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U.S. FISH AND WILDLIFE SERVICE

ROCKY MOUNTAIN ARSENAL FIELD OFFICE

FISCAL YEAR 1991 ANNUAL PROGRESS REPORT

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

February 15, 1991

APPENDICES A - F

by

The U.S. Fish and Wildlife Service
Rocky Mountain Arsenal Field Office
Building 111
Rocky Mountain Arsenal
Commerce City, Colorado 80022-2180

LIST OF APPENDICES

APPENDIX A

NATURAL RESOURCES CONSERVATION COMMITTEE
MEETING MINUTES
9 OCTOBER 1990

The meeting was convened at 1330 hours by Jim Green at the Fish and Wildlife Service (FWS) Visitors Center on RMA. A list of attendees and meeting agenda are provided as attachments A and B, respectively.

1. **OPENING REMARKS BY MEMBERS**

   Jim Green stated that most people received a copy of the minutes from the June 12, 1990 meeting and that no corrections or concerns were noted.

   Ron French asked if a map was available showing where the prairie gentian plants would be located. Pete Gober responded that he would get him a copy.

2. **U.S. FISH AND WILDLIFE SERVICE MANAGEMENT ACTIVITIES**

   Pete Gober reported on current wildlife studies:

- Fisheries. A new fisheries graduate student will soon start work at the Arsenal through the COOP unit at Colorado State University. He will be looking at why the lakes are so productive, in particular, at their structural diversity.

  Fishing season at RMA ended September 30.

- Burrowing owls. Most burrowing owls have migrated off RMA.

  Kathy Demarest asked what came out of the burrowing owl study. Pete responded that results have not yet been analyzed, however, burrowing owls did seem to prefer roadways possibly because of higher insect vulnerability.
  Radiotelemetry equipment proved to be difficult to use; therefore its use was discontinued during the study.

- Prairie dogs. Translocation of prairie dogs from off RMA to on post is continuing. Preliminary results indicate the smaller the group size, the greater the mortality. Approximately 2000 prairie dogs have been translocated this year, primarily from off post. Prairie dogs were eliminated by phosgene gas from the northwest corner of Section 36. Rodney Gabehart stated that parts of this area will need to be reseeded.

- Mammalian predators. Work continues on trapping, marking and releasing coyotes and badgers. Radiotelemetry work to monitor animal movement will begin soon.

- Deer. Preliminary results indicate discrete, adjacent fawning areas for mule deer and white-tailed deer; the preliminary assumption is that mule deer are excluding white-tailed deer. The separation line for each area is the road between Upper and Lower Derby Lakes. White-tails occur east of this road and mule deer occur west of it.

- <u>Potential Contaminant Hazard.</u> Migratory shorebirds are using the water collecting on top of the covers on Pond A and B.

- <u>Mitigation.</u> USFWS is currently in the process of developing plans for mitigation in response to Arsenal projects and interim response actions.

- <u>Bald Eagles.</u> BEMA closure goes into effect October 15. BEMA orientation meeting was held on October 3 to go over areas affected, instructions, point of contact, etc.

  The Arsenal bald eagle study will continue but will be scaled down, possibly allowing more time to work with the Barr Lake eagles.

- <u>Community Relations.</u> Visitor use was down over the summer months, but anticipate greater participation once school starts again.

- <u>Comprehensive Monitoring Program.</u> Brian Anderson will be the Contracting Officer Representative, Patty Stevens will help in the coordination and management of the program.

  Cindy Vagelos asked about Museum of Natural History (MNH) activities. Pete responded that MNH had submitted task plans for Army and Service review. Most of the work will start next spring except the education and raptor studies which may start sooner.

3. **RMA FACILITIES MAINTENANCE (FM) REPORT**
   Jim Green reported on current activities:

- Construction of Lower Derby Lake spillway is completed, D Street in this area will be paved.

- Water has been transferred from Upper Derby to Lower Derby Lake to its allowable level. Water has also been transferred into Lake Ladora to fill it up for winter.

- The Highline Lateral has lots of water in it.

- The boundary fence was destroyed at First Creek and Buckley Road. Work is ongoing to repair it.

- The City and County of Denver are close to finalizing plans for the new airport road. Primary concerns include water quality entering the Arsenal via non-point sources and First Creek and the rate of flow of this water.

