes, 95% of the anglers were satisfied with the number of fish captured; 80% were satisfied with the length of fish captured, and 95% were satisfied with their overall fishing experience at the Arsenal. Arsenal anglers reported expertise levels of 30%, 60% and 10% for inexperienced, experienced, and expert anglers, respectively.

FISH POPULATION ASSESSMENT

The Lake Mary largemouth bass population continued to grow slowly and remained low through 1992 (Table 39). The trout stocking program continued in 1992, and may act as an additional forage fish for largemouth bass. No trout were captured during the 1992 standardized sampling, and creel surveys indicated very few fish were caught. The average total length of grass carp stocked in 1991 was 346 mm. Grass carp should reduce vegetation levels in lake Mary during 1993. Lake Ladora largemouth bass and pike average sizes have remained similar to 1991. It appears that black bullheads (Ictalurus melas) have successfully been eliminated from Ladora Lake. Lower Derby Lake continues to have an extremely large carp population. The tiger muskies stocked in May 1991, are growing and should become effective predators on common carp. Average length of two measured tiger muskies was 495 mm.

Lake Mary electrofishing results show a small largemouth bass population (17.3 per hour). Typical bass populations should support 50 largemouth bass > 200 mm total length per hour (Table

AQUATIC HABITAT MANAGEMENT

The 1992 grass carp stocking results should become apparent during the 1993 season. Typically, grass carp require one or two years to produce the desired reduction in aquatic vegetation. Mechanical removal of aquatic vegetation occurred at the Lake Mary and Lake Ladora fishing docks just prior to handicap fishing programs.

The twenty tons of hay spread in Lower Derby does not appear to have improved water clarity (Secchi disc) dramatically (Table 32). Typically, water clarity improves over at least one year time period, therefore next seasons results will confirm hay spreading effects.

AQUATIC RESOURCE SAMPLING PROGRAM

Summary of water chemistry characteristics for Lakes Mary, Ladora, and Lower Derby are in Table 3. Water temperature remained above 10^0C (50^0F) from April to September (Fig. 4). Therefore, largemouth bass had the potential to grow throughout the reporting period. Dissolved oxygen (See Water Quality Report) dropped below the critical 5 ppm in the deepest parts of Lake Mary. This may partially explain the loss of trout stocked in May. pH values were acceptable (6-9) with the exception of Lake Mary with a pH value of 10.1. High pH is historically common in Lake Mary and is caused by large amounts of aquatic vegetation. Trout cannot tolerate pH values of 10 or greater, preventing them from living through the summer. Water conductivity ranges from 430 to 690 unmhos, typical of Front Range waters.

Table 39. Gillnet sampling results on Arsenal Lakes Mary, Ladora, and Lower Derby, 1991.

MARY	TROUT		BASS		BLUEGILL	
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
1992	0	0	205	0.04	124	0.01

LADORA	PIKE		BASS		BULLHEAD	
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
1992	671	1.01	3.04	0.22	-	-

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
1992	760	0.18	379	0.18	540	0.89

Table 40. Electrofishing sample results from Lakes Mary, Ladora, and Low Derby, Rocky Mountain Arsenal, 1991 and 1992.

MARY	LARGEMOUTH BASS			BLUEGILL			CHANNEL CATFISH		
YEAR	#/hr	Ave Ln	#>Stock/ hr	#/hr	Ave Ln	#>Stock/ hr	#/hr	Ave Ln	#>Stock/ hr
1991	40	296	32	376	119	116	4	510	4
1992	36	230	17	289	116	227	4	514	4

LADORA	PIKE			LARGEMOUTH BASS			BLUEGILL		
YEAR	#/hr	Ave Ln	#>Stock/ hr	#/hr	Ave Ln	#>Stock/ hr	#/hr	Ave Ln	#>Stoc /hr
1991	2	575	2	86	235	44	642	104	78
1992	-	-	-	55	238	30	129	112	98

LOWER DERBY	PIKE			LARGEMOUTH BASS			BLUEGILL		
YEAR	#/hr	Ave Ln	#>Stock/ hr	#/hr	Ave Ln	#>Stock/ hr	#/hr	Ave Ln	#>Stoc /hr
1991	-	-	-	-	-	-	-	-	-
1992	2	605	2	90	145	32	104	96.4	50

Table 41. Summary of water quality characteristics: Secchi depth (water clarity) (cm), Conductivity (UMHOS), and pH from April through September 1992 in Arsenal lakes Mary, Ladora, and Lower Derby.

MARY	Apr	May	Jun	Jul	Aug	Sep
Secchi (cm)	205	264	193	163	122	137
Cond.(UMHOS)	600	530	650	690	610	610
pH	8.6	9.1	10.0	8.0	10.1	9.7
LADORA	Apr	May	Jun	Jul	Aug	Sep
Secchi (cm)	221	360	150	183	196	183
Cond.(UMHOS)	600	620	510	610	600	569
pH	8.6	9.0	8.1	9.2	9.0	9.0
LOWER DERBY	Apr	May	Jun	Jul	Aug	Sep
Secchi (cm)	160	109	86	96	81	127
Cond.(UMHOS)	430	600	575	600	510	482
pH	-	8.4	8.5	8.5	8.6	8.9

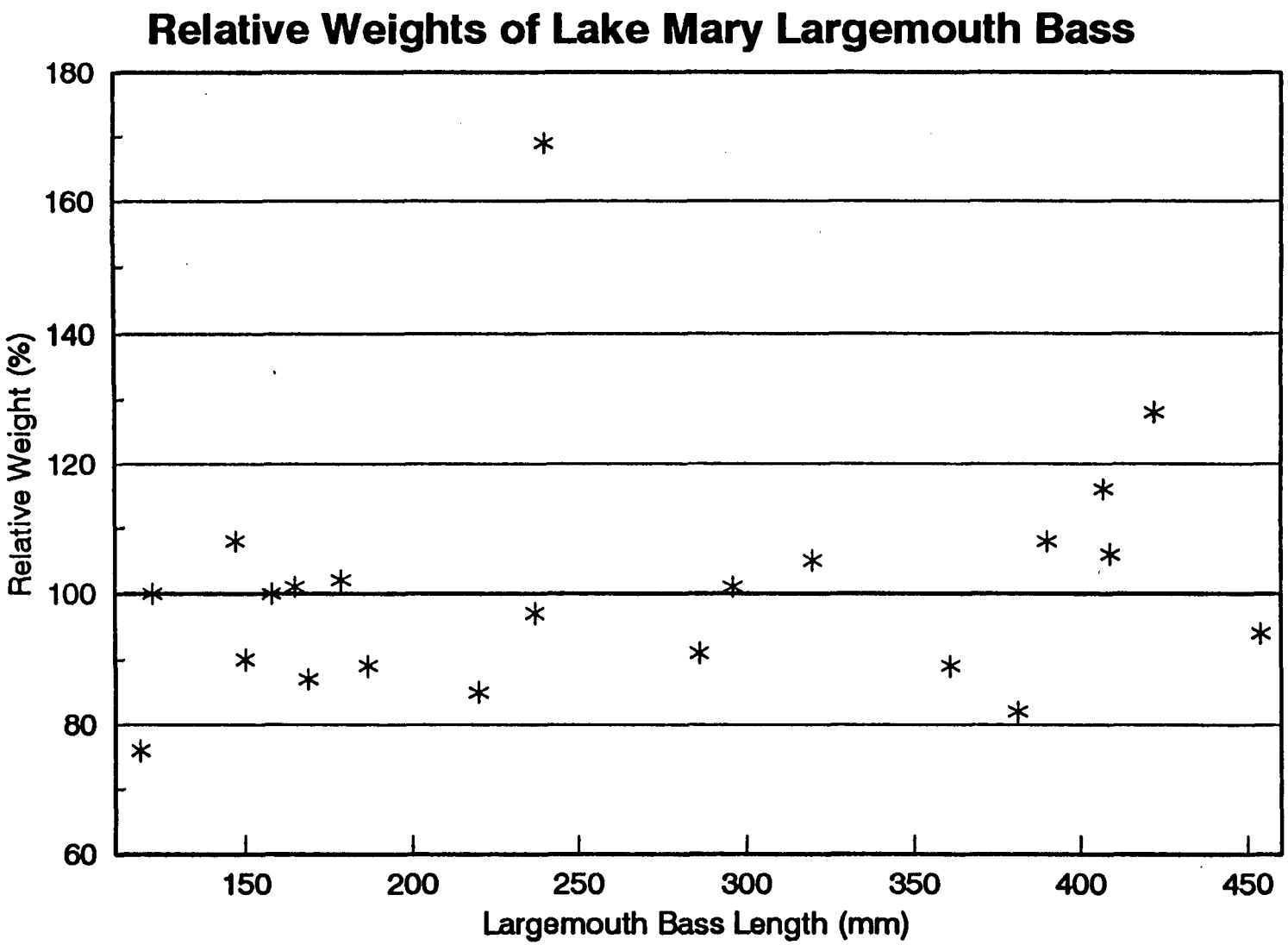


Fig. 29. Relative weights of Lake Mary largemouth bass collected during June of 1992.

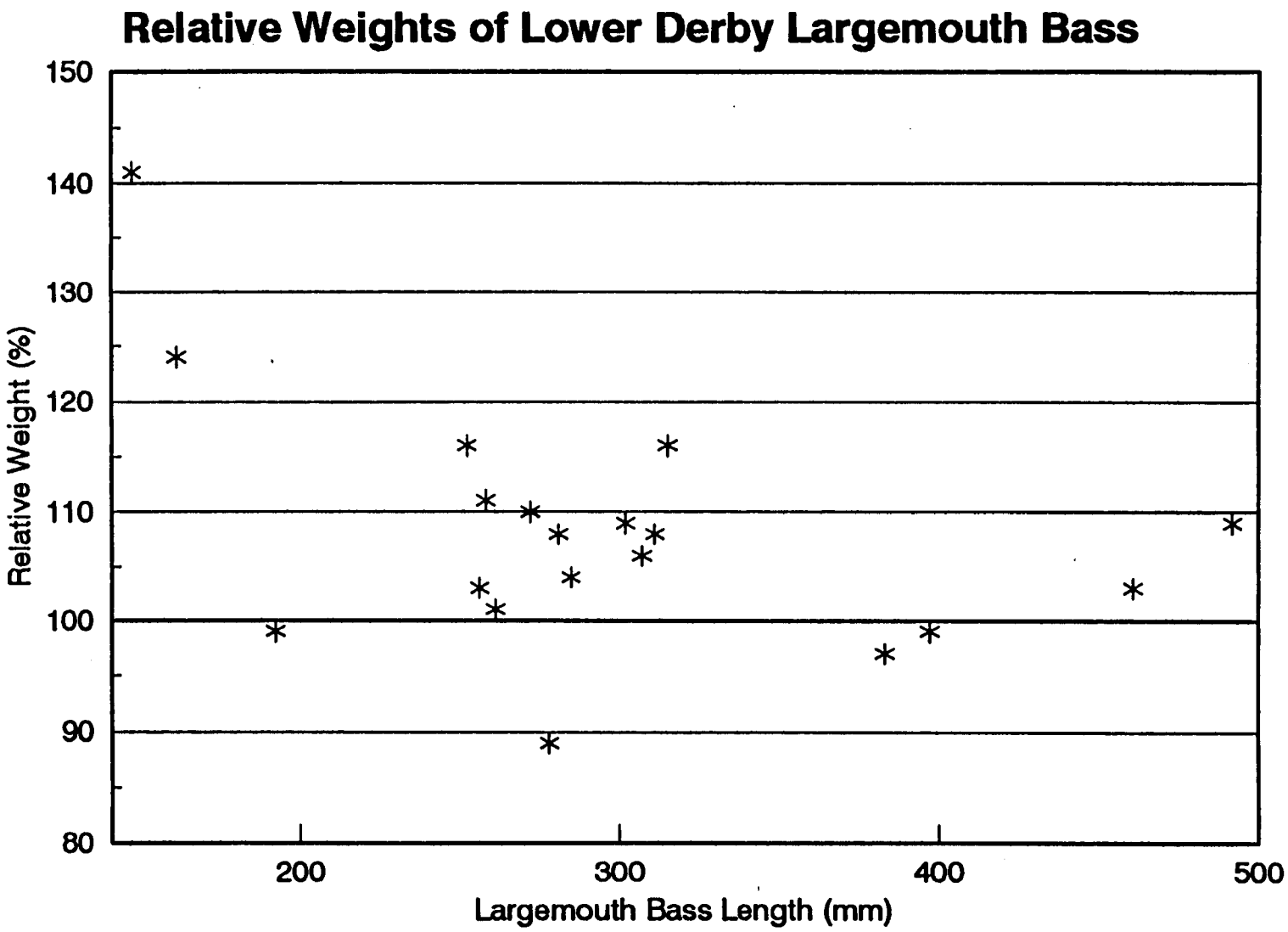


Fig. 30. Relative weights of Lake Ladora largemouth bass collected during June of 1992

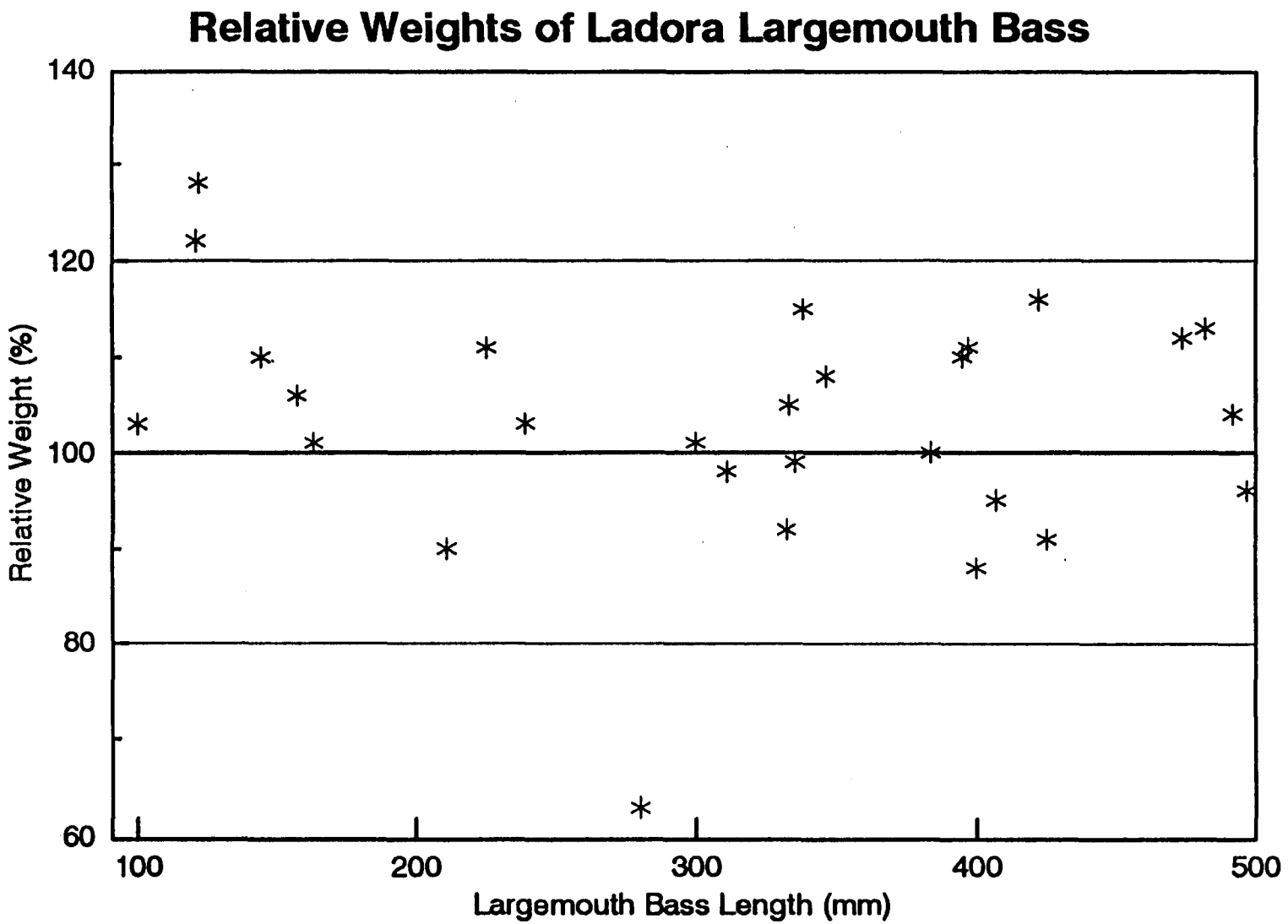


Fig. 31. Relative weights of Lake Lower Derby largemouth bass collected during June 1992.

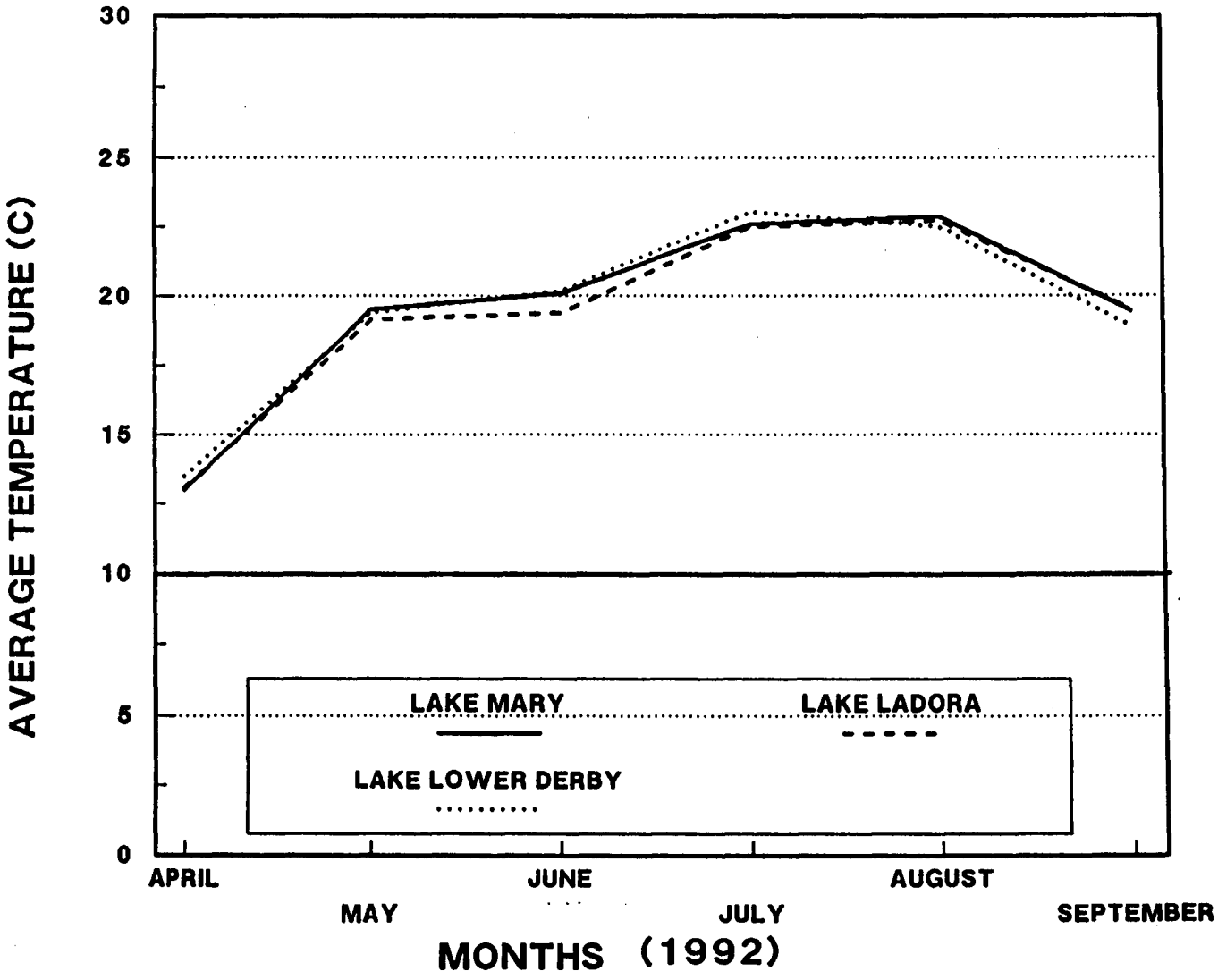


Fig. 32. Average water column temperatures of Arsenal lakes Mary, Ladora, and Lower Derby from April to September, 1992.

TASK 2 - MANAGEMENT AND OPERATIONAL ASSISTANCE

TITLE: Activities Management

INTRODUCTION

Activities Management at the Arsenal consists of two separate projects of Activities Coordination and Bald Eagle Management Area (BEMA) access. The Activities Coordination Program, established in April of 1991, is supervised jointly by the Service and the Army Compliance Office. The objectives of the program are (1) to reduce activity conflicts between, and ensure the safety of, all Arsenal employees, contractors, and other entities; and (2) to minimize deleterious cleanup impacts on Arsenal fish and wildlife resources. In this report, contractor activity and modification statistics will be provided.

A communal winter roost for bald eagles was discovered in the eastern portion of the Arsenal in 1986. Two years later, the Service and Army established a protective area, the BEMA, to encompass sensitive eagle roosting, feeding, and loafing areas. Between 15 October and 15 April, all access into the BEMA for cleanup and maintenance activities is regulated by Service personnel to minimize disturbance to wintering bald eagles. This report presents BEMA access statistics for the 1991-1992 regulation period.