- All reseeding projects are nearing completion for the year. Reseeding of BEMA areas is completed. Other projects include: north and northwest boundaries, Basin F floor, near Basin F tanks and Ponds A and B, by channel at First Creek and Sixth Avenue, borrow pit near Building 1710, and spillway area near Lake Ladora.
  Seed mixtures to be planted include:
  - crested wheat/rye grass mixture will be planted at the boundaries
  - test plot (approximately 10 acres) of native grasses indicative of soil composition will be planted in the spillway area

- The Army will soon begin a project to replace and install water lines at: Seventh Avenue from E to F Street, along Seventh Avenue to the Eagle Watch, and from Lake Mary across Rose Hill to the existing waterline located west of the airport runway in Section 10 (this will eventually be replaced all the way to 56th Avenue).

- Army contractors will soon finish power line installations to the Eagle Watch and on C Street from 8th Avenue to 9th Avenue to tie into the incinerator.

- FM will be laying gravel on perimeter roads from northeast of the northwest boundary around the perimeter road to the Eagle Watch.

- Army contractors have broken ground north of Building 111 for the consolidation project. The first buildings to be started are the new Motor Pool and Maintenance buildings.

  This project is being undertaken as part of the Sanitary Sewer IRA because of the need to move people out of South Plants in order to work on sewers in that area. It will take approximately one year for people in the South Plants to move into their new buildings.

- Possible gas line work will start at either 56th Avenue and Peoria Street or at Building 321 up D Street to SQI facility.

- Possible new water fireline will be constructed from the North Plants to the SQI facility. This work may start this fall.

- An extension of the railroad track from the North Plants to the SQI facility is proposed.

- Repair work on the existing railroad that feeds into the Arsenal loop is proposed.

  Cindy Vagelos asked if any work will take place after the next meeting (in 60 days). Jim responded that a number of projects are proposed:

  - Contract for the design of FWS Building will be awarded.
  - Waterline that feeds into the elevated water tank in the South Plants will be repaired.
  - Relocation of power lines due to remediation activities scheduled for M-1 Settling Basins.
  - Installation of electrical and gas lines to the boundary treatment systems.
  - Remodelling of the main entrance of Building 111.

4. **COMPREHENSIVE MONITORING PROGRAM (CMP)**

Jean Tate reported on CMP activities:

  - Field sample collection is completed. All species numbers proposed were collected except for earthworms and pheasants which fell short of proposed numbers.

  - The final report will integrate all three years.

- Prairie dog distributional surveys are completed. This work consisted of replicated counts on 2 hectare plots, however, prairie dog numbers were so low that it was hard to find adequate study sites for this. It did appear that prairie dog numbers were increasing.

5. **MKE PROGRAMS**

   Carl Mackey was gone, therefore no report was given.

6. **MISCELLANEOUS DISCUSSION ITEMS**

- The bald eagle nest at Barr Lake was stabilized and a ladder was installed to reach the nest.
- A botulism outbreak occurred north of Greeley. FWS is already aware of this and is watching for signs of it at the Arsenal.
- FWS is operating under the draft FY90 and FY91 management plans. The final plans were given to Army for review.
- The next meeting of the NRCC was tentatively scheduled for 11 December, 1990 at 1330 hours in the Visitors Center.

The meeting was adjourned at approximately 1445 hours.

Submitted by : Patty Stevens, USFWS

ATTACHMENT A

NATURAL RESOURCES CONSERVATION
COMMITTEE MEETING
9 Oct 1990

NAME	ORGANIZATION	Phone
Jim Green	RMA FM	289-0166
Kathi Demarest	Colo Div of Wildlife	291-7367
D. Jean Tate	Ebasco	988-2202
Marion Fischel	Shell	713 241-0139
Rodney Gabehart	MK-ES	860-8621
Ed Benton	Shell Oil Co.	861-700
Bud Bridgewater	DOJ	292-232c
John Fomous	Army	289-0104
Pete Gober	US Fish+wildlife	289 0232
Ron French	CDM / EPA	298-1311
JOHN BARTH	US EPA	294-7560
Thomas Cope	HRO	861-7000
Kurt Swingle	GeoTrans	440-455
Patty Stevens	USFWS	289-02
Cynthia Vagelos	CO AGO	894-72