METHODS

Activities Coordination

For Activities Coordination, an Arsenal map indicating locations of contractor activities was printed and reproduced weekly. Attached to the map was a schedule describing activity, location, and duration, level of personal protective equipment (PPE) required, and designated point of contact for all proposed activities. All Arsenal contractors and associated entities planning to conduct field activities were required to submit the aforementioned activity information on a standard activities coordination form one week prior to the onset of work. The one-week notice period allowed time for activities management personnel to review the proposed field work for compliance conflicts and to prepare the map and schedule for the following week. A revision list was kept at the Activities Coordination office for any last minute changes. Maps and schedules were distributed at a weekly contractors meeting. A more detailed description of the activities management process is presented in "Activities Policy and Procedures for Rocky Mountain Arsenal" dated 17 July 1991.

BEMA Access

Access into the BEMA was regulated by Activities Management personnel from 15 October 1991 to 23 March 1992. Contractors needing access were required to inform Activities Management personnel prior to each BEMA entry. Information such as date, contractor name, activity, duration, and work location(s) were recorded for each entry. Numbered, magnetic vehicle hood cones were distributed to all entities entering the BEMA to conduct legitimate activities. Activities management personnel conducted periodic patrols through the BEMA to ensure contractor compliance with established protocol.

RESULTS AND DISCUSSION

Activities Management

Fifty-two weekly activity maps and schedules representing the work of 40 different entities were produced and distributed in FY92. There were approximately 18,900 distinct activities performed during the year with an average weekly total of 363.5 projects. The number of daily activities ranged from three on Christmas Day to 87 on 17 December, and averaged 51.8 activities per day. Contractor activities varied in duration, and all levels of PPE (A, B, C, and D) were represented.

There were approximately 400 revisions made to the activities schedules during the year, with an average of 33.3 modifications per month.

BEMA Access

Activities Management personnel recorded 1,254 entries by 20 Arsenal entities from 15 October 1991 to 23 March 1992. The number of entries per entity ranged from 662 (United Engineers and Constructors) to 1 (Dominion); 3 entities requested entry more than 100 times (Table 42). The number of entries per month ranged from 143 in March to 258 in November (Table 43). Typically, bald eagle abundance is greatest on the Arsenal during the months of December and January. Activities recorded during these two months comprised 31% of the total. This was considerably more than in past years (U.S. Fish and Wildlife Service unpubl. data), and was attributed to the mild winter which allowed contractors more time in the field. Entities that were denied access into the BEMA were not recorded, but will be starting the 1992-93 BEMA season.

Activities during the 1991-1992 regulation period occurred in all 14 sections of the BEMA. Some activities extended into portions of several sections. The total number of recorded entries contained 3,302 sectional requests. Section 1 received the greatest number of entries (1163) and Section 32 received the

fewest (7) (Table 44). Ninety-four percent of the cumulative BEMA entry requests were for sections around the lakes. This area contains some of the best diurnal habitat for eagles on the Arsenal.

Activities within the BEMA occurred primarily during normal business hours (0730 - 1600). Some daytime activities were rescheduled for night hours to minimize disturbance in bald eagle diurnal areas. Cumulative time spent within the BEMA was 2344.5 hours (Table 45). Section 11 amassed the greatest amount of time per individual section (355.0 hours), and Section 32 the least (12.5 hours). Extensive well drilling along the Highline Canal in Section 11 accounted for most of the time spent in that section. Seventy-three percent of the cumulative time was spent in sections around the lakes. The amount of time spent around the lakes during previous years was not available for comparison.

Table 42. Arsenal entities requesting BEMA access and respective number of entries recorded during the 1991-92 regulation period, 15 October 1991 - 23 March 1992.

Entity	Number of recorded entries
United Engineers & Constructors	662
U.S. Fish and Wildlife Service	198
Woodward/Clyde	121
U.S. Geological Survey	82
Morrison-Knudsen Environmental Service	51
Facilities Maintenance	40
Harding Lawson Associates	21
H.L. Stollar	20
Robino Surveyors	13
Army Compliance	12
Total Terrain	6
Arsenal Fire Department	6
Shell Oil	4
Public Affairs Office	4
Federal Aviation Administration	4
Weston	3
Wyco Pipeline	2
U.S. Army Corps of Engineers	2
Arsenal Security	2
Dominion	1
Total	1254

Table 43. Recorded number of BEMA entries/month during the 1991-92 regulation period, 15 October 1991 - 23 March 1992.

Month/Year	Number of recorded entries
October 1991	232
November 1991	258
December 1991	195
January 1992	193
February 1992	233
March 1992	143
Total	1254

Table 44. Recorded number of BEMA entries/section during the 1991-92 regulation period, 15 October 1991 - 23 March 1992.

Section #	Number of recorded entries
1	1163
2	937
11	733
MS[a]	106
5	85
8	70
7	64
12	38
19	26
6	25
30	20
31	11
24	9
25	8
32	7
Total	3302

[a] Multiple Sections. Includes more than 5 sections.

Table 45. Cumulative time (hour) of activities within each BEMA section during the 1991-92 regulation period, 15 October 1991 - 23 March 1992.

Section #	Total time
11	355.0
1	354.5
2	320.5
MS[1]	265.0
8	205.0
5	188.0
7	158.5
30	90.0
19	87.0
12	81.0
6	45.5
24	31.5
25	27.0
31	22.5
32	12.5
Total	2344.5

[1] Multiple Sections. Includes more than 5 sections.

TITLE: Pest Management: Mosquitos

INTRODUCTION

Wetland features at the Arsenal contain significant mosquito production habitat. As many of these features are located in close proximity to residential areas of Montbello, large numbers of mosquitos represent possible community relations and public health problems for Rocky Mountain Arsenal. In 1992, the Service provided technical guidance and assistance to the Army for controlling mosquitos in the southern wetland areas of the Arsenal. Operations related to this project have been performed by the Service, Army, and Tri-County Health Department (TCHD). Methods of management included introduction of mosquitofish (Gambusia affinis) and using the bacterial larvicide Bacillus thuringiensis israeliensis (BTI).

Mosquitofish are a small carnivorous fish common in the southeastern United States. Mosquitofish belong to the family Poeciliidae, the livebearers and have superior (forward and upward facing) mouth parts which allow them to feed on items above their body. As mosquito larvae typically hang downward in the water from the surface film, mosquitofish are successful in preying upon the larvae. Because of their southern origin, it is not expected that many individuals will survive the winter at the Arsenal. The only body of water in which they might survive would be the deeper portions of wetland #1. As such, mosquitofish will have to be supplementally stocked each year to maintain adequate population densities.

BTI is a naturally occurring biological control agent. The active ingredients of BTI are endospores and delta-endotoxin crystals produced by the B. t. israeliensis bacteria. The toxins are typically suspended on a substrate of ground corncob granules. When applied in water the toxins are dissolved from the corncob granules and are ingested by the mosquito larvae. The toxins attack the midgut of the larvae, resulting in death within 24 hours. BTI is highly specific to Nematocerous Dipteran larvae (mosquitos and blackflies) and is non-toxic to other forms of aquatic life.

METHODS

The Mosquito Management Program identified known or probable mosquito production areas by three methods: site tour, light traps, and historical information. These efforts were performed by the Service, Army, TCHD, and other local health departments. Problem areas were defined as those which: have standing water for at least two consecutive weeks, are protected from wind and wave action, and are within 1.61 km (1 mile) of a residential area.

Mosquitofish were received from TCHD on several occasions and stocked into areas known to be problem areas. These areas included:

The wetland East of the Army Reserve Center in Section 12,
Rod and Gun Club Pond in Section 12,
Wetland #2 and Wetland #5 in Section 7, and
Havana Pond in Section 11.

Mosquitofish were also introduced into secondary problem locations which included:

Havana Pond inlet
Sand Creek Lateral below Havana Pond
Wetland #1
Randolph Tributary

Mosquitofish were introduced into these locations in order to prevent future mosquito problems.

Mosquitofish were stocked into waterbodies during the summer of 1992. The only population information collected on mosquitofish during 1992 was number stocked. This information does not consider mortality (predation) or natality parameters of the various stocks.

BTI was applied once at the Army Reserve Center wetland. This BTI was supplied by TCHD on a spot basis in response to large numbers of complaints received about mosquitos on the Arsenal.

RESULTS AND DISCUSSION

Mosquitofish

Approximately 3500 mosquitofish were stocked into wetlands #1 and #2 and the Randolph Tributary on 20 May 1992, and 3000 mosquitofish were stocked into Havana Interceptor and Ponds, Sand Creek Lateral, and Rod and Gun Club Pond on 7 July 1992.

Mosquitofish were stocked at an average density of approximately 84 fish\ha (34 fish\surface acre). Original plans called for overall densities of approximately 125 fish\ha (50 fish\surface acre).

Subsequent to these introductions, several size classes of mosquitofish were observed, which is an indication of reproduction. Some of these fish were then recaptured from Wetland #1 and moved to the Army Reserve Center Pond and Wetland #2. Also, mosquitofish were noted to have spread to all areas of the Sand Creek Lateral above Lake Ladora and the entire on-post reach of Uvalda Interceptor.

Because of weather and scheduling conflicts, mosquitofish could not be introduced onto the Arsenal until May 1992. This late introduction allowed mosquitos to establish healthy population levels before treatment could occur. Biological control efforts typically revolve around the ability to control pest populations before they become a problem. Since this could not be achieved in 1992, mosquito populations in some areas, such as the Army Reserve Center wetland and Rod and Gun Club Pond, became quite large and difficult to treat.

BTI

BTI was used once in the Army Reserve Center wetland in July 1992. This was in response to the large number of larvae found in this small water body (over 100 larvae/dip). Approximately 13 kg (30 lbs.) of BTI was applied and larvae densities were reduced for a short period of time. However, populations soon returned to the original densities due to the lack of follow-up applications. This waterbody remained a major mosquito production area throughout the summer.

RECOMMENDATIONS

Mosquito control efforts in 1993 should concentrate on the Army Reserve Center wetland and Rod and Gun Club Pond, with other problem areas receiving secondary levels of effort. Recommendations for 1993 include reintroducing mosquitofish into the problem wetlands. Reintroduction should achieve populations densities of 125 fish\ha (50 fish\SA). Also, water levels in wetland #2 should be maintained at levels sufficient to support fish.

Recommendations for the use of BTI in 1993 include acquiring sufficient amounts of BTI before the summer breeding season (April) and performing weekly applications throughout the summer in areas that cannot support mosquitofish.

TASK 3 - CLEANUP GUIDANCE

TITLE: Service Involvement in CERCLA Activities

INTRODUCTION

The Service is responsible for all issues regarding Arsenal contaminants and their effects on wildlife. Duties include CERCLA issues, biomonitoring program, and water quality evaluations.

OBJECTIVES

1. Provide assistance to the Army regarding the Remedial Investigation/ Endangerment Assessment/Feasibility Studies (RI/EA/FS) processes, Interim Response Actions (IRAs), and Biota Comprehensive Monitoring Programs.

2. Assist in developing and implementing natural resource management programs and provide coordination/guidance to other Service sections working at the Arsenal.

3. Design and implement specific projects to address wildlife-contaminant issues.

4. Initiate a 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 during 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 166 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) On-post Exposure Assessment - 1992 has been an important year in the development of the food web model for the Ecological Risk Characterization. An ecological risk model has been developed to establish soil, sediment, and water criteria protective of fish and wildlife species. The Service has been involved in the development and review of the parameters included in this model. Additionally, a new parameter was proposed, home range, to spatially weight the animals area of exposure. A major concern with this model is that it cannot predict the biological uncertainty associated with data collected from field and laboratory studies. Site specific data collected from the Arsenal have been used to calibrate the model, however, there is concern that this data may be inappropriate for calibration purposes. 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) On-post Feasibility Study - Service involvement in the Feasibility Study process has increased significantly during the past year. The Development and Screening of Alternatives was issued this year and extensive comments were prepared by the Service. While preliminary ecological goals were listed, it appeared that cleanup would be based primarily on human health

remediation goals. The report also described the various remediation alternatives reviewed and screened for inclusion in the next phase of the FS process, Detailed Analysis of Alternatives. The Service provided detailed comments regarding the exclusion of many alternatives based on impacts to habitat and effects to wildlife, dismissal of biota criteria in areas where both human health and biota exceedances are found, and selection of Preliminary Remediation Goals based on human health criteria only. Numerous meetings have occurred on these issues resulting in direct Service involvement in the FS process. This involvement consists of a detailed habitat evaluation of Arsenal lands to determine potential levels of mitigation and priorities for protection of sensitive or important habitats in areas where remediation may occur. This evaluation has been initiated by the Habitat Restoration/Endangered Species section.

(c) Off-post Endangerment Assessment/Feasibility Study - The Service initiated the dispute resolution process as defined by the Federal Facilities Agreement regarding the finalization of the Proposed Final Endangerment Assessment/Feasibility Study for the Off-post Operable Unit. This dispute was initiated because of several concerns: failure to address provisions of the Migratory Bird Treaty Act, incorporating new information regarding the ecological risk model that had not been reviewed by the Service and other parties, concern over particular values used to determine risk, and failure to address "hot spots" of significantly contaminated sediment. Through a series of meetings and revisions to the document, the Service has resolved its dispute with the Army on all of these issues. The document was made final in December 1991.

(d) Interim Response Actions - Service involvement is ongoing related to IRAs at the Arsenal. IRAs of particular concern during FY92 include the South Tank Farm Plume, Lime Settling Basins, and Basin F Liquids. Additionally, two new IRAs were initiated this year, including: Chemical Process Related Activities IRA and two additions to the CERCLA Wastewater Treatment IRA to include temporary storage of hazardous material generated as a result of CERCLA activities and remediation of PCB contaminated equipment.

South Tank Farm Plume - The Service continues to monitor results of the quarterly surface water and groundwater elevation measurements. The Service remains concerned regarding the potential migration of the plume closer to the lakes. If results of this program indicate any potential for contaminated water to enter the lakes and

the process cannot be controlled by managing the lake elevation, then additional measures will be taken.

Basin F Liquids - The Service assisted in the development of a brochure and fact sheet on the Submerged Quench Incinerator. 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.

(e) Wildlife exposure/protection issues: The Service has provided assistance to the Army on several issues regarding the potential for exposure to wildlife. Recommendations, guidance and input were provided on the following issues: ponding of surface water in Basin A, animal control devices at Pond A, animal control at the Basin F Wastepile, and the unvegetated piece of land immediately northwest of the Basin F Wastepile.

2. Internal Assistance - Guidance and input were provided to the Conservation, Mitigation, Community Relations, 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 the general public. Information obtained from reviewing documents, attending meetings, and discussions with other parties was used in providing this guidance and input.

3. Biomonitoring Program (BM) - In mid-1992, a fish and wildlife biologist was hired to serve as the Biomonitoring Coordinator. 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 fish and wildlife exposure to contaminants through tissue residue analyses,
(b) monitoring 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, and

(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.

These tasks are discussed in more detail in their respective annual reports found Appendix A.

4. Natural Resource Damage Assessment (NRDA) - The Service anticipates initiating a formal NRDA for completion after the Record of Decision.

TASK 4 - BIOMONITORING

TITLE: Fortuitous Specimen Program

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. Prior to 1990, selected fortuitous specimens found on the Arsenal were submitted for tissue residue chemical analysis under the Biota Comprehensive Monitoring Program conducted by the Army.

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 of unusual animals (e.g. badger). Service personnel were notified of dead or sick/injured animals by Army personnel, contractors, or other Service personnel. Animals were collected and a determination was made whether to send the animal to Colorado State Veterinary Diagnostic Laboratory (CSVDL). In some instances, if the animal was a migratory bird listed under the Migratory Bird Treaty Act, it was sent to the U.S. Fish and Wildlife Service National Wildlife Health Research Center (NWHRC). The animal was either placed on ice or transported live, if possible. Once at CSVDL or NWHRC, an examination and necropsy were conducted. In some instances, tissues were saved for potential contaminant analyses.

RESULTS

Ten partial or full post-mortem examinations were performed between October 1991 and September 1992. Six were examined by CSVDL and four were examined by NWHRC.

(1) A cottontail was reported live inside the South Tank Farm perimeter fence. Contractors reported seeing this animals running in circles. Upon capture, the animal was breathing heavily and experiencing spasms. The animal died in transport to CDSVL. Upon physical and histopathological examination, the exact cause of death could not be determined. Hemorrhages on the brain and within the thoracic inlet may have been associated with trauma or a predator.

(2) A coyote was observed near death in Section 31. Upon approach, the coyote began circling. The animal was

the fat. Cholinesterase activity in the brain was within normal limits.

(9,10) Two barn owls were collected from an abandoned building in the North Plants. One bird was collected live, though it died shortly after collection and the other was already dead. Both birds were sent to NWHRC. Physical and histopathological examinations indicated that both birds were emaciated. The cause of emaciation was not determined. Cholinesterase activities in the brain were within normal limits. Tissues were saved for chemical analysis.

RESULTS AND DISCUSSION

The Service has entered into discussions with PMRMA-Laboratory Support Division regarding chemical analytical methodology to ensure that as much consistency as possible is maintained between the CMP and the Service's Biomonitoring Program. The Service has also asked for input from personnel involved with previous biota collections for the CMP to maintain as much continuity as possible between the two programs.

The Service has purchased much of the field supplies needed to support the Biomonitoring Program. These supplies include but are not limited to: necropsy kits, various sizes of ziplock bags, EPA approved chemically-cleaned jars, Service Chain-of-Custody tape and forms, and micro-transmitters for use in the kestrel investigation.

Currently, the Service is preparing the TBMP Plan. The Plan should be finalized in early 1993. The Service anticipates that field work will begin in early May 1993.

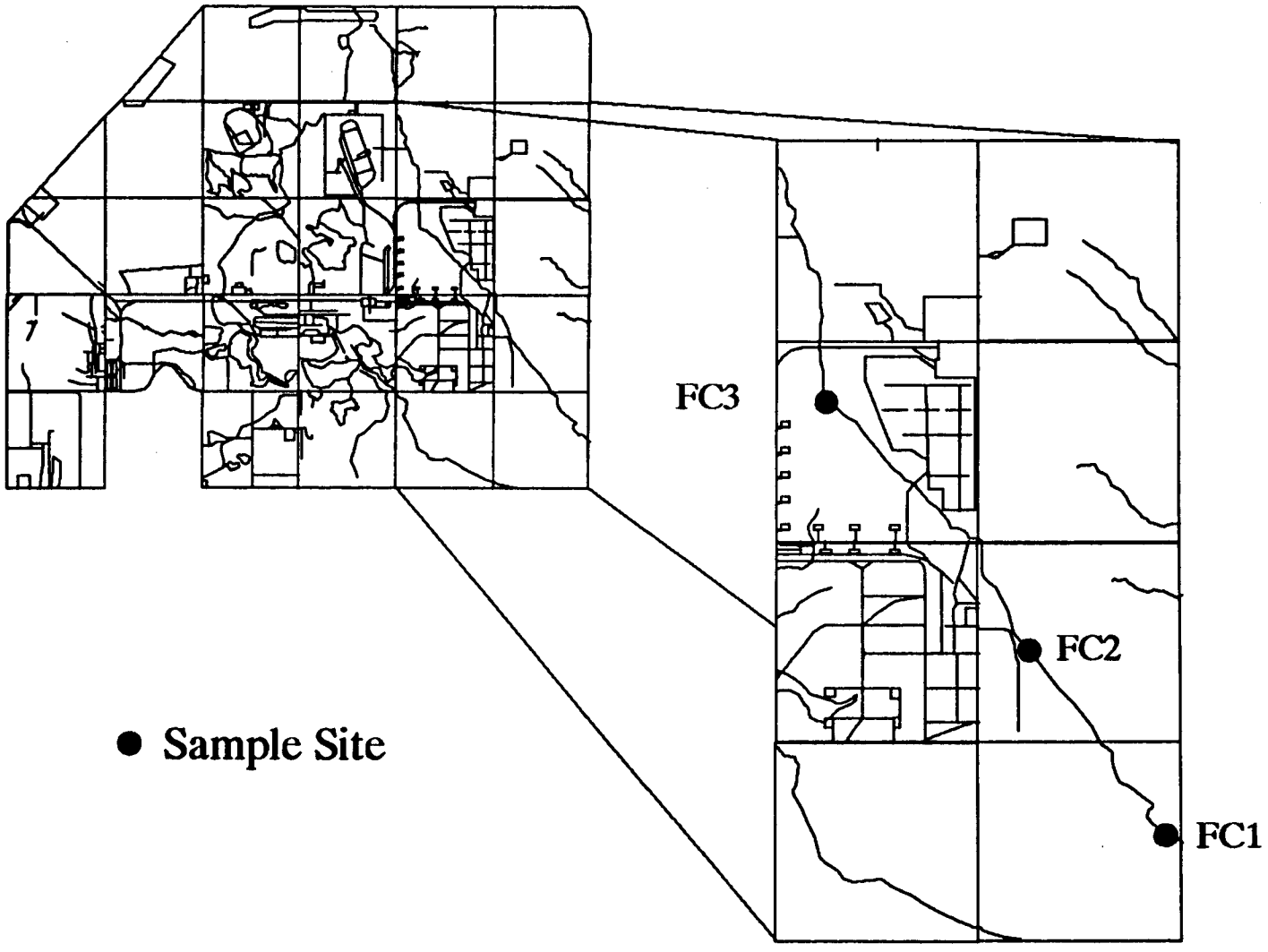


Fig. 33. First Creek aquatic macroinvertebrate sampling locations during FY92.

by a group of 23 mule deer sighted in February. All figures, 36 through 43, show the fluctuation in bird numbers expected during migration months. There was comparatively heavy use of the Basin F Wastepile and Basin F Storage Tanks (Figs. 40 and 37) by passerines, during the breeding/nesting season. Ponds A & B also received relatively high usage by waterfowl during the breeding/nesting season even though zon guns and "tweeters" designed to discourage use were operational.

Since the initiation of this survey in April 1990, specific 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 totally effective, they have decreased wildlife use of some contaminated areas considerably, particularly prairie dogs in Section 36.

Table 46. Average number and percent frequency of mammals observed in contaminated areas, January - September, 1992 (31 survey days).

Species	Basin A	Basin C	North Bog	Toxic Storage Yard	TSY Ponds	Pond A	Pond B	Spill Over	Basin F Tanks	Waste Pile
Mule Deer	3.8 32%	.9 13%	---	---	.45 19%	----	---	---	---	---
White-tailed Deer	---	---	---	---	.38 16%	---	---	---	---	---
Cottontail	1.29 29%	---	---	.13 6%	---	---	---	.4 16%	---	.26 13%
Prairie Dog	24.26 93%	.1 15%	---	1.9 55%	---	---	---	---	---	---
Muskrat	---	---	.06 6%	---	---	.03 3%	---	---	---	---
Coyote	.29 19%	---	.03 3%	---	---	---	---	---	---	---
Fox Squirrel	---	---	---	---	.03 3%	---	---	---	---	---
Jackrabbit	.03 3%	---	---	---	---	---	---	---	---	---
Badger	---	---	---	.03 3%	---	---	---	---	---	---

Table 47. Average number and percent frequency of raptors observed in contaminated areas during January - September, 1992 (31 survey days).

Species	Basin A	Basin C	North Bog	Toxic Storage Yard	TSY Ponds	Pond A	Pond B	Spill Over	Basin F Tanks	Waste Pile
Red-Tailed Hawk	.03 3%	---	---	.06 6%	.03 3%	---	---	---	---	---
Swainson's Hawk	.03 3%	.03 3%	---	1.0 6%	---	---	---	---	---	---
Northern Harrier	.03 3%	---	---	---	---	---	---	---	.03 3%	.03 3%
Kestrel	.26 22%	---	---	1.0 39%	---	---	---	---	---	---
Golden Eagle	---	---	---	.1 9%	---	---	---	---	---	---
Bald Eagle	.03 3%	---	---	---	---	---	---	---	---	---
Ferruginous Hawk	.13 16%	---	---	.06 6%	---	---	---	---	---	---
Merlin	.03 3%	---	---	.03 3%	---	---	---	---	---	---

Table 48. Average number and percent frequency of waterbirds in contaminated areas during January - September, 1992.

Species	Basin A	Basin C	North Bog	Toxic Storage Yard	TSY Ponds	Pond A	Pond B	Spill Over	Basin F Tanks	Waste Pile
Least Sandpiper	---	---	.06 3%	---	---	---	---	---	---	---
Gadwall	---	---	.06 3%	---	.06 3%	.03 3%	---	---	---	---
Blue-winged Teal	---	---	---	---	.22 10%	---	---	---	---	---
Mallard	---	.06 6%	.39 19%	---	3.26 55%	.61 16%	.06 6%	---	---	---
Redhead	---	---	---	---	.45 16%	---	---	---	---	---
Cinnamon Teal	---	---	---	---	.06 6%	---	---	---	---	---
Coot	---	---	---	---	1 42%	---	---	---	---	---
Great Blue Heron	---	---	.13 35%	---	.42 45%	.03 3%	---	---	---	---
Black Crowned Night Heron	---	---	.03 3%	---	.06 6%	1 15%	---	---	---	---
Pied-Billed Grebe	---	---	---	---	.35 19%	---	---	---	---	---
Double-Crested Cormorant	---	---	.35 13%	---	.06 6%	.03 3%	---	---	---	---
Canada Goose	---	---	.13 13%	---	.19 6%	---	---	---	---	---

Species	Basin A	Basin C	North Bog	Toxic Storage Yard	TSY Ponds	Pond A	Pond B	Spill Over	Basin F Tanks	Waste Pile
Robin	---	---	---	1.13 19%	.26 9%	---	---	---	---	---
Killdeer	---	---	.19 13%	.03 3%	---	---	---	---	---	---
Ring-Necked Pheasant	.03 3%	.03 3%	---	---	.32 19%	---	---	---	---	---
Loggerhead Shrike	---	---	---	.29 9%	---	---	---	---	---	---
Rock Dove	.45 13%	---	---	.32 19%	---	---	---	---	---	---
Common Nighthawk	---	---	---	.03 3%	---	---	---	---	---	---
American Crow	---	---	---	---	.03 3%	---	---	---	---	---
Brown-headed Cowbird	---	---	---	.16 6%	---	---	---	---	---	---
Bluebird (sp.)	---	---	---	.61 3%	---	---	---	---	---	---
Lark Bunting	1.65 3%	.64 6%	---	5.65 39%	---	---	.16 3%	.129 3%	1 13%	.58 9%
Red-Headed Woodpecker	.03 13%	---	---	---	---	---	---	---	---	---
Vireo	---	---	---	.06 3%	---	---	---	---	---	---

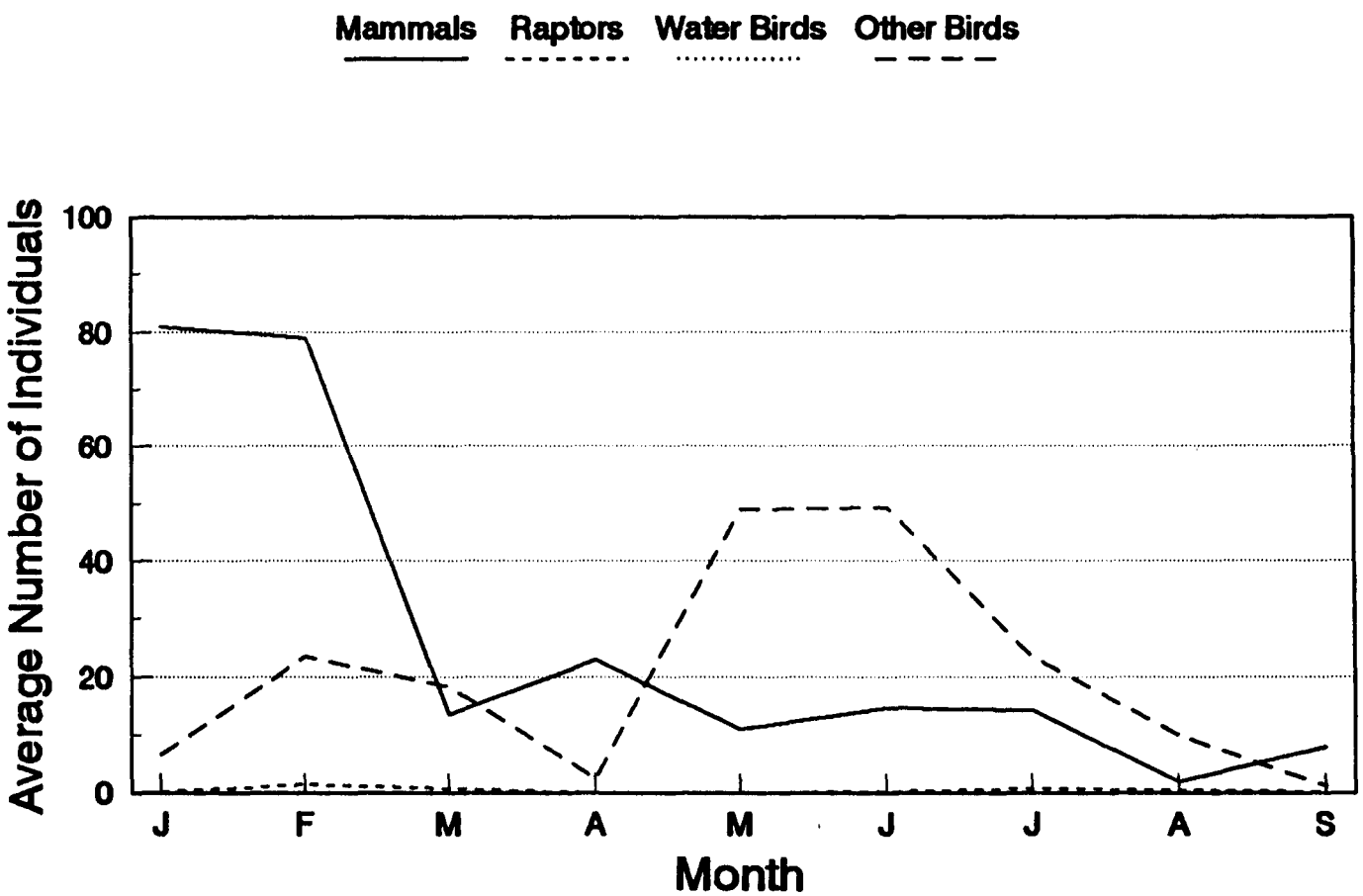


Fig. 35. Arsenal wildlife land use survey results - Basin A, January through September, 1992.

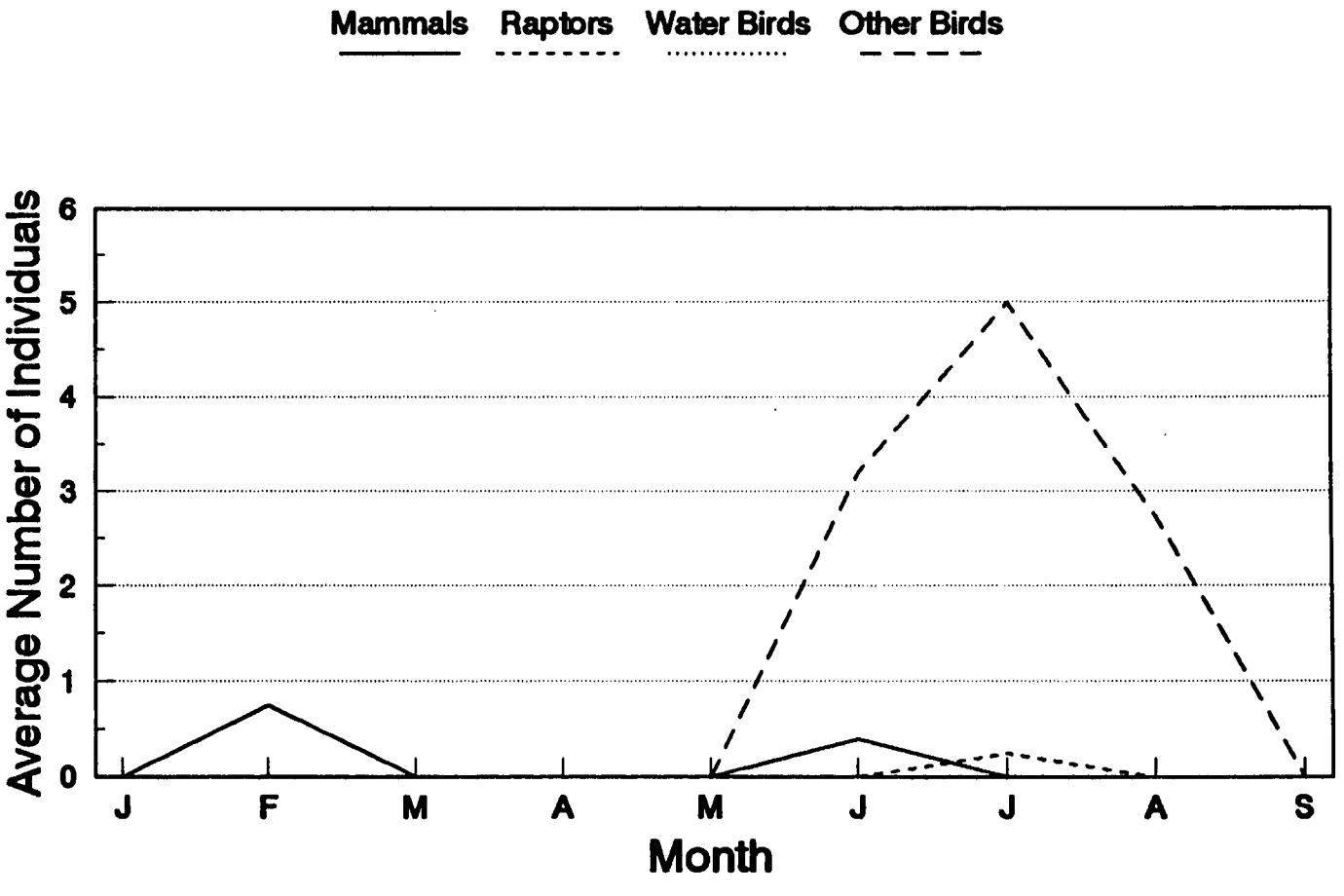


Fig. 37. Arsenal wildlife land use survey results - Basin F Wastepile, January through September 1992.

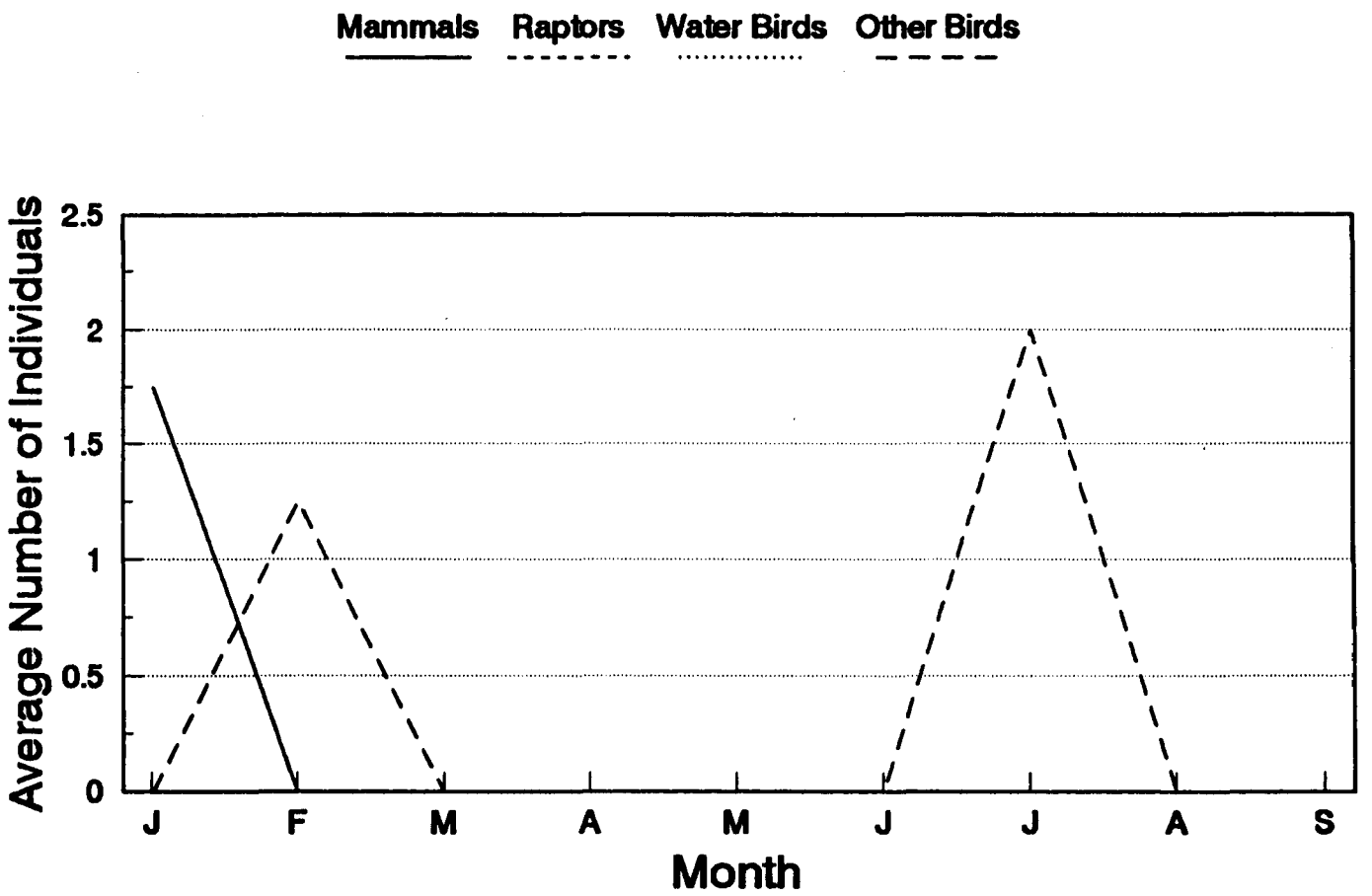


Fig. 38. Arsenal wildlife land use survey results - Basin F Spillover Pond, January through September 1992.

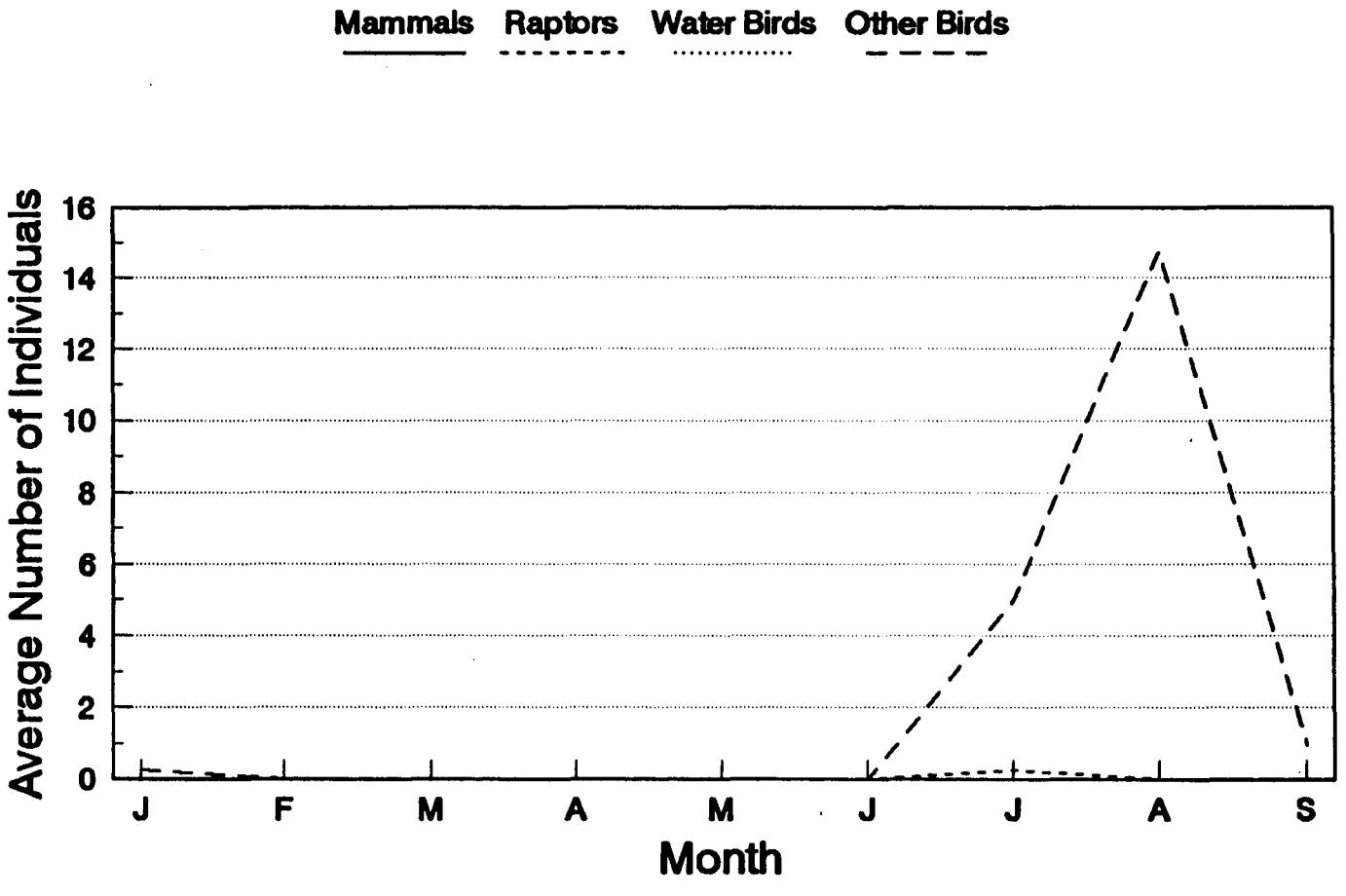


Fig. 40. Arsenal wildlife land use survey results - Basin F Storage Tanks, January through September 1992.