ATTACHMENT B

NATURAL RESOURCES CONSERVATION COMMITTEE
AGENDA
9 OCTOBER 1990

1. OPENING REMARKS BY MEMBERS
2. U.S. FISH AND WILDLIFE SERVICE ACTIVITIES
3. RMA FACILITIES MAINTENANCE REPORT
4. COMPREHENSIVE MONITORING PROGRAM
5. MKE PROGRAMS
6. MISCELLANEOUS DISCUSSION ITEMS
7. ADJOURNMENT

NATURAL RESOURCES CONSERVATION COMMITTEE
MEETING MINUTES
11 December 1990

The meeting was convened at 1345 hours by Major John Fomous at the Fish and Wildlife Service (FWS) Visitors Center on RMA. A list of attendees and meeting agenda are provided as attachments A and B respectively.

1. Opening Remarks

Cynthia Vagelos asked that the commitment by Major Fomous to share all task plans for RMA studies with the State of Colorado and EPA be noted in the meeting minutes. The commitment was acknowledged and is so noted.

2. Fish and Wildlife Service Activities

Larry Malone reported on the current status of FWS activities on RMA.

o Fishing

The first fishermans club meeting for RMA is scheduled for this evening, December 11th.

o Burrowing Owls

One owl remained on RMA into late November. The bird was captured and the transmitter removed. No burrowing owls are present on RMA at present.

o Prairie Dogs

3,288 prairie dogs were released on RMA this year. Approximately 1,000 individuals were relocated from other areas on RMA; the remainder were introduced from off post locations in cooperation with non-FWS prairie dog rescue efforts.

o Mammalian Predators

Twelve coyotes and 8 badgers have been captured and equipped with radiotransmitters.

o Deer

Two mule deer bucks have been trapped and equipped with radiotransmitters. Deer surveys were conducted on November 18, 1990. A total of 289 deer were observed of which 252 were mule deer, 7 were undetermined, and the remainder were whitetail. FWS estimates that there are at least 318 deer on RMA. There are records of two deer being poached on RMA this year.

- <u>Mitigation</u>

  FWS is working on the fish and wildlife mitigation associated with development plans (IRAs and other Army projects), but not have been completed.

- <u>Bald Eagle Management Area</u>

  At present there are 7 to 10 eagles on the roost each night. This is slightly higher than the number observed on the roost at the same time last year. One of the eagles is a return from last year.

- <u>Contamination Assessment</u>

  FWS has purchased a -90° C freezer for preserving tissues and small whole body carcasses of fortuitous samples collected on RMA. FWS will maintain a catalog of these samples and a serum catalog of tissues analyzed. FWS biologists and toxicologists at Crab Orchard have been consulted regarding sample handling, etc. that could be implemented at RMA.

- <u>Public Use</u>

  This has been changed to Public Relations within the FWS organization at RMA. Monthly tours totaled 1,779 people. Outreach program reached more than 1,000 individuals included educational materials to schools. FWS presented a poster on RMA studies at a meeting held in Iowa that was attended by 150 people. Public relations programs in October-November reached a total of 3,028 people.

  Thirty new people were enlisted into the volunteer program. A total of 241 volunteer hours were logged during October-November. Over 5,000 people attended the Open House held in early December. Over 550 people attended the opening of the Eaglewatch.

  Cynthia Vagelos asked where the visitors at the Open House went on RMA. Larry replied that they visited the Eaglewatch, FWS Visitors Center, and visited other areas on the tour buses. Cynthia asked about the purpose of the fishing club and how often they met. Greg responded that tonight's meeting was the first and that the purpose was to discuss fishing on RMA.

Dave Weber requested exact information on the burrowing owl activities on RMA because of the CDOW's concern over when to allow prairie dog poisoning programs. Mike promised to provide this information to Dave.

Vera asked for information regarding a rumor she had heard regarding ducks dying at the Basin F ponds. FWS responded that they had heard nothing about any such deaths.

Jeff asked if there was a change in the way that samples of chance were being handled. Brian responded that far more samples had been collected than were analyzed under the CMP. The Army is interested in long-term and whether the contaminants are still accumulating in food chains. He added that formal collection under the CMP was finished in September 1990.

Jeff asked how RMA enforced the catch and release requirement for fishermen on RMA. FWS responded that this was accomplished by spot checks at the gates and by creel census work at the lakes.