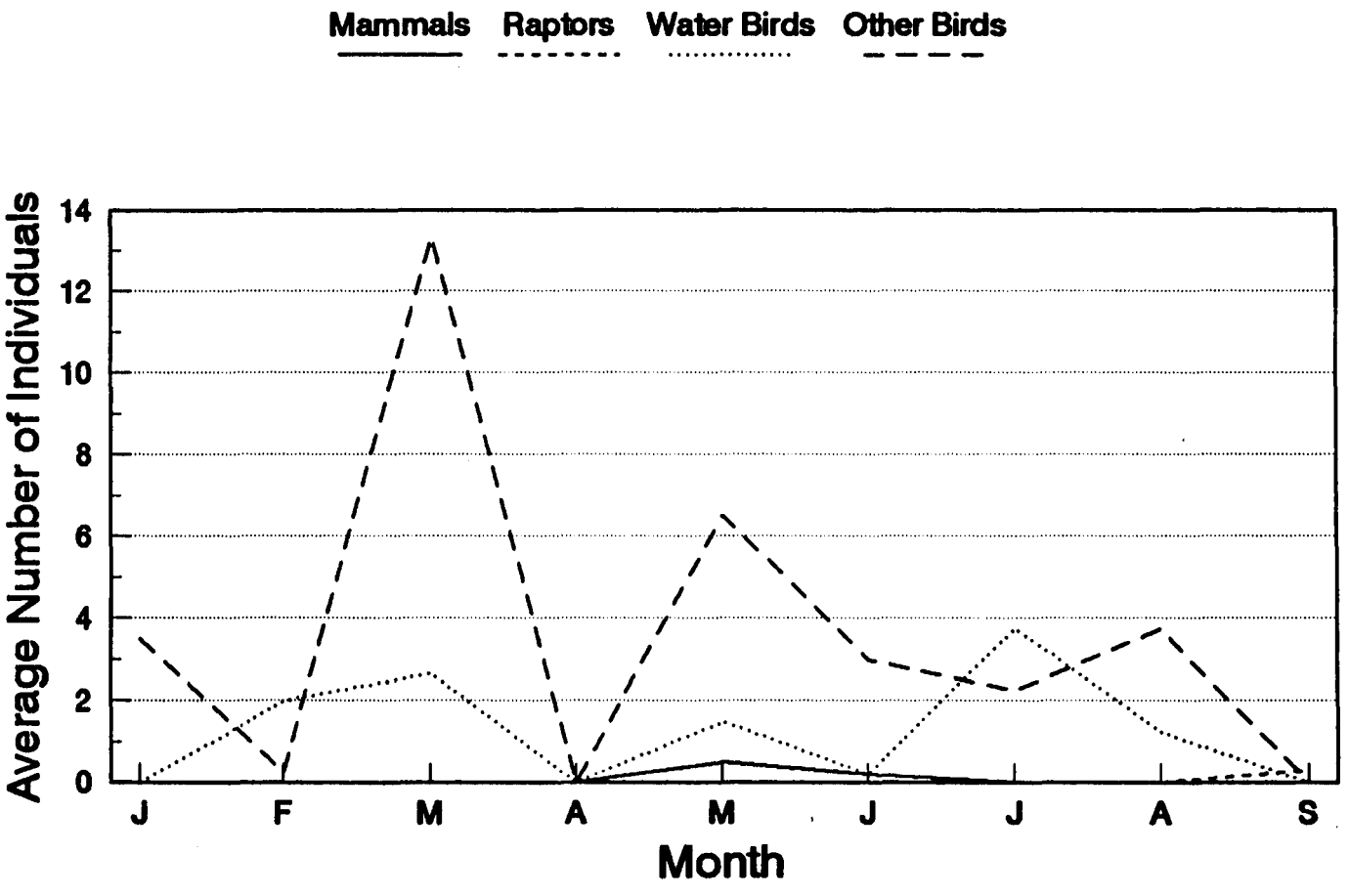


Fig. 41. Arsenal wildlife land use survey results - North Bog, January through September 1992.

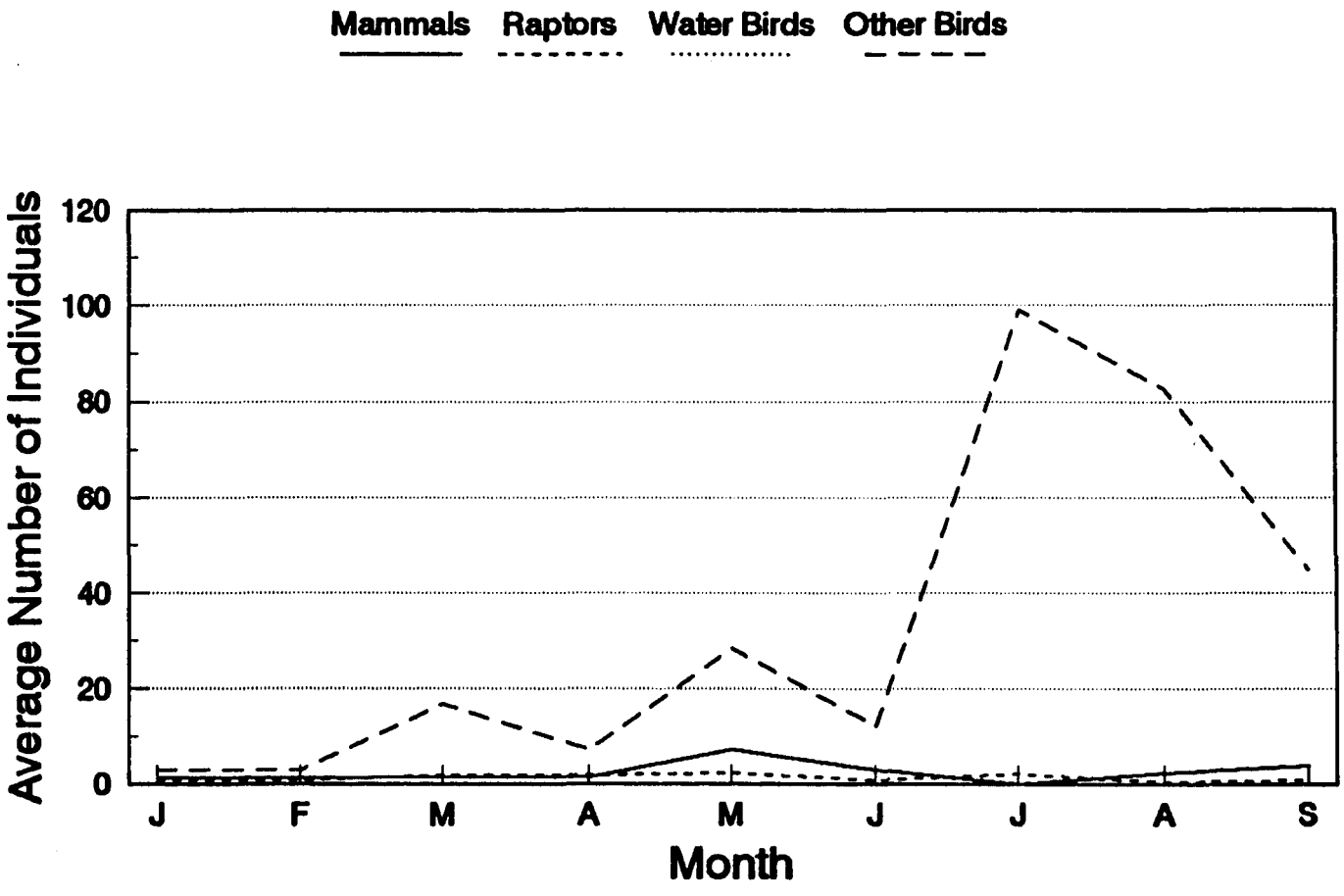


Fig. 42. Arsenal wildlife land use survey results - Toxic Storage Yard, January through September 1992.

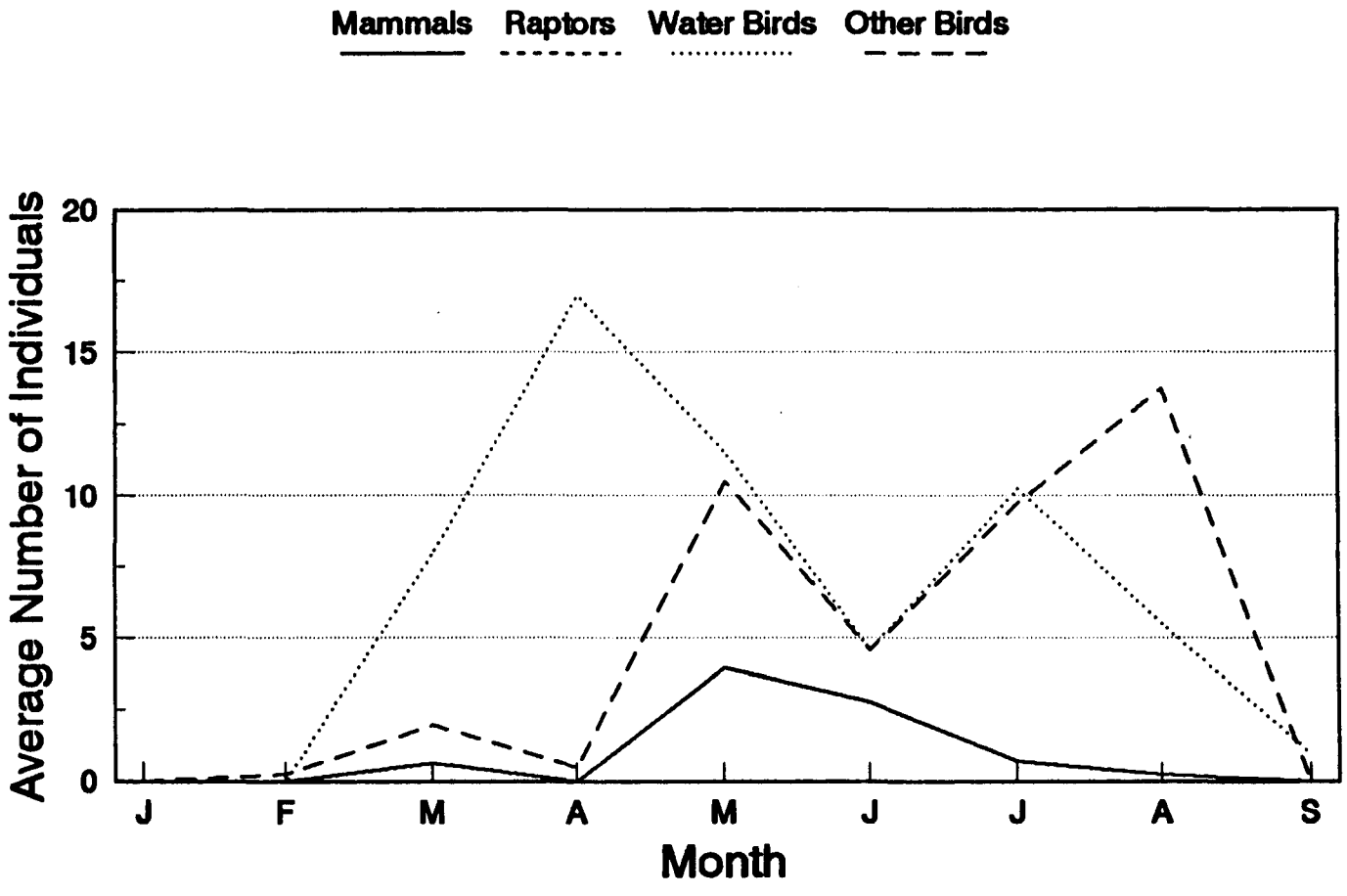


Fig. 43. Arsenal wildlife land use survey results - Toxic Storage Yard Ponds, January through September 1992.

TITLE: Whole Effluent Toxicity Test (WETT) Laboratory

INTRODUCTION

In 1992, the Service continued to assemble equipment and supplies required to operate a Whole Effluent Toxicity Test laboratory. This lab will operate under the guidelines detailed in "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (USEPA, 1989) and "Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms" (USEPA, 1991). The lab will be used to monitor water quality in the canals and ditches entering the southern portion of Rocky Mountain Arsenal. Many of these waters drain the residential and light-industrial areas of Montbello, and in the future, will drain developed areas associated with the new Denver International Airport. This situation raises concerns that urban non-point source pollution may impact natural resources at the Arsenal.

RESULTS AND DISCUSSION

During 1992, the Service purchased most of the equipment and supplies required to operate the lab. The lab was planned to be housed in a mobile trailer acquired from BLM in Montana. In September, the Army invited the Service to house the lab in their new analytical laboratory (Bldg. 130). During September, major items of equipment were moved into the Inorganic Lab of Bldg. 130 for set-up and calibration.

FUTURE WORK

Calibration and standardization tests will be performed to verify lab performance. Start-up operations will begin in January 1993.

TITLE: Water Resources: Physiochemical Water Quality Parameters

INTRODUCTION

Physical water quality parameters were measured in Lakes Mary, Ladora, and Lower Derby beginning in April, 1992. The following parameters were recorded: dissolved oxygen (DO), temperature, pH, conductivity, and secchi depth. This data will be used by Service biologists for fishery and lake management decisions. Parameters were measured at two locations in Lakes Mary and Ladora and three locations in Lower Derby Lake (Fig. 44).

METHODS

Data were collected once a month. The following routine sampling methods were used to collect water quality data:

Dissolved Oxygen: A YSI Model 50B dissolved oxygen meter with standard field probe attached to a 7.65 m (25 ft.) cable was used. At the beginning of the sampling day, the meter was calibrated according to the manufacturers instructions for both percent (%) and mg/L values. If the surface temperature varied by more than 5°C between sites, the meter was recalibrated to the new temperature. Dissolved oxygen levels were measured at the surface and at 0.31 m (1 ft) intervals to the bottom of the lake, concurrent with temperature measurements. Difficulty was experienced during the summer months in getting the probe to descend through the dense aquatic vegetation. Also, the vegetation made it difficult to set an anchor to hold the boat in place. These difficulties resulted in inexact site replication and varying depths achieved. Data were recorded on a standardized field data sheet, then entered into a computer data base for analysis.

Temperature: The YSI Model 50B dissolved oxygen meter described above comes equipped with a built-in temperature probe. Temperatures were recorded at the surface and at 0.31m (1 ft) intervals to the bottom of the lake, concurrent with DO measurements. Sampling difficulties similar to those discussed above were also experienced with collection of temperature information. Data was recorded on a standardized field sheet, then entered into a computerized data base for analysis.

pH: pH was measured with a hand-held ion-selective probe (Aquatic Eco-Systems, Apopka, FL). For occasional verification of measurements, a Corning "CheckMate" pH probe was used. The Corning probe was lab calibrated at pH 7.0 and 10.01 before use. Also, a Hach field kit was used to verify measurements above pH 10.0. This data was recorded

on a standardized field sheet and then entered into a computerized data base for analysis.

Conductivity: A YSI Model 33 field conductivity meter was used in the first half of the sampling season. Technical difficulties with this instrument required replacement by a Corning "CheckMate" conductivity probe. Only surface conductivities were collected. This information was recorded on a standardized field sheet, then entered into a computerized data base for analysis.

Secchi Depth: Secchi depth was measured using a standard 20.3 cm (8 in) Secchi disk. The disk was lowered until no longer visible, then slowly raised until visible again. The depth that the disk became visible was recorded on a standardized data sheet, then the data was entered into a computerized data base for analysis.

Other information collected during each sampling session included date, start and stop time at each site, general weather conditions, name of crew collecting the data, water color, and vegetation density.

Each sampling session began at approximately 1300 hours at the Lower Derby #1 site. Data were later collected at the remaining Lower Derby sites, then the Lake Ladora sites, and then the Lake Mary sites.

Sampling was conducted by boat with a crew of two. Sample sites were located by triangulating readily visible landmarks. Locating sites with this method often leads to difficulty in exact replication of sample site. However, exact replication of sample location was not essential. This difficulty in relocating sample sites resulted in varying depths recorded. Once the site was located, a small anchor was set to hold the boat in place. Data was collected and recorded before proceeding to the next site.

RESULTS

Under existing Colorado Department of Health - Water Quality Control Commission State Use Classifications (Colorado Department of Health, Water Quality Control Commission 1989), the lower lakes at the Arsenal would fall under the classification of "Class 1 - Warm Water Aquatic Life." This classification is defined as:

> "waters that (1) currently are capable of sustaining a wide variety of warm water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or

levels, and water quality conditions result in no substantial impairment of the abundance and diversity of species."

The Colorado Department of Health, Water Quality Control Commission (1989) has issued the following physical parameter standards for warm water aquatic life waterbodies:

Dissolved Oxygen	5.0 mg\L
pH	6.5-9.0
Temperature	30°C max.

Figures 45 through 61 depict water quality parameter variation between April and September, 1992.

Generally, dissolved oxygen levels were above the State standard of 5.0 mg/L except during July (minimum of 3.35 at Lake Mary site 1 at 2 m) and August (minimum of 1.99 at Lake Mary site 2 at 1.6 m). One site, Lower Derby Lake site 3, was also below 5.0 mg/L (2.62 mg/L at 4.6 m) during the September sampling session. All sites, except Lake Ladora site 2, experienced DO levels below 5.0 mg/L.

Lake Mary pH measurements were above the State standard of 9.0 in May (sites 1, 2 = 9.1), June (site 1 = 10.0, site 2 = 9.7), August (site 1 =9.8, site 2 = 10.1), and September (site 1 = 9.9, site 2 = 9.7).

Lake Ladora pH measurements were above the State standard in June (site 2 = 9.1) and July (site 2 = 9.2).

Lower Derby Lake pH measurements were not measured at levels above the State standard of 9.0. No measurements were collected at any of the sites at levels below the State standard of 6.5.

Temperatures ranged from a minimum of 12.0 °C (Lake Mary site 2 in April) to a maximum of 25.0 °C (Lake Mary site 1 in August).

DISCUSSION

Dissolved oxygen (Figs. 45 - 51) levels were influenced, in all three lakes, by areas of dense aquatic vegetation. Piper et al. (1983) suggests that most species of warm water fish can survive well (although showing little growth) at concentrations above 4 mg/L, can survive extended periods (days) at 3 mg/L, and can tolerate 1-2 mg/L for a few hours. Another factor present in the Arsenal lakes were nearby areas of high DO refugia (areas to "escape" from low DO). Instances where DO levels dipped below the State standard of 5.0 mg/L probably did not limit the existence of aquatic life in the Arsenal lakes, although fish probably migrated from lake areas due to low DO.

pH (Fig. 52) in natural ponds is controlled to a great extent by photosynthesis (Piper et al. 1983). A simple chemical reaction occurring between water and carbon dioxide yields a form of carbonic acid. As CO_2 increases, pH decreases, and vice versa. Plants, which consume CO_2 during the "light" cycle of photosynthesis, can drive the pH up during the day, and as they respire, CO_2 during the night, can lower the pH accordingly. Dense, sometimes very dense, levels of aquatic macrophytic growth were noted in most areas of Lakes Mary and Ladora, and at Lower Derby site 3. During some sampling sessions, it was almost impossible to access the Ladora and Mary sites by boat due to vegetation density. This would explain the occurrences of high pH recorded during late afternoon summer days at the Arsenal lakes.

At no time did the temperature exceed the State standard of 30 °C (Figs. 53 - 59). Both the minimum and maximum temperatures recorded during 1992 were in Lake Mary. This can be explained by the fact that Lake Mary is the smallest of the Arsenal lakes, and is more reactive to ambient temperature changes.

Secchi depth (Fig. 60) is an objective measure of the distance light can penetrate water. This distance can be used as an indication of the productivity potential of the lake. Secchi depth information was collected by measuring the greatest distance the disk could be seen or would travel. Smaller Secchi depths indicate less light can reach aquatic plants, indicating lower primary productivity. Larger Secchi depths indicate light can reach greater depths and enhance plant growth. Secchi depths can be controlled by several biotic and abiotic factors (total suspended solids, phytoplankton, zooplankton, etc.) Generally, Lower Derby was the most turbid, and Lake Ladora was the clearest of the Arsenal lakes. The Secchi disk was often obscured by vegetation long before water clarity obscured the disk. Also, at the shallower sites, the disk could be clearly seen lying on the bottom.

Conductivity (Fig. 61) can be used as an indication of salinity in natural waters. Sources of salinity include natural and anthropogenic (manmade) sources. Various species have various tolerances to salinity in freshwater.

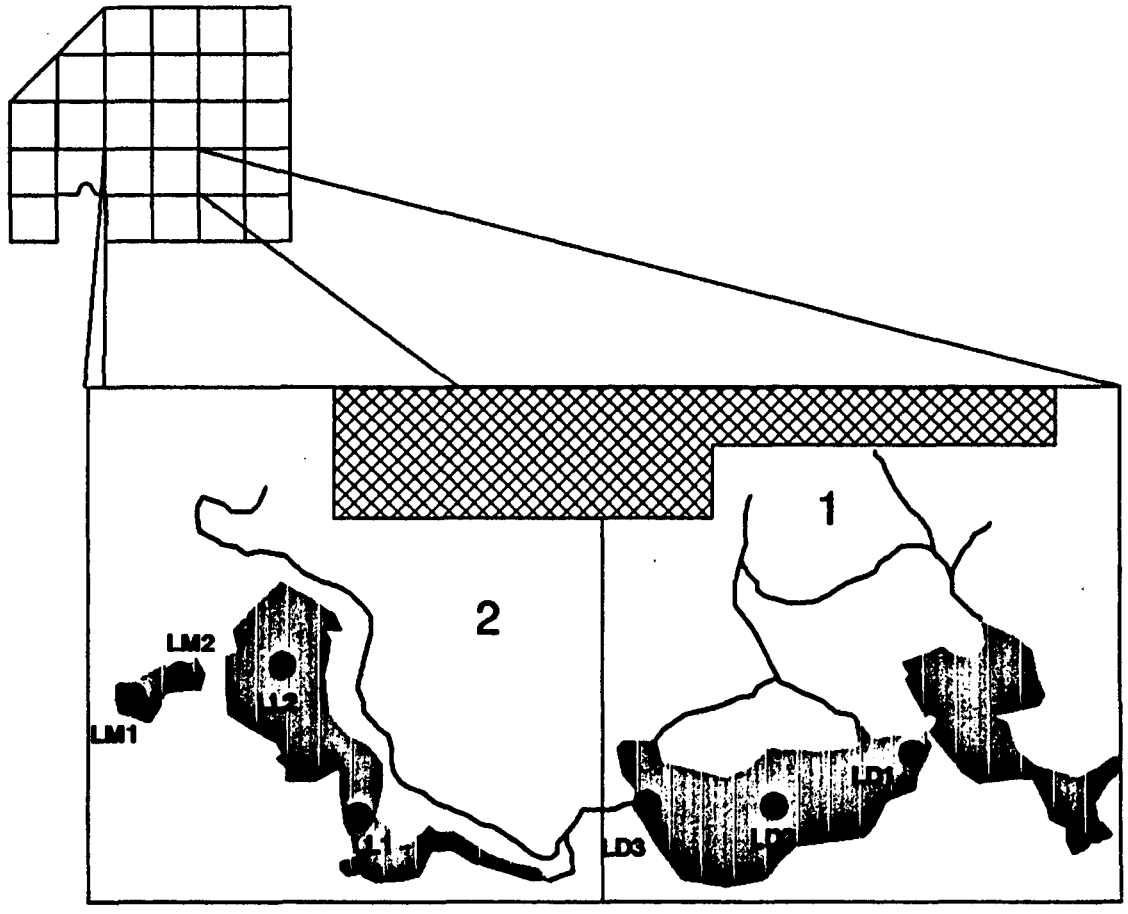


Fig. 44. Location of surface water quality sampling sites during FY92.

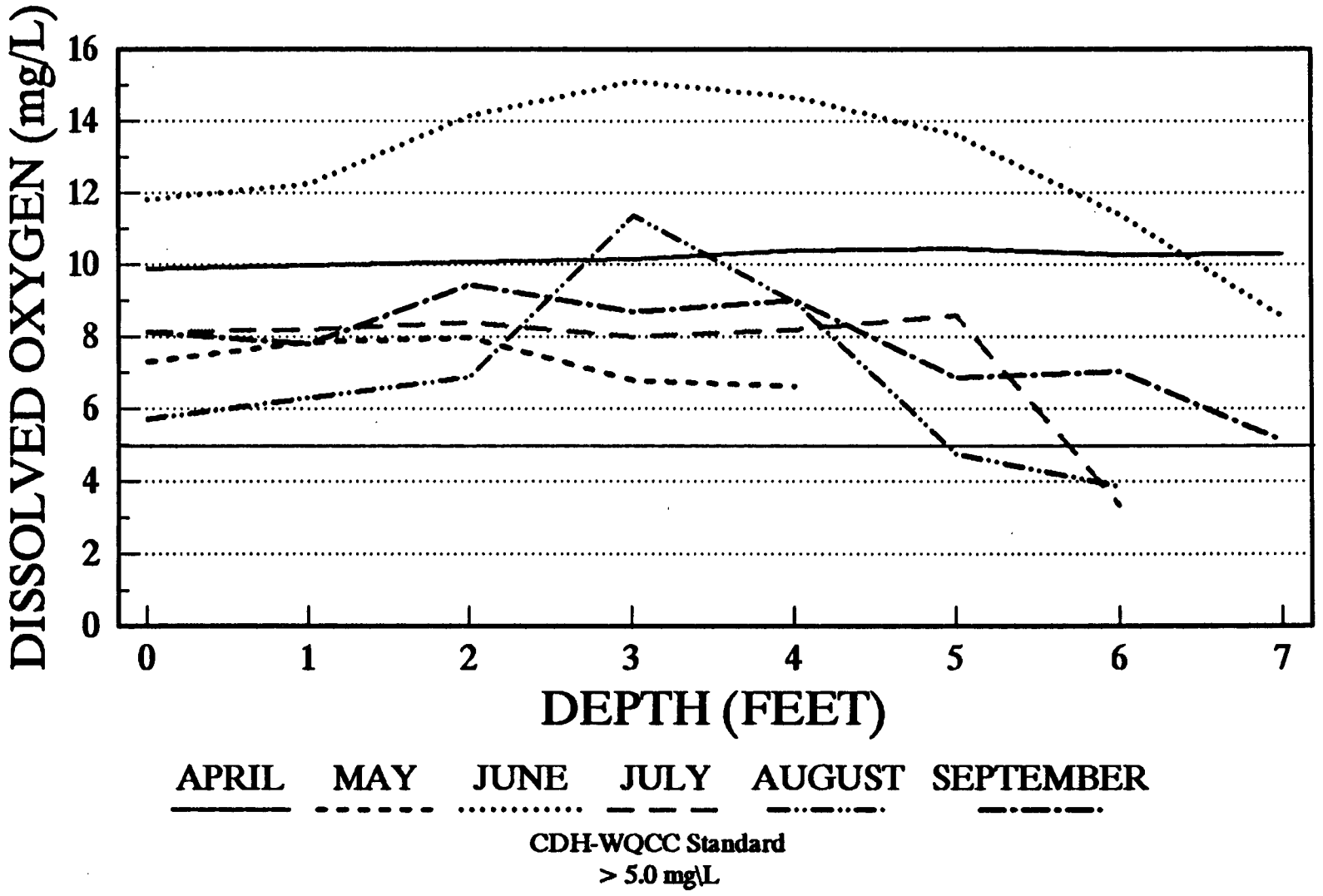


Fig. 45. Dissolved oxygen profiles recorded at site #1 on Lake Mary during FY92.

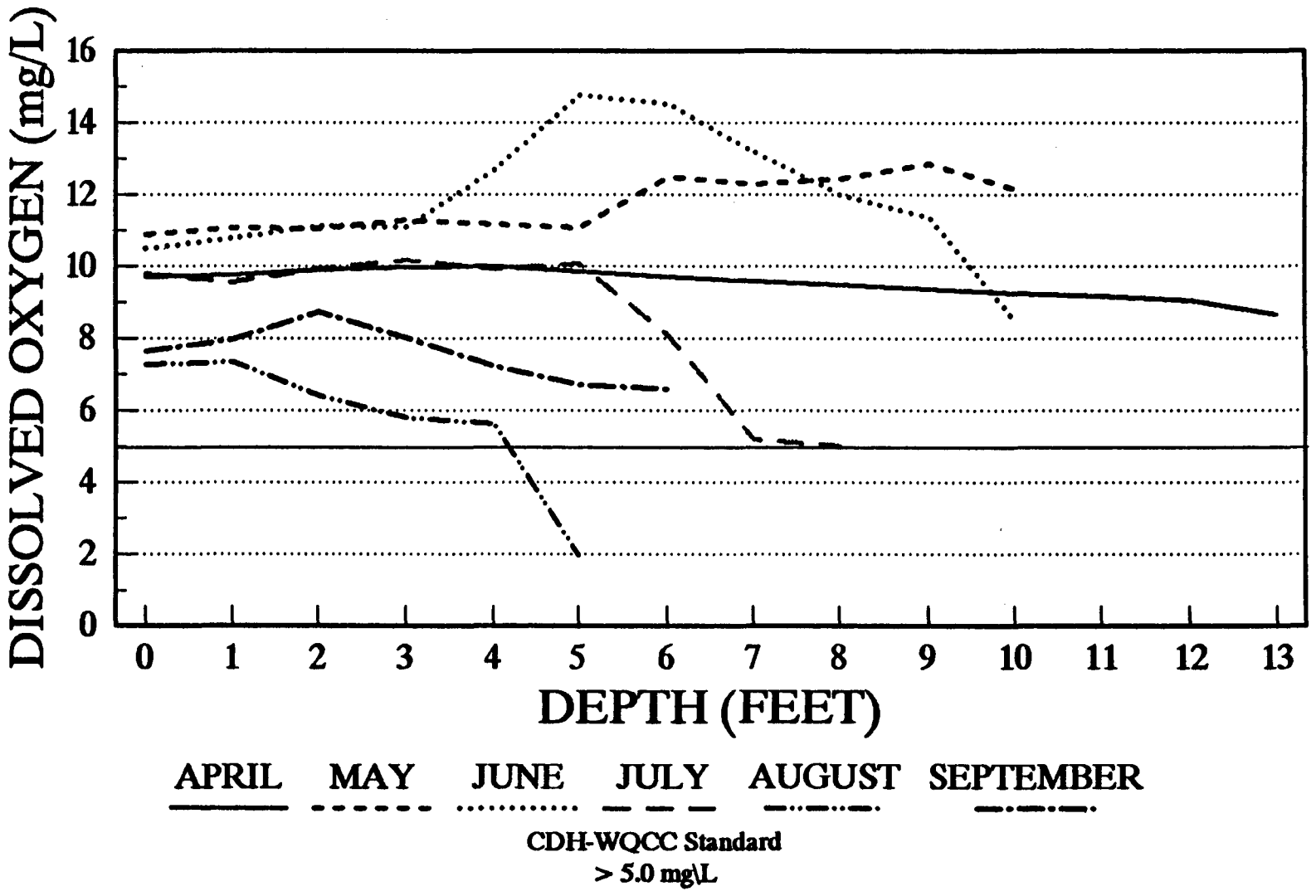


Fig. 46. Dissolved oxygen profiles recorded at site #2 at Lake Mary during FY92.

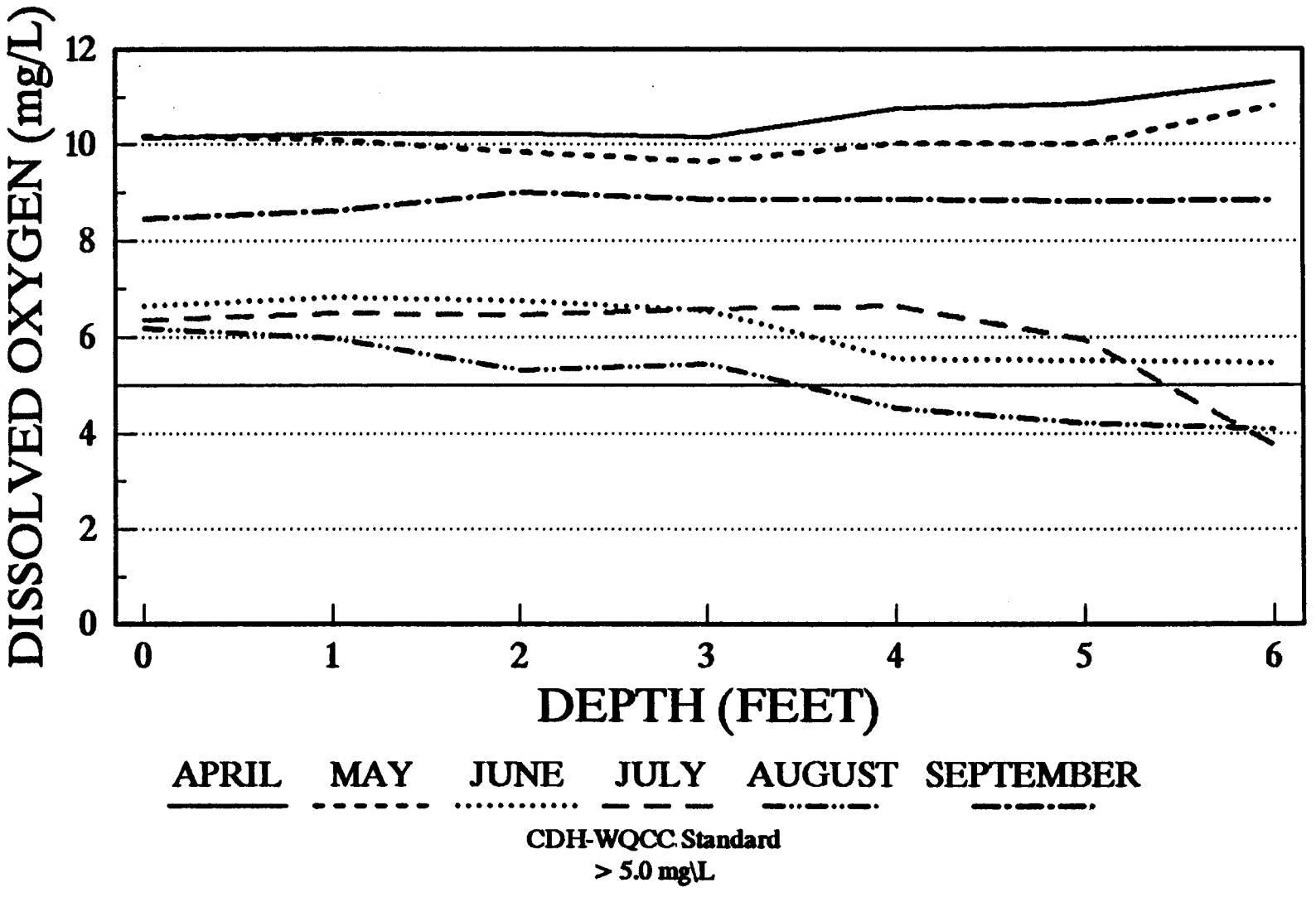


Fig. 47. Dissolved oxygen profiles recorded at site #1 on Lake Ladora during FY92.

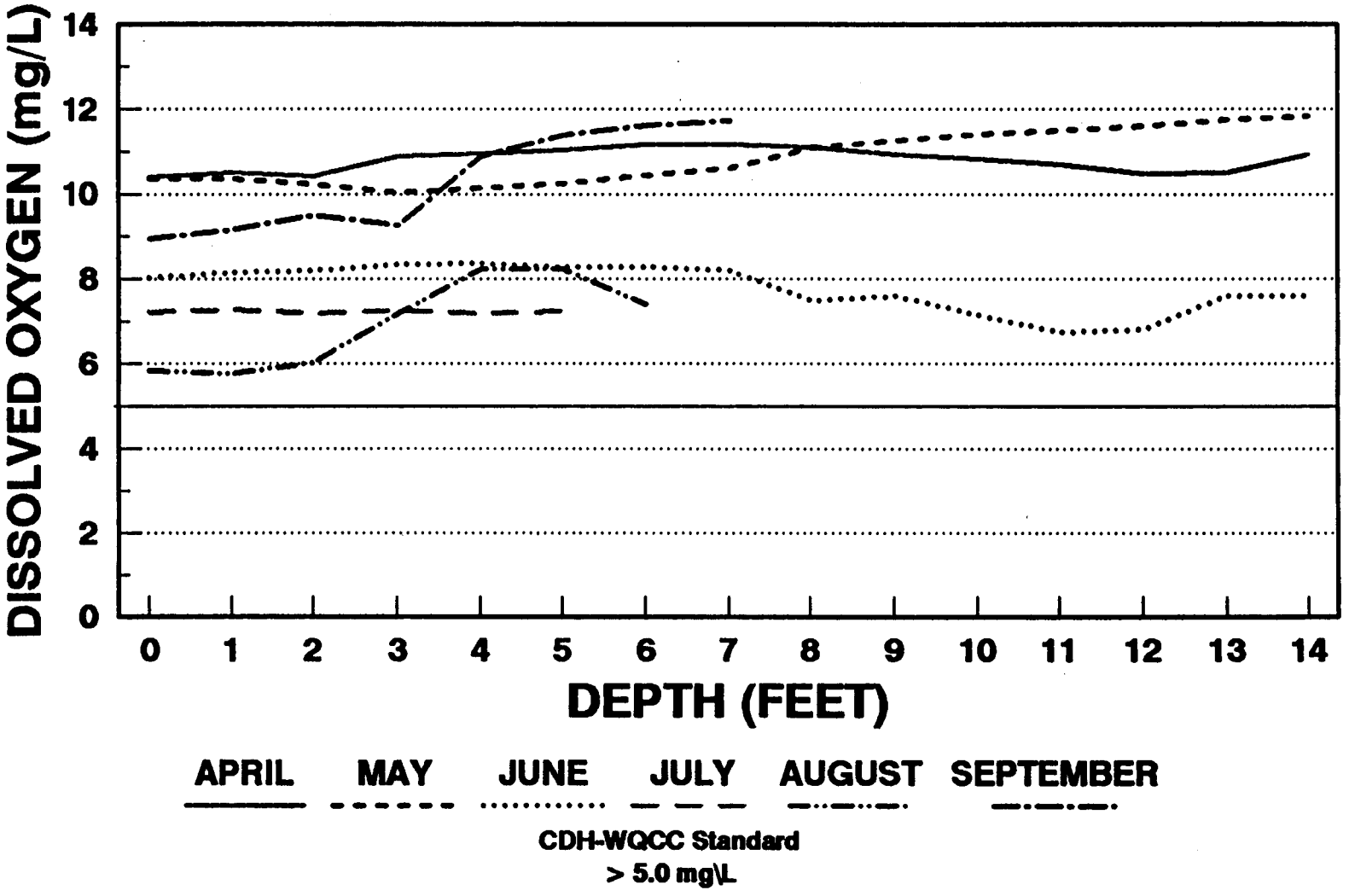


Fig. 48. Dissolved oxygen profiles recorded at site #2 on Lake Ladora during FY92.

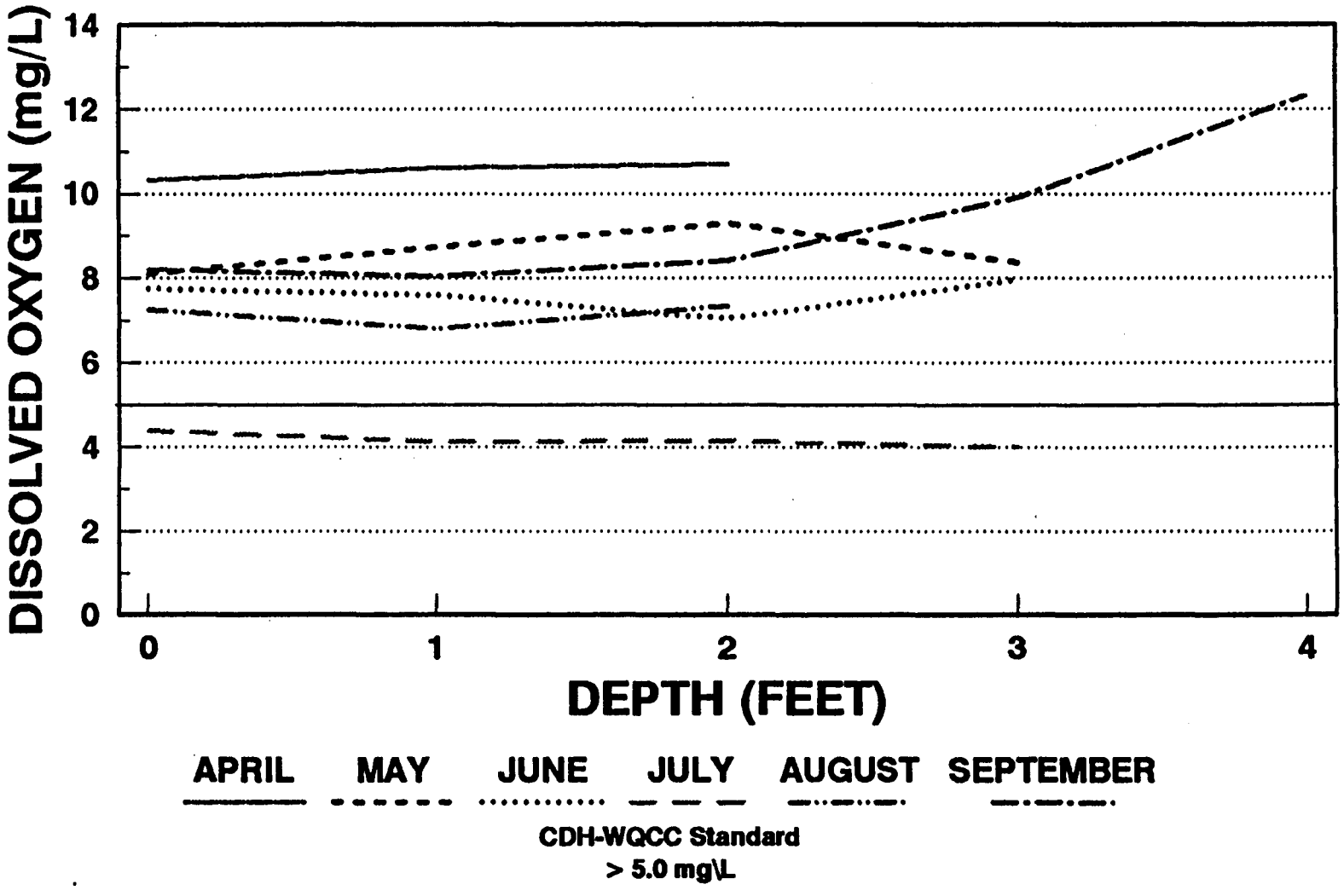


Fig. 49. Dissolved oxygen profiles recorded at site #1 on Lower Derby Lake during FY92.