Jeff asked if only blood work would be performed on the fortuitous samples and if all parties would have an opportunity to comment on the analysis program. Major Fomous will look into this.

Jeff then asked if there would be a continued contract for CMP biota monitoring. Brian responded that work was in progress for a task order to continue the monitoring program. The Army is currently in the technical program planning stage. The plan will include some changes, and fortuitous samples will be addressed. The plan will pass through the draft, draft final, and final versions plus addenda and will be treated as other deliverables.

3. **RMA Facilities Engineer's Report**
   Jim Green was unable to attend the meeting. No report was provided.

4. **Comprehensive Monitoring Program**
   Jean Tate was not in attendance at the meeting. Major Fomous reported that all field work for the Biota CMP had been completed and that the final report would be issued in the spring.

5. **Shell/MKE Programs**

Carl Mackey reported that reseeding had been completed in all but the northwest corner of section 36. Some prairie dogs did invade the seeded area. MKE collected cover data in the seeded barriers and seeded BEMA sites.

The needle-and-thread mulch from last June's harvest was spread as planned. Dave asked if this was done to improve the range. Carl said yes and added that the harvest was done because this species is difficult and expensive to obtain commercially. Seeds were collected in the southwestern corner and spread in the southeastern corner of section 5.

Vera asked if these was weed control in these areas. Carl responded that MKE was using an integrated weed control program that involved mostly tillage and some Roundup.

Rod reported on the Basin C remediation test plots. All field work is scheduled to be completed by late March 1991. This is the third and last year of the study. A report will be available, probably in June if all field work is completed on schedule.

Vera again requested a map of the locations where prairie gentian had been planted on RMA. Pete stated that such a map had already been provided to Ron French of CDM. Carl reported that there was high survival success of these plants through the fall.

6. **Proposed Wetlands Development on RMA**

Major Fomous introduced a presentation and discussion of the proposed wetlands and stated that the plan and environmental assessment (EA) as presented at this meeting had not completed internal Army review. Copies of the plan were distributed to all parties. Cynthia expressed her appreciation for the Army's advanced notice on this issue. Major Fomous requested that all parties return comments by 20 December 1990 so that the Army can address them prior to preparing the draft EA for public comment.

Brian Anderson and Mike Lockhart then provided a detailed presentation, supplemented with slides and handouts, on the concept and details of the plan. Numerous questions were asked by all parties regarding the rationale and design of the wetlands, possible effects on contamination migration and remediation, and other concerns. These comments were addressed at length by Brian, Mike, and other representatives of the Army and FWS.

7. **Miscellaneous Discussion Items**

Dave Weber informed the committee that CDOW had submitted a letter to the City and County of Denver regarding mitigation implementation on the new airport construction. He will coordinate with FWS on this issue.

Dave added that the State had conducted some sampling on First Creek upstream of RMA and had found fathead minnows, gambusia, and brook stickleback. Sampling was done downstream of Tower Road.

Major Fomous stated that the comments on the wetlands EA should be directed to Jim Green's office with a copy to FWS.

The next meeting of the NRCC is scheduled for Tuesday, 12 February 1991 at the FWS Visitors Center on RMA.

Respectfully submitted: Doug Reagan

Douglas P. Reagan, Ph.D.

ATTACHMENT A

NRCC MEETING 11 Dec. 90

Name	Organization	Phone
Doug Reagan	ESE, Inc.	790-0770
John Fomous	Army	289-0104
Peter Gober	FWS	289-0232
Cynthia Vaughn	State of Colorado	894-2299
Janet Yanowitz	GeoTrans	440-4556
Brian Anderson	PMRMA	289-0239
Sue Hartley	CDM/EPA	298-1311
Greg Langer	FWS	289-0232
David Cooper		499-6441
~~Ernie Husmann~~	USFWS/RO ENG.	236-5319
LTC Jeff Guilford	PMRMA	289-0147
Jeff Edson	Colorado	331-4851
Mark Lamb	CDOW	291-7227
Dave Weber	CDOW	291-7231
Larry Molone	USFWS	289-0232
Marion Fischel	Shell	713 241-0139
Carl Mackey	MK-ES	303-860-8621
Robert Tuchman	HRO	861-7000
Vera