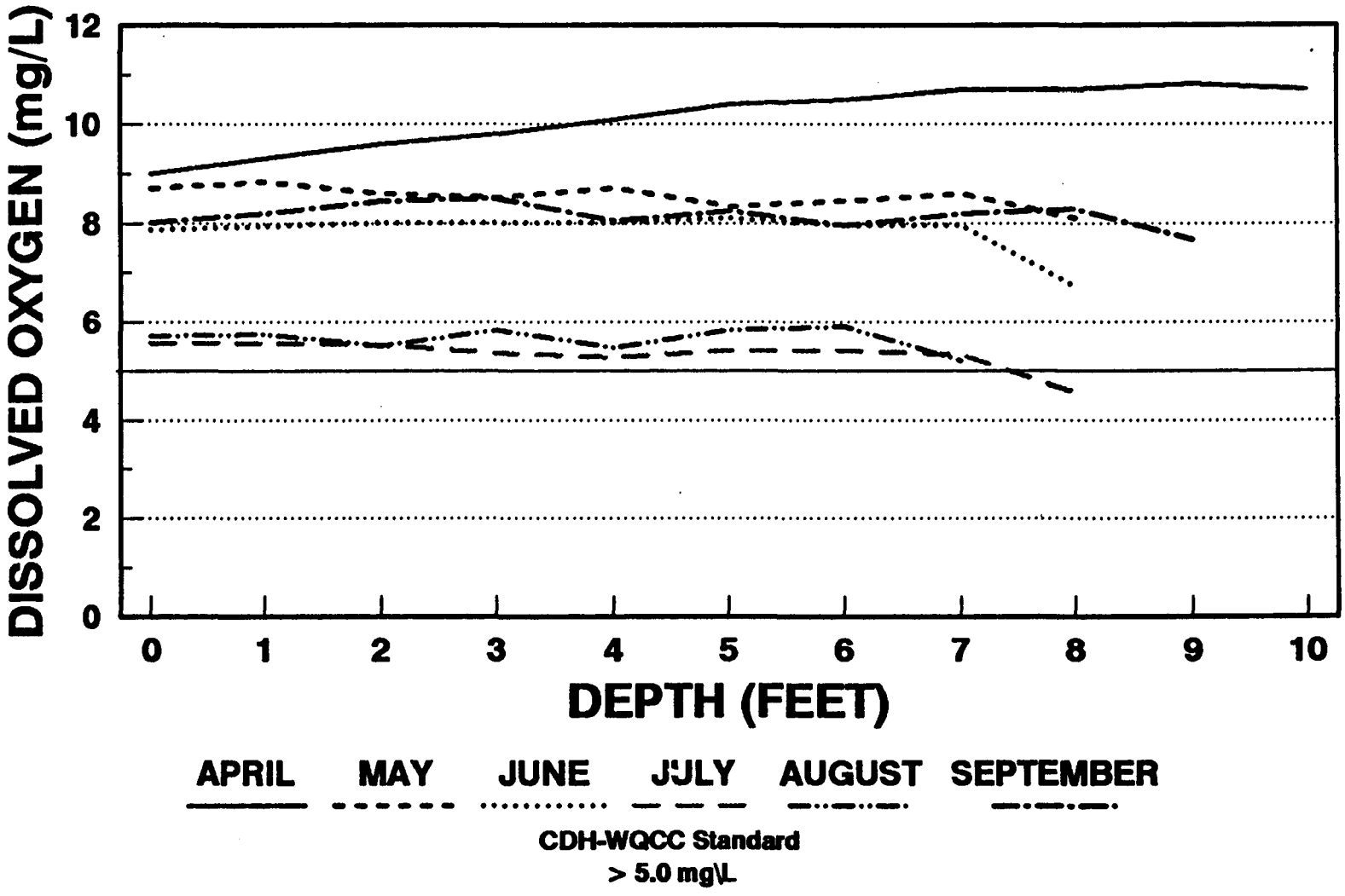


Fig. 50. Dissolved oxygen profiles recorded at site #2 on Lower Derby Lake during FY92.

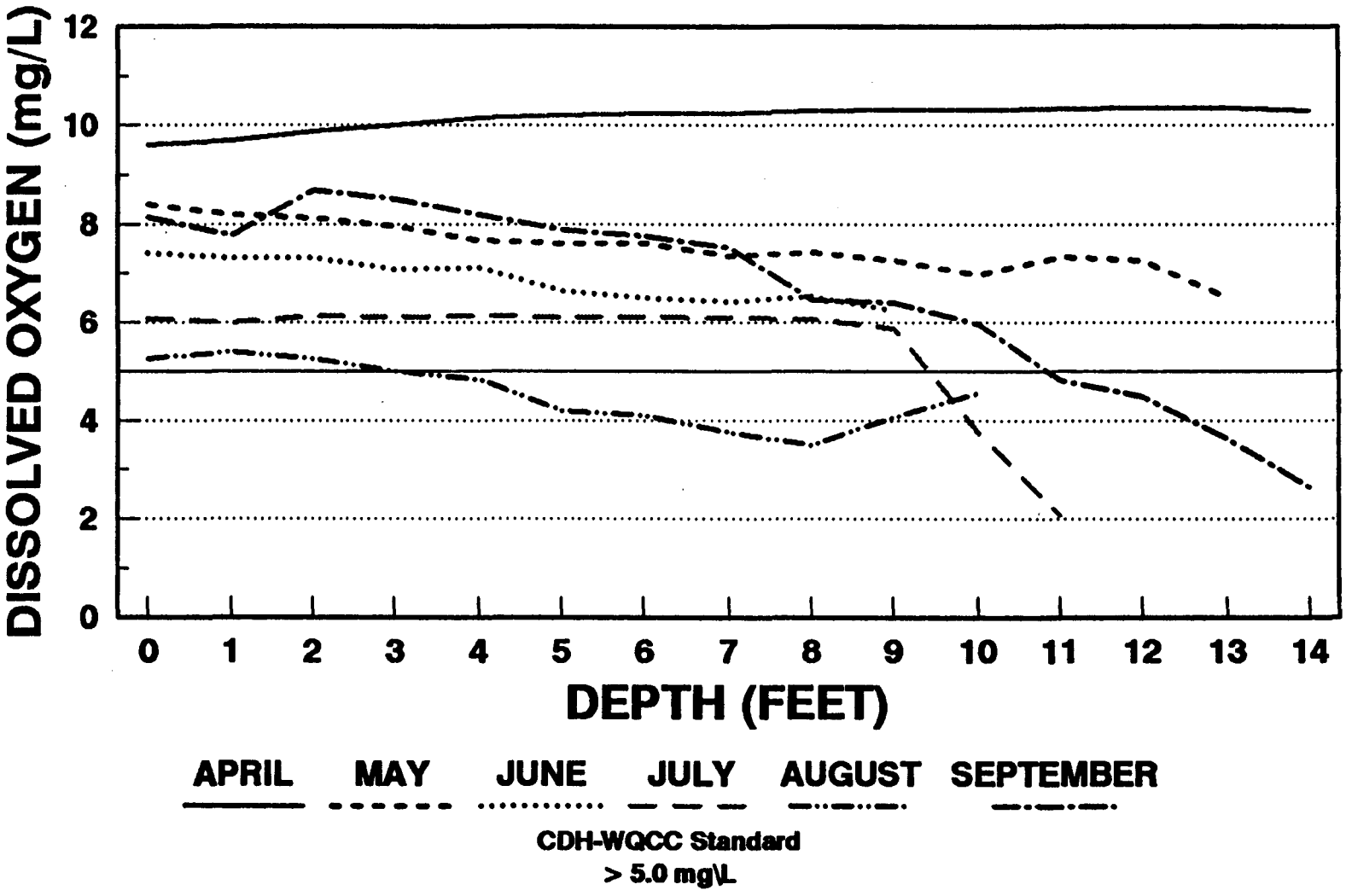


Fig. 51. Dissolved oxygen profiles recorded at site #3 on Lower Derby Lake during FY92.

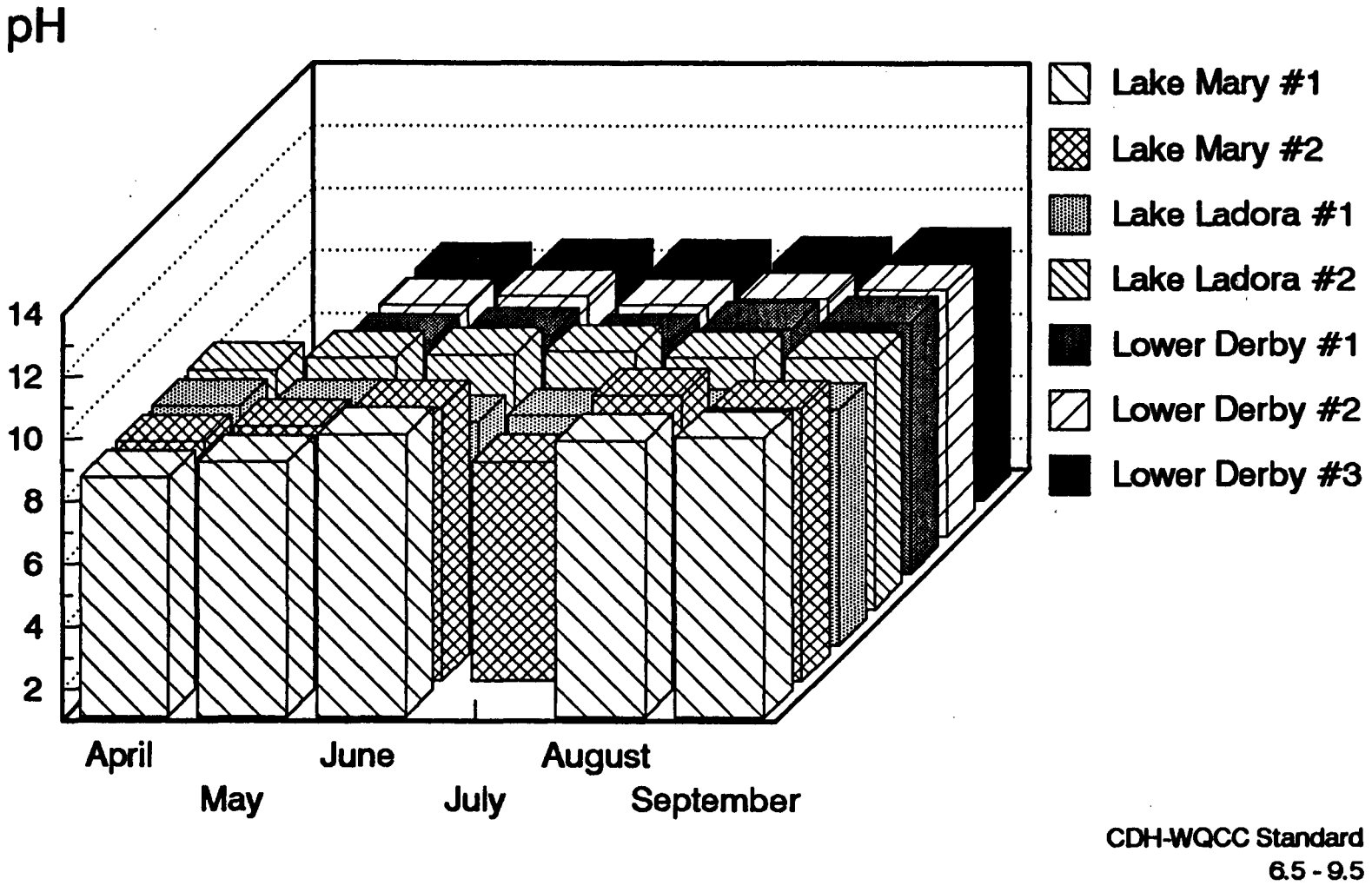


Fig. 52. Surface pH values for the Arsenal lower lakes during FY92.

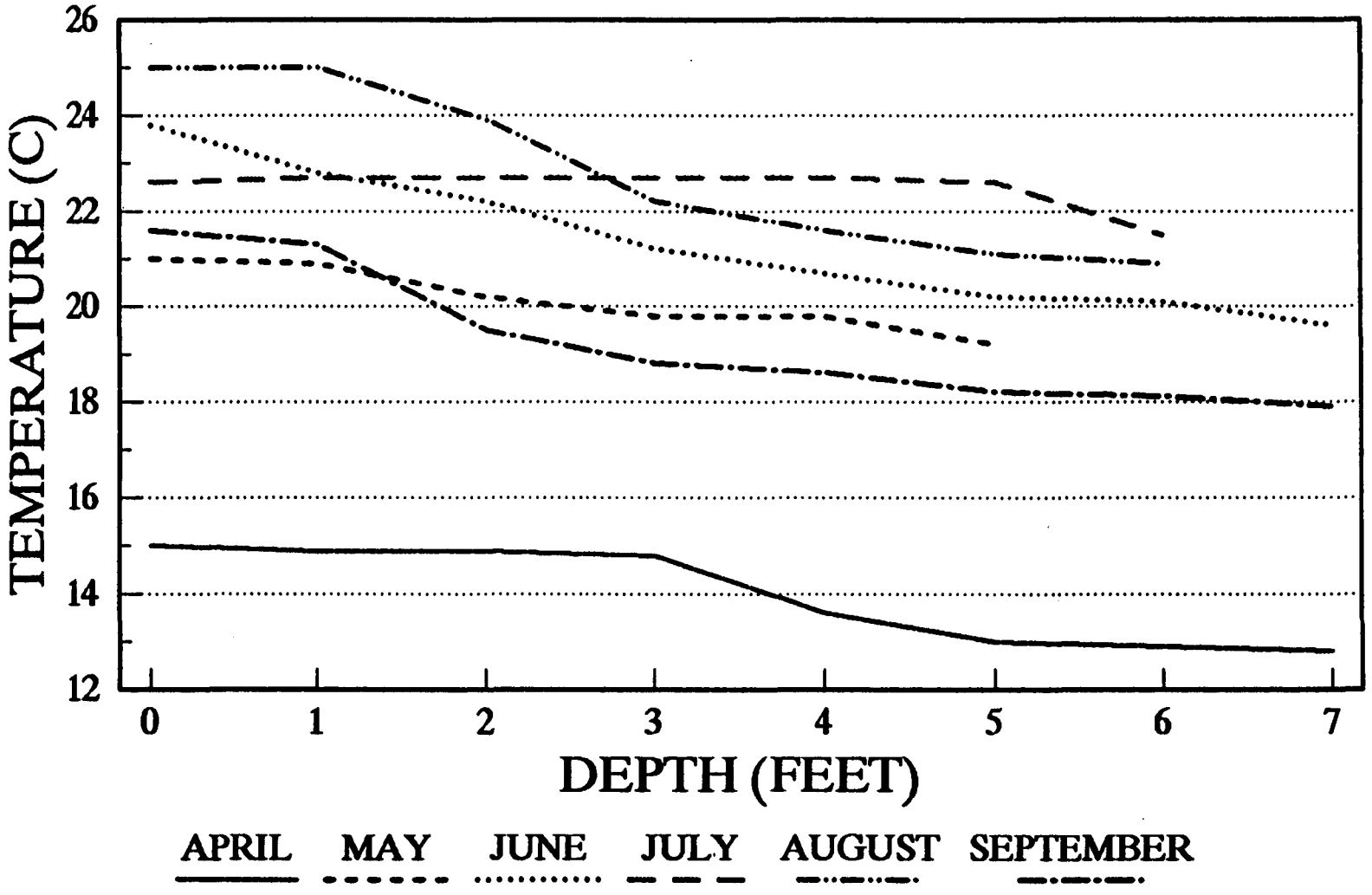


Fig. 53. Temperature profiles recorded at site #1 on Lake Mary during FY92.

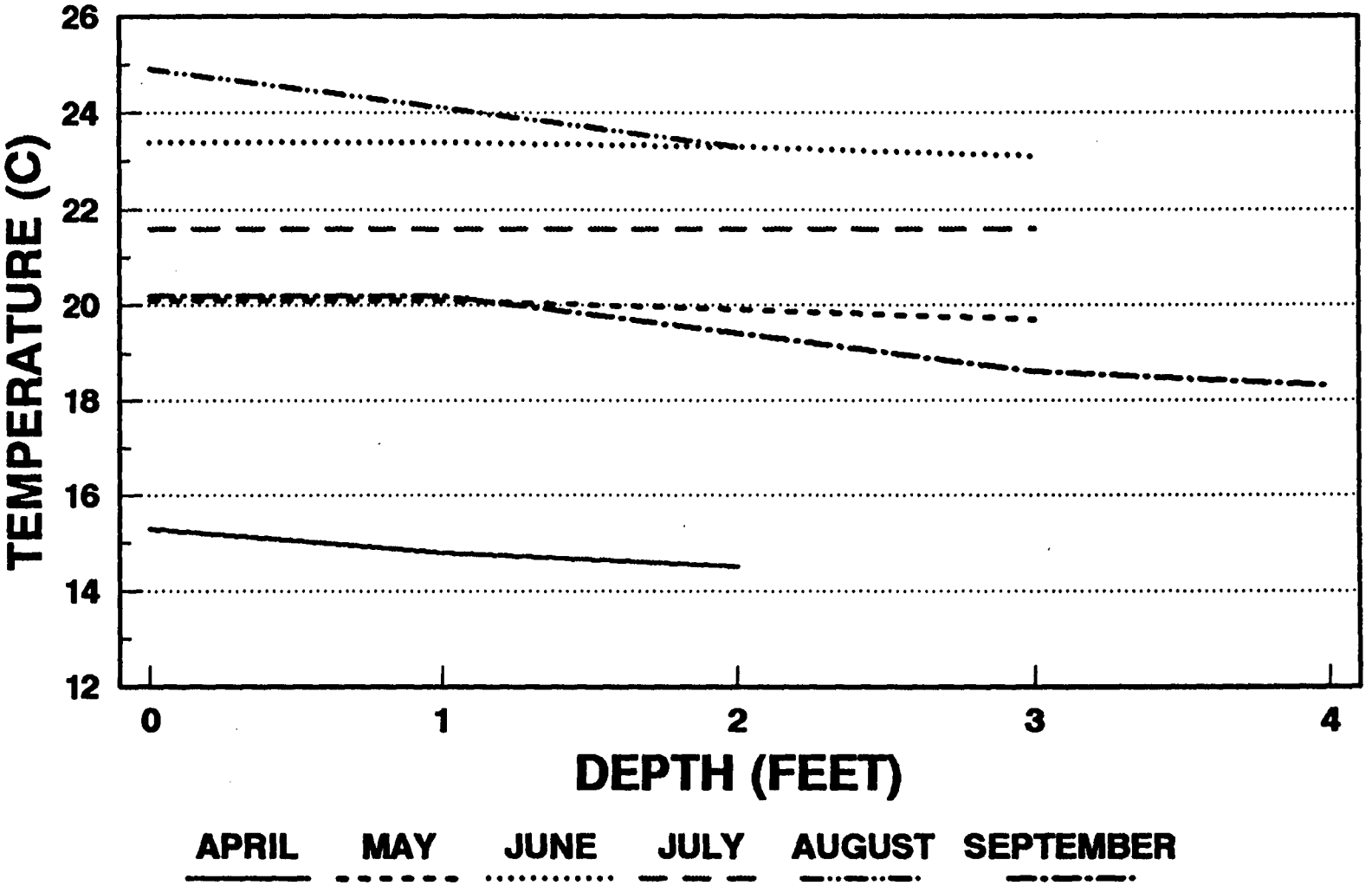


Fig. 57. Temperature profiles recorded at site #1 on Lower Derby Lake during FY92.

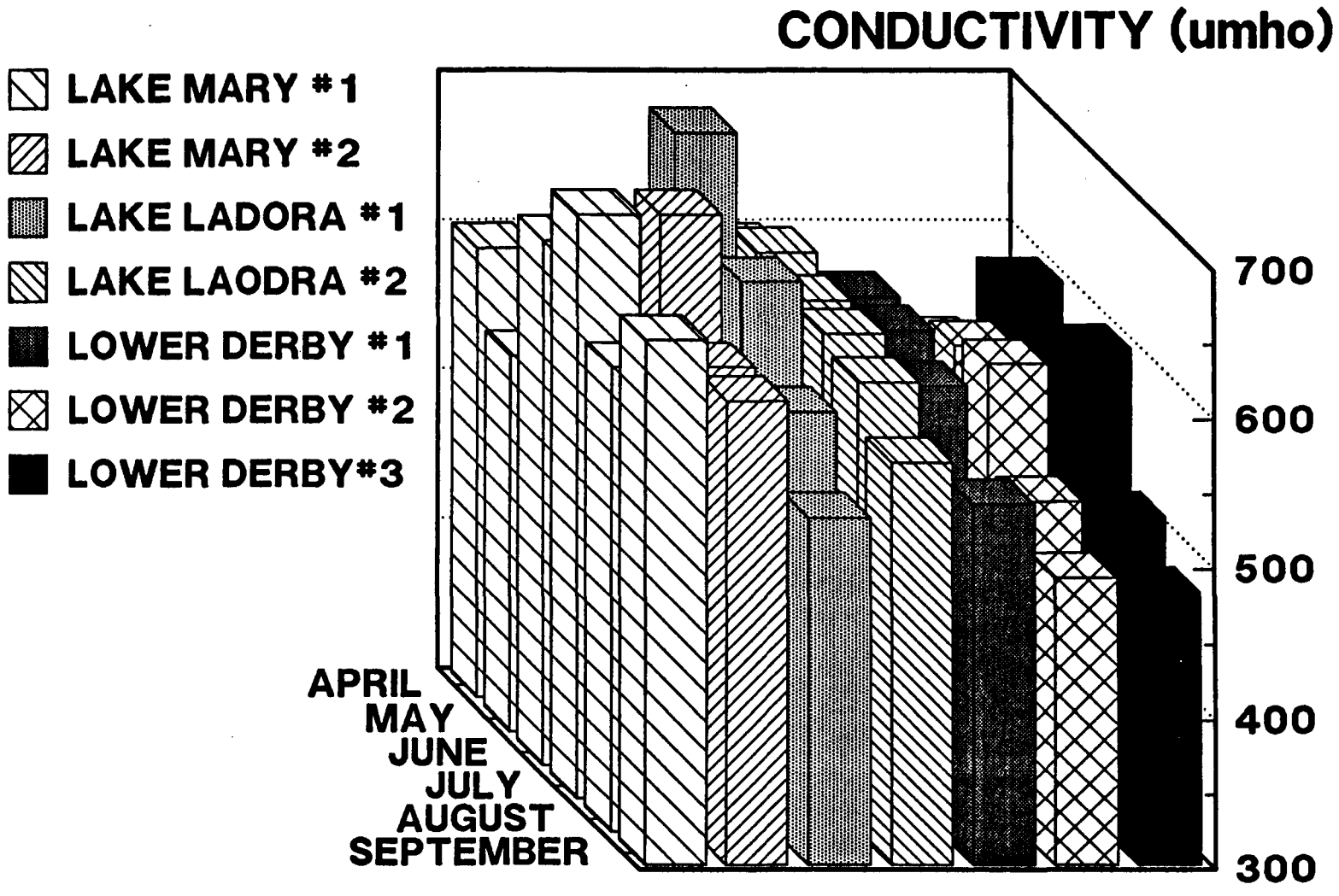


Fig. 61. Surface conductivity values recorded at the Arsenal lower lakes during FY92.

TITLE: Wetlands Monitoring Plan

INTRODUCTION

Five pilot wetlands were constructed during FY91 and FY92. Monitoring plans for water quality, groundwater impacts, and functional wetland success/wildlife use were prescribed as part of an Environmental Assessment for this project. Preparation of a long range management element was deemed appropriate to properly scope and schedule a wetlands monitoring program. Such an effort is needed not only to define a monitoring program for the pilot wetland project, but to direct monitoring efforts for other existing wetlands and for any future wetland construction initiatives.

The objectives for FY92 were to 1) examine information requirements and data needs for development of a wetland monitoring management element, 2) identify responsible personnel, 3) plan development and implementation schedules, and 4) investigate and locate other wetland enhancement locations on the Arsenal.

METHODS

The Service continued to support two wetlands studies for wetlands monitoring: "The creation of wetlands at the Rocky Mountain Arsenal: monitoring the trends and processes of vegetation establishment on short and long term scales and along water table gradients" and "Successional changes and water quality in artificial wetlands at the Rocky Mountain Arsenal." The U.S. Geological Survey (USGS) also worked on this project by monitoring groundwater. Additional methods included discussing biological factors for evaluating wetland projects with wetland construction experts, identifying water quality factors, examining the potential for contracting development and implementation of the management element, examining existing water resources and water drainage problems on the Arsenal to identify locations for other potential wetlands, and locating and developing additional wetlands in Sections 7 and 8.

RESULTS AND DISCUSSION

The Wetland Monitoring Plan is in an early stage of development. The two wetland studies and the USGS project are beginning to provide the necessary water quality, vegetation, and hydrology information to help plan future development of wetlands. In particular, the effects of soil type, decomposition of original vegetation, planting of different wetland vegetative communities, and fluctuations of water level are being examined to predict how and where to construct future wetlands (see annual wetland research reports in Appendix A).

RESULTS AND DISCUSSION

United Engineers and Constructors

The Service worked with UE&C and FM to complete construction and to fill the five wetlands in Sections 7 and 8 in the southwestern portion of the Arsenal during FY92. The U.S. Geological Survey assisted with monitoring the wetlands. Construction of Wetland 1, the largest wetland, was completed by improving the intake of the syphon pumping system and adding riprap to the pumping system outlet. A distribution structure was constructed and minor ditches were trenched in the vicinity of Wetlands 3, 4, and 5 to improve water flow. UE&C supplied each wetland with visual gauges, Parshall flumes, and gauging stations. Water levels were usually maintained at optimal levels for wetland research projects (see Appendix D for description of wetland research). The Service presented John Harper (wetland construction coordinator for UE&C) with an award for his dedication to the project.

UE&C irrigated trees and shrubs in Section 2 (Tasks 19 and 19B), as needed. Some problems resulted from late initiation of watering and from some sites receiving less water than others. Most problems were resolved, and most plants responded well.

Total Terrain

Total Terrain completed construction of the prairie dog barrier along the northwestern and western borders of Section 36 (Task 2) by 23 March 1992. Some problems arose when badgers (Taxidea taxus) dug holes under the fence, allowing easy access for prairie dogs (Cynomys ludoviciana). (Prairie dogs will rarely dig under an object that they cannot see over, through or under, when no coterie members are located on the other side.) Subsequent removal of the few remaining prairie dogs just inside the fence appeared to stop further immigration into Section 36.

Total Terrain fenced approximately 190 shrubs and trees by 22 October 1991 (Task 19) and all of the new trees in Section 2 (Task 19B) by 8 July 1992. Fences were 100% effective in preventing further deer damage to trees and shrubs.

All of Total Terrain's field workers obtained appropriate physicals and OSHA courses during FY92.

Total Terrain planted 440 shrubs within Section 34 in clumps of 40 plants during summer of 1992 (Task 5). All plants were 5-gallon container sized. The following species of shrubs were planted: 80 American plums (Prunus americana), 80 three-leaf sumacs (Rhus trilobata), 80 sand cherries (Prunus bessyii), 80 white snowberries (Symphoricarpus alba), 80 New Mexico locusts (Robinia neomexicana), and 40 rubber rabbitbrush (Chrysothamnus

at Site 5B. Cover by warm season grasses decreased primarily due to a decrease in sand dropseed (Sporobolus cryptandrus) and buffalograss (Buchloe dactyloides). Cover by blue grama (Bouteloua gracilis) increased, however. The moisture regime at this site may be better suited to mixed grass prairie species as evidenced by the increase in cover by western wheatgrass (Pascopyrum smithii) and foxtail barley (Hordeum jubatum). Several species of annual forbs desirable as wildlife forage provided considerable cover and resulted in an increase in diversity at the site. These included sweetclover, spear orache (Heriatriplex hastata), kochia, and white pigweed. As with Site 5A, caution is raised by the increase in cover by Canada thistle in 1992 over 1991.

Data were not collected for Site 5C. However, a visual inspection revealed a diversity of seeded grasses at this site.

Site 6 East continues to support a monotypic stand of western wheatgrass which contributes about 77% of the total vegetative cover of 53%. Cover by perennial and annual forbs decreased at the site resulting in a decrease of total vegetative cover compared with previous years. Plant species diversity also decreased and is low at a mean of 2.8 species per transect. Prairie dogs are using the area which will likely result in an increase in species diversity, as adventive species move into areas disturbed by prairie dogs.

Site 6 West supports a more diverse community, even though it has been managed to promote establishment of western wheatgrass similarly to site 6 East. Cover by western wheatgrass, as well as species diversity, increased at this site compared to 1991. Cover by annual forbs, especially kochia and Russian thistle (Salsola iberica), decreased significantly from 46% in 1991 to 16% in 1992. Cover by cheatgrass increased dramatically from 3% in 1991 to 28% in 1992. There was no change in total vegetative cover.

Site 7A continues to support a diverse grassland community. Perennial grass cover is somewhat lower than in 1991, but continues to be high. Annual forb cover also decreased in 1992 primarily due to a decrease in cover by kochia. Annual grass cover increased due to an increase in Japanese brome (Bromus japonicus). Species diversity also increased at this site in 1992. Cover by perennial grasses was somewhat lower in 1992, but cover by vegetative litter was considerably higher. This may indicate that standing biomass is beginning to inhibit plant production, and that controlled burning should be considered in management plans.

Site 7B continues to develop. Cover by cool season perennial grasses decreased due a decrease in cover by slender wheatgrass (Agropyron trachycaulum), a short-lived species. Cover by annual

grasses also decreased. Cheatgrass and Japanese brome together contributed less the 1% cover combined. Warm season grasses, especially sand dropseed, increased in cover, as did annual forbs, especially kochia. Total vegetation cover and species diversity also increased at this site in 1992.

The needle-and-thread harvest area is relatively unchanged from 1991. Annual forbs and species diversity increased. This increase should not affect the management goals for this site.

The Ladora Test Plots and the Section 29 Test Plots were not developed enough to initiate monitoring during FY92.

Facilities Maintenance

FM was unable to seed the designated disturbed areas during FY92. This activity was rescheduled for spring of 1993.

Service

The Service implemented the last of the FY92 technical plans (Appendix D, Tech Plan 25) by installing four barn owl nest boxes. The nest boxes were not monitored because their late placement precluded use by barn owls during FY92.

Miscellaneous

The Service provided guidance and recommendations to Army and contractors on a variety of other projects such as seeding the Boundary Treatment Systems and the Off-Post Operable Unit, removing and replacing trees at Building 111, developing vegetation displays in Building 111, and using shrubs on parade floats. The Service also provided Army with a draft policy statement for working with the Service on habitat alterations. Most significantly, the Service detailed Arlene Tortoso to Army for assistance in soils-related projects. Army and Service employees worked together to partially mitigate tree removal through construction of brushpiles in Section 5.

The Service developed a program for documenting and mapping impacts to wildlife habitat on the Arsenal and the efforts that have and will mitigate those impacts. Several maps of past and potential mitigation projects were produced. This program converted into a more comprehensive approach through the Habitat Assessment project.

The Service continued a mitigation and conservation photography program. Detailed record-keeping accompanied the photography. Plans for construction of the West Gate Parking Lot and preventing raptor electrocutions on the Arsenal was coordinated by the Service. The Service's scope of work on raptor

electrocution was not funded by Army during FY92 due to lack of funds.

The Service worked on further planning of the Eagle Watch and Visitor Center areas in Sections 5 and 2 respectively. Phases 2 and 3 of Technical Plan 4B were written and processed for upgrading the facilities at the Eagle Watch. The Service also wrote the plan for Phase 4 plan for planting 400 shrubs north of the blind; the shrubs would partially mitigate for Lower Derby Dam Spillway and also provide a living snow fence for the Eagle Watch.

The Service provided tours of mitigation projects to a variety of audiences. Most notable were representatives of Service Refuge staff, the National Wildlife Federation, MK, the Office of Surface Mining, the High Altitude Revegetation Workshop participants, and the Denver Botanical Gardens. The Denver Botanical Gardens has since agreed to provide thousands of shrub seedlings to the Service for mitigation projects beginning in FY93.

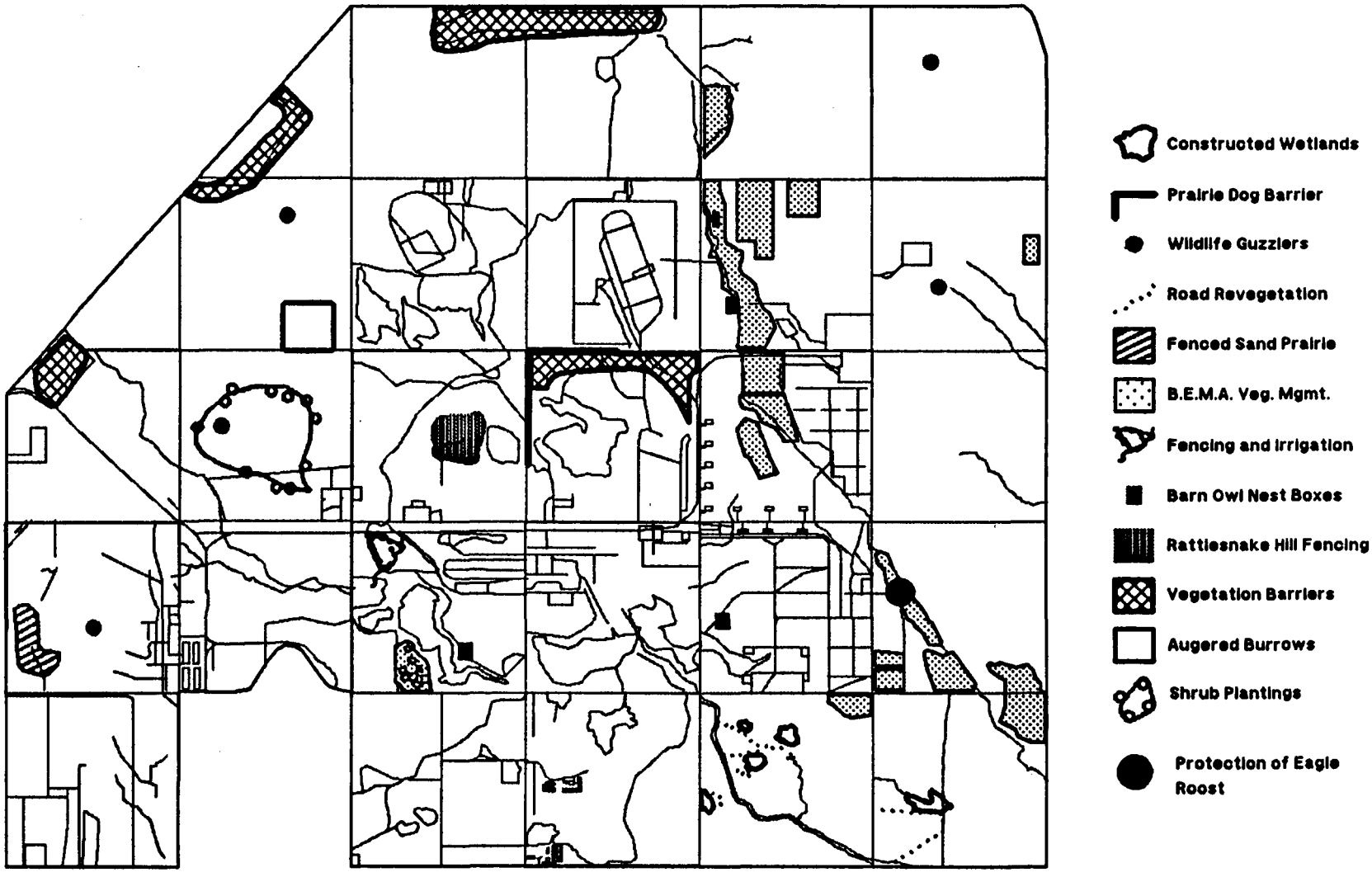


Fig. 62. Locations of mitigation projects on the Arsenal during FY92.

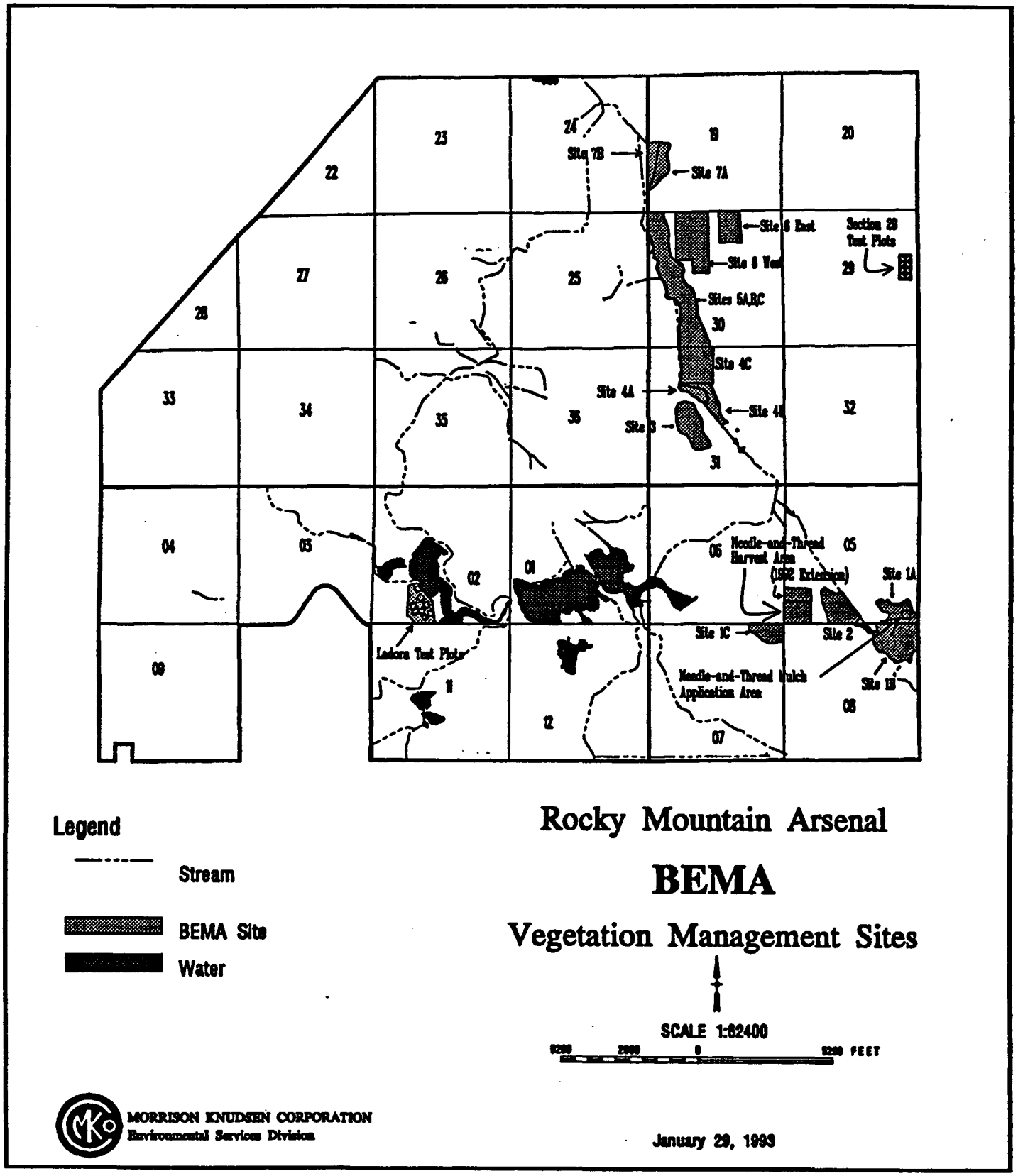


Fig. 63. Locations of habitat restoration projects for the Bald Eagle Management Area on the Arsenal from 1989 through 1992.

TASK 6 - LAW ENFORCEMENT

TITLE: Law Enforcement

INTRODUCTION

When the Conservation Agreement between the Service and the Army was revised in 1991, law enforcement responsibilities of the Service at the Arsenal were increased. Responsibilities included assisting the Program Manager's police force with situations involving fish and wildlife, conducting internal reviews for staff and the Arsenal's police force, and assisting with public use activities on-post.

OBJECTIVES

1.) Conduct internal review of Service/Army programs and security measures at the Arsenal to provide recommendations on means of minimizing poaching activity.
2) Provide appropriate introductory training to Service and Army Security personnel regarding potential poacher contacts, safety, surveillance, reporting, safeguarding evidence, etc.
3) Provide Arsenal Service staff with appropriate investigative and arrest authority.

METHODS

During FY92 two Service employees with law enforcement authority were assigned to the Arsenal. Two additional staff members were sent to the Federal Law Enforcement Training Center in Georgia.

RESULTS

A total of four Service employees had refuge law enforcement authority during FY92. These officers are responsible for enforcing, among other things, the Endangered Species Act, the Migratory Bird Treaty Act, and the Eagle Protection Act.

The Arsenal is presently being "managed as if it were a refuge". Therefore, the Code of Federal Regulation, Title 50, subchapter C - The National Wildlife Refuge System could, and should be adopted by the Service for use on the Arsenal. Title 50 is the regulation giving the Service authority to enforce wildlife and public use laws and regulations on the Arsenal.

TASK 7 - COMMUNITY RELATIONS

TITLE: Community Relations and Public Use Program

INTRODUCTION

The primary goals of the Community Relations and Public Use Program are to inform and educate people about Arsenal fish and wildlife resources, history, and cleanup activities. Since the program began in late October 1989, more than 100,000 people have visited the Arsenal and an additional 50,000 have learned about the site's unique natural and cultural history through programs in the community. Community Relations programs include: wildlife tours, environmental education programs, special events, the Eagle Watch wildlife viewing area, Arsenal Visitor Center, interpretive trails, off-site slide presentations, public aspects of the Arsenal fishing program, field dog trials, answering requests for information, community outreach, a volunteer program, and cooperative projects with the Denver Museum of Natural History, Colorado Division of Wildlife, and Colorado Wildlife Federation.

During FY92, 54,664 people participated in Community Relations programs (Table 50). These programs were made possible, in part, by an active corps of volunteers who contributed almost 7,000 hours in FY92. An additional 19,370 people participated in FY92 programs, compared to FY91 (Table 51), an increase of 55 percent.

Wildlife Vehicle Tours

The goals of the tour program are to provide opportunities for children and adults to learn more about Arsenal cultural and natural history and provide urban Denver residents with a site to observe, increase awareness about and appreciate wildlife. Tours for school groups are offered Monday through Friday during school hours and last between one and two hours, depending on student grade levels. Public tours are offered on Saturdays and Sundays at either 8:00 am, 2:00 pm or 6:00 pm, depending on the time of year. Special tours for senior citizens, conservation organizations, photographers, and other groups are scheduled as requested. All tours require advanced reservations. Most tours include a short interpretive program in the Visitor Center, and some include an eight-minute video. Double-decker buses are used for most tours.

Table 50. Summary of Fiscal Year 1992 Community Relations programs and visitation.

ACTIVITY	ADULTS	CHILDREN	TOTALS
Wildlife tours	8,900	23,854	32,754
Public	5,638	3,742	9,380
Schools	2,126	19,997	22,123
Other	1,136	115	1,251
Field Programs	302	2,785	3,087
Eagle Watch	4,075	1,040	5,115
Special Events	7,475	3,906	11,381
Fishing Events	61	76	137
Field Dog Trials	686		686
Presentations	726	673	1,399
School	15	254	269
Other	711	419	1,130
Nature Walks	73	33	106
TOTALS	22,302	32,362	54,665

Table 51. Comparison of FY91 and FY92 Community Relations programs and visitation.

ACTIVITY	FY91	FY92
Wildlife tours	21,000	32,754
Field Programs	214	3,087
Eagle Watch	3,000	5,115
Special Events	7,000	11,381
Fishing Events	85	136
Field Dog Trials	890	686
Presentations	3,000	1,399
Nature Walks	105	106
TOTALS	35,294	54,664

During FY92, staff and volunteers led 701 school, public, and special group wildlife vehicle tours of the Arsenal. Volunteers led 61% of the total tours offered. Of the 32,754 people who toured the Arsenal in FY92, 23,854 (73%) were children and 8,900 (27%) were adults (Table). School tours made up the majority (67%) of tour visitors, serving 22,123 people, including 19,997 children and 2,126 adults. Twenty-nine percent of the total number of tour visitors went on public tours, with 9,380 people (3,742 children and 5,638 adults). Special groups made up the remaining four percent of tour visitors, with 1,251 total people (115 children and 1,136 adults).

The tour program continues to be our largest public visitation program, reaching 11,750 more people than were reached in FY91, a 56% increase (Table 51).

Environmental Education Programs

The Arsenal environmental education program includes field trips from nearby schools for tours and field-based programs, teacher workshops, the Summer in the Wild program, projects for Cooperative Education Students, special programs with target schools, and education projects with the Denver Museum of Natural History.

Field Program

The first field-based environmental education program was developed for students in grades kindergarten through eight in August and September of FY91. This hands-on, 2.5 hour program included an introductory video or discussion about urban wildlife through the Close to Home exhibit in the Visitor Center, a short nature hike or bus tour, a lesson about adaptation using animal parts, and several Project WILD and other games which stressed habitat issues and environmental ethics.

During August and September of FY92 a new field-based program was developed for students in grades Kindergarten through eight. This program included a historical lesson in the Visitor Center focusing on past human activities, contamination, future cleanup and habitat restoration efforts at the Arsenal. The historical activity was followed by a 1.5 hour field trip with the theme of habitat change at the Arsenal. Students learned to recognize signs of habitat change in the prairie ecosystem and its effects on wildlife. They developed skills for doing biological field work through a role playing exercise and habitat scavenger hunt. They recorded observations of wildlife and plants, and learned how to use hand lenses, insect nets, and other equipment.

During FY92, 96 field programs were offered to 2,785 students and 302 teacher and parent chaperons. Students came from Adams, Arapahoe, Denver, Jefferson, and Boulder Counties.

Project WILD Workshops

Two Project WILD teacher workshops were held at the Arsenal, one on 28 March for inner city middle school teachers and another on 26 June 1992. Twenty and 16 people, respectively, attended these workshops. All workshops were developed cooperatively with the Regional Office and Colorado Department of Education. Another workshop, planned for September, was canceled. In the future, we plan to develop Arsenal-specific teacher workshops.

Denver Museum of Natural History Teacher Activity Guide

Work continued on the Denver Museum of Natural History Rocky Mountain Arsenal Teacher Activity Guide during FY92. Service and Army staff spent considerable time with the Guide's author, providing information and answering questions. The guide will be complete in Spring 1993.

Denver Museum of Natural History Eagle Book

Service staff reviewed text and artwork for technical accuracy for the **Eagles, Hunters of the Sky** book, part of the Wonder Series. The book includes information about the Arsenal bald eagles.

Summer Program

Service and Colorado Wildlife Federation staff joined forces to offer a four-week July summer program to children from the neighboring recreation centers in Montbello, Commerce City, and Aurora. The program was called "Summer in the Wild." For one morning each week during the month of July the students were transported to the Arsenal to learn more about wildlife, habitat, and environmental issues. Participants ranged from grades 3 through 6 and included 18 from Commerce City, 25 from Montbello, and 64 from Aurora.

During the first week students were introduced to the Arsenal with a slide program and tour and learned how to use binoculars and keep a journal. The second week focused on Arsenal habitats including wetland, woodland and grassland. Students played habitat bingo, developed tree bark rubbings and a plant key, and assisted with native plant seed collection. The third week explained predator/prey relationships with a puppet show, prairie dog censusing, and a presentation with a live great-horned owl. The final week explored environmental concerns, putting Arsenal issues in a global context. A picnic lunch and presentation of books, fanny packs, and certificates completed the program.

Coop Education Students

Rory Carpenter, a Cooperative Education Student from Grambling State University, began his first coop assignment in September at the Arsenal. Rory assisted the education staff in developing resource materials, kits, and handouts for tours and environmental education programs. Rory also answered routine questions from visitors, conducted tours and educational field programs for school groups, and assisted with special events. Lisa Murphy, another coop student, assisted with Community Relations programs for two days per week during June.

During the spring of 1992, Service staff worked cooperatively with Adams City High School to develop a pilot education program for students to visit the Arsenal during the 1992-1993 school year. A tour of the Arsenal was conducted for science teachers to plan field programs for students, complimenting existing school curriculum. A more in-depth teacher orientation was planned for FY93 to

introduce teachers to biological studies conducted by the Service on-site and discuss accessibility issues.

Special Events

Several special events were held during FY92, including Bald Eagle Day on 11 January, Spring into the Wild Day on 11 May, Colorado Wildlife Federation Annual Meeting on 16 May, and the Wild Things Where I Live Art Contest Reception and Open House on 26 September. Service staff also hosted several fishing events (see Fishing Program) and assisted Army with the Fiftieth Anniversary Open House for former Arsenal staff and residents. A total of 11,381 people attended Service-sponsored special events during FY92.

Bald Eagle Day was a huge success, attracting over 10,000 visitors. Unfortunately several thousand people were turned away because we could not accommodate them. Despite this problem, the Public Relations Society of America awarded the event their silver medal. Attractions included: a bird house building contest for children, tours, slide programs by wildlife experts and middle school students, environmental education games, casting demonstrations, conservation group booths, live birds of prey, visits to the Eagle Watch, free calendars and free refreshments. Good weather, advance advertising and help from Army, Shell, and all Service staff contributed to the success of the day.

The spring event, called "Spring into the Wild," attracted 2,000 visitors and featured similar attractions. The fall event, an open house and reception for the "Wild Things Where I Live" Art Contest, attracted 700 contest participants and families.

Eagle Watch Wildlife Viewing Area

The Eagle Watch Wildlife Viewing Area overlooks a bald eagle winter roost on First Creek near the eastern border of the Arsenal. The facility accommodates twenty people comfortably and is the only developed site for viewing eagles in the Denver area. Since first opening in the winter of 1989/90, the Eagle Watch improved in many ways, including major facility modifications and accessibility improvements, addition of a closed-circuit video camera, microwave audio system and television monitors, a new kiosk and interpretive signs, and improvements in volunteer management and training. The video camera presented considerable challenges and was operational approximately 40 percent of time. When the weather was cold the iris did not work properly. When the camera was operational, it made visits to the Eagle Watch very exciting since it offered close-up views of eagles. Considerable effort was made to link KCNC-TV to the camera but technical difficulties prevented this link.

The Eagle Watch was open daily from 3:00 p.m. to dusk and Saturday mornings from 6:30 a.m. until 8:00 a.m. between 7 December 1991 and 15 March 1992. During FY92, 5,115 people (1,040 children and 4,075 adults) visited the Eagle Watch. Volunteers staffed the Eagle Watch 98% of the time in FY92 and took pride and ownership in its efficient operation.

Visitor Center

The Rocky Mountain Arsenal Visitor Center is the former Army officers' club. Improvements have been made each year to the building since its first use as a Visitor Center in January 1990. This year plans were developed by the Army to make the restrooms wheelchair accessible, create a separate conference room, and remove all equipment from the kitchen to convert the room to more useable space. Service staff contracted with the exhibit designer to reduce amount and enlarge type-size on exhibit text, create protective cases for animal mounts, and create some interactive and audio portions for existing exhibits. The Visitor Center was closed for portions of the year in anticipation of remodeling work, originally scheduled to start in August.

From December 1991 through mid July 1992, the Denver Museum of Natural History's **Close to Home** urban wildlife exhibit was on display in the Visitor Center. The exhibit was a valuable resource for the field programs and tour participants because the displays illustrated how and where wildlife can be found in urban areas. The exhibit generated student discussion about generalized and specialized species, various habitats, and wildlife survival. A skunk, fox, barn swallow, raccoon, great horned owl, and magpies were featured in various urban settings. Other display panels included lighted photos of other urban wildlife in their urban habitats.

The Visitor Center has always been a multipurpose facility for meetings, tours, education programs, Project WILD workshops, fishing permit sales, volunteer training, and special events. The National Park Service used the Visitor Center for an interagency Wayside Exhibit Training in February. Colorado Wildlife Federation held their annual meeting at the Visitor Center in May. Bald Eagle Day on 11 January, Spring into the Wild Day on 11 May, summer fishing events, and "Wild Things Where I Live" Art Contest Reception and Open House on 26 September 1991 are some of the events which took place at the Visitor Center. The following groups used the Visitor Center for meetings: U.S. Fish and Wildlife Service (Arsenal and Regional Office), U.S. Army, Arsenal contractors, U.S. Geological Survey, Shell Oil Company, and the Colorado Forestry Association.

Volunteers assist Service staff at the Visitor Center with various duties. Their main responsibilities include answering

the tour phone, scheduling tour reservations, and greeting visitors. They also set-up chairs, tables, and video equipment, performed minor maintenance, and assembled school packets.

Colorado Division of Wildlife

Service staff provided comments for the final drafts of the Colorado Division of Wildlife (Division) report, **Rocky Mountain Arsenal Wildlife Viewing Recreation, Analysis and Recommendations.** This report completed a 2.5 year cooperative agreement between the Division and the Service, involving 50 individuals from over 20 agencies, universities, organizations and school districts. Components of the report include an analysis of user groups, an overview of existing recreation, proposals for developing specific areas for wildlife recreation, a brochure design for the visiting public, and recommendations for future developments.

Nature Walks and Interpretive Programs

During FY92, thirteen nature walks and four special interpretive programs were offered in summer and fall. Special programs included a bird walk, photography tours, a night hike, and a "Drawing from Nature" workshop. One hundred and six people (33 children, 73 adults) participated in nature walks, which started in June and ended in September. Photography tours were popular and easy to fill but other special programs required more promotion and lead time.

Interpretive Trails

In June 1992, designs for trails linking the Visitor Center with Lake Mary and Lake Ladora were developed. Morrison-Knudsen Environmental Services, Inc., a Shell contractor, designed the trail system. The first phase of construction began in late September. By this time several interpretive signs were in place and text written for kiosk signs. Thirty four redwood, sand blasted trail signs include the following topics: locust groves, irregular shorelines, blackbirds, songbirds, life supported by one tree, rain shadow, prairie habitats, ant hill, tracks, lake succession, fish and their food chain, waterfowl, Arsenal fisheries, northern pike, muskrats, cottontails, prairie dogs, coyotes, sounds of nature, islands, rodents, jackrabbits, bison, habitat variation, unseen animals, and tall grasses. Four kiosks were built in FY92, one near the Visitor Center, one at Lake Mary and Lake Ladora, and one at the Eagle Watch.

Fishing Program

Community Relations staff are responsible for managing the public aspects of the fishing program including permit sales, answering questions about fishing, managing educational fishing activities, and working with the fishing club, the Arsenal Anglers.

a) Permit Sales

A total of 656 fishing permits were sold during FY92, 518 to the general public, 76 to military and Arsenal personnel, and 62 to disabled and retired citizens. Permits cost $20 for the public, $5 for military and Arsenal personnel, and $2 for disabled and senior citizens. Permit money totalled $10,864 and was sent to Aberdeen Proving Ground. Public permits were sold on a first-come, first-served basis on 4 April 1992, with the first people waiting in line on 3 April at noon. Fishing season opened on 15 April 1992.

b) Fishing Events

Several events were held for children and disabled anglers during FY92. Service staff and Arsenal Anglers organized and assisted with these events, which occurred at Lake Mary and Lake Ladora. A total of 137 people, 76 children and 61 adults, participated in the these special fishing programs. Events included:

1) A National Fishing Week celebration on 6 June 1992 with 29 children and 9 adults associated with Scout troops from Englewood, Northglenn, and Lafayette.
2) Five adult patients from Craig Hospital and a patient's son fished on 24 June 1992.
3) Fifteen children and 15 adults, associated with Children's Hospital, participated in a bluegill fishing day on 30 June 1992.
4) Four patients from Craig Hospital and 6 family members fished on 22 July 1992.
5) The first "Pathway to Fishing" (PTF) educational program was offered to the general public on 25 July 1992; 10 children and 11 adults participated.
6) Five children from Montbello Recreation Center fished on 15 August 1992. (PTF)
7) Six patients and two family members from Craig Hospital fished on 19 August 1992.
8) Twelve Scouts and seven adults from an Aurora Cub Scout group fished on 12 September 1992. (PTF)

c) Pathway to Fishing

Pathway to Fishing is an introductory fishing lesson for children, cooperatively developed by U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Bureau of Reclamation, U.S. Forest Service, Berkley Outdoor Technologies, and In-Fisherman.

Visiting 12 stations in an hour, children are introduced to topics such as fish anatomy and habitat, fishing techniques, and fishing safety and ethics. Each child receives a certificate of accomplishment after finishing the program. After completing the Pathway to Fishing Program at the Arsenal, children practice what they have learned by fishing at the lakes for a few hours.

d) Arsenal Anglers

Approximately twenty fishing permit holders were active members of the Arsenal Anglers, a fishing club which assists with fisheries biology projects and Community Relations activities. These active club members participate in volunteer safety training, CPR, and First Aid training. All active members signed Service volunteer agreements. Arsenal Anglers assisted with all special fishing events. During open house events, the club hosted an informational booth and taught children how to cast. They have also volunteered to help with parking during special events.

Field Trial Program

Colorado hunting dog clubs have used the Arsenal for over thirty years, hosting field trials and hunting tests. Currently, only pointing dog clubs are scheduling their events at the Arsenal. People on horseback follow their dog while it is being tested. Clubs are restricted to Sections 33, 34, 3 (east of the railroad tracks) and 9 (eastern strip). Community Relations staff sets and revises policy (with input from other Service personnel), schedules trials, and coordinates with club representatives prior to and during trials.

During FY92, 686 people participated in 13 weekend dog trials and hunting tests on the Arsenal. Eight clubs participated in the trials including: the Mile High Weimaraner, Colorado Field Dog, Skyline Brittany, German Shorthaired Pointer, Irish Setter, Rocky Mountain Pointing Dog, Northern Colorado Brittany, and High Plains Gordon Setter Clubs, and the Colorado Fat Toads Society.

Problems associated with dog trials during FY92 included dogs wandering off and entering contaminated and restricted areas, scheduling conflicts (with an open house event), and introduction of sick quail (ulcerative enteritis). A veterinary health certificate for target birds is now required as part of trial policy.

Volunteer Program

Volunteers are an integral part of the Arsenal Community Relations Program. An average of sixty people assist with a

range of programs, including tours, nature walks, environmental education and fishing programs, special events, presentations, Visitor Center and Eagle Watch management, administrative tasks, and biological work. Approximately 55% of our programs are led by volunteers. During FY92, volunteers contributed 6,994 hours, equivalent to the time worked by 3.4 full time employees, and more than doubled the number of volunteer hours contributed in FY91.

Volunteers were recruited during the fall through local newspapers, television, radio, and conservation group newsletters and during Arsenal public activities. Volunteer flyers were placed in libraries and recreation centers. Volunteers for Outdoor Colorado and the Mile High United Way also recruited for us through their clearinghouse and network, respectively. The most effective way to recruit volunteers has been through personal contact at Arsenal events.

A very effective way to attract and retain active volunteers is to offer a thorough training program. At the Arsenal, we offer volunteer orientations; monthly meetings featuring programs about wildlife, Arsenal history, or contamination cleanup; specific training for bus tours, education programs, and Eagle Watch; and a comprehensive 32-hour Arsenal training. Twenty-four volunteers completed the first 32-hour volunteer training program. All Service staff, some volunteers and some Army and EPA staff assisted with this program. An important part of the training program includes shadowing tours and other specific programs for three or four sessions before being expected to lead the activities. During FY92, we incorporated a 4-hour safety training, first aid, and CPR sessions for all volunteers leading public activities.

Volunteers are recognized and rewarded after serving a specific number of hours. A minimum of 48 service hours is expected each year for all Arsenal volunteers. The following items are given to volunteers with corresponding hour requirements: volunteer hat for 8 hours, volunteer pin for 250 hours, special pin for 500 hours, U.S. Fish and Wildlife Service belt buckle for 750 hours, and a wind breaker with a Service volunteer patch for 1,000 hours. Volunteers and their spouses or significant others were recognized in April with a special dinner. A special certificate of appreciation, burrowing owl poster, and name badge was given to volunteers.

Several volunteers have contributed a significant number of hours and deserve special recognition. Russ Fox, a long-time volunteer, surpassed 1,200 hours of service in FY92. Ed Hendrickx, a charter volunteer, served more than 800 hours by FY92. He also took over editing the monthly volunteer bulletin, The Talon, and continued preparing detailed monthly activity reports. Dennis Downing, completed more than 500 hours and Diane

Buell, Harvey Cochrane, Jack Hegele, George Lewis, Jo Platt, and Al Tennes surpassed the 250 hour benchmark.

Volunteers bring new life to Arsenal programs, increase staff efficiency, and offer a unique way for community members to become actively involved in Arsenal activities. They are an increasingly important link to the community and essential to the success of Community Relations Programs.

Community Outreach

During FY92, Community Relations staff and volunteers, gave a total of 41 presentations in the community, reaching 1399 people, including 673 children and 726 adults. Programs included a slide show featuring Arsenal wildlife and history followed by a question and answer session. Programs were given to students and interest groups.

Service staff and volunteers participated in several special events in the community during FY92, including the Denver and International Sportsmen's Shows, the Commerce City Memorial Day Parade, and Commerce City's Derby Daze celebration. Sportshow attendance was estimated at 50,000 people with roughly half of those visiting the Arsenal booth. The theme for our float in the Commerce City Memorial Day Parade was "From War to Wildlife" - representing 50 years at the Rocky Mountain Arsenal. The float included historical photographs, large cutouts of deer and a double-decker bus, Army and Fish and Wildlife Service personnel, and live trees and shrubs. The float was awarded third prize in the commercial division.

Community Relations staff assisted with the Urban Design Forum Conference and helped staff Army exhibits (Hazardous Materials Conference in Washington, D. C. and Department of Environmental Health Conference in Baltimore, MD). Arsenal Service staff was indirectly involved in Two Ponds planning and public meetings.

Planning meetings for the 1993 Arsenal wildlife calendar began in June. Participants included Service staff; Wendy Shattil; Carl Mackey and Cricket Smith, representing Shell; and Urling Kingery from Denver Audubon Society. The theme for the calendar is urban wildlife. Some of the entries from the "Wild Things Where I Live" Art Contest were included in the calendar.

With the help of MGA, a summer program flyer, promoting evening tours and nature walks, was prepared and distributed throughout the metro area.

Media and Special Requests

Arsenal Service staff assisted the print, video, radio and television media with numerous requests, interviews, and information during FY92. Newspaper requests or articles included:

- Christian Science Monitor article - September 1991
- Numerous articles in local and some national newspapers about the refuge bill passing the House of Representatives and Senate in July and September, respectively
- Articles about Bald Eagle Day in Denver Post and Rocky Mountain News, and local daily and weekly newspapers - January 1992
- Eagle Watch article in Denver Post - February 1992
- Colorado Springs Gazette Telegraph - February 1992
- High Country News article - March 1992
- Chicago Tribune - March 1992
- Ft. Collins Coloradoan article - April 1992
- Wild Things Where I Live Art Contest articles - September 1992
- provided information to Pat Durkin from National Geographic News Service

Magazine coverage included:

- Westword article - February 1992
- Sunset Magazine article - March 1992
- provided information for National Geographic Magazine article
- Garbage Magazine - May/June 92
- provided information and photo tour for Rose Bacon - freelancing for Modern Maturity Magazine
- provided information for American Airlines Magazine article
- provided information for Mike Gradowski from Outside Magazine

Television coverage included:

- Prime Network interview
- "Lure of the Wild" - Dan Fong
- Burrowing Owl study of Linda Pezzolesi with Paul Day from KCNC-TV
- Cable Channel 28 - Aurora public access television filmed portions of the summer program

Radio coverage included:

- Interview with MAJIC 100.3
- Interview for Mutual Broadcasting with Marcia Wood
- Earthwire radio program also on Mutual Broadcasting

Other special assistance was provided to: British Broadcasting Company - Miles Barton and Franz Camenzind in November 91 and February 92 for a film they are doing about ferrets; Martin Zell - videographer for USDA; provided scripted slide program for Washington office for Assistant Secretary of Interior Mike Hayden; Representative Dan Schaefer requested footage for an interview program developed for cable television with Wayne Allard; provided numerous articles for Colorado Wildlife Federation and Army newsletters; provided information to Kathy Witkowski, a free lance writer. Service staff met several times with Claude Steelman about a film he hopes to develop for Survival Anglia, a British Broadcasting Company television program.

Numerous photographers requested access to photograph Arsenal wildlife. In May, a new photography contract was awarded to Tom Tietz.

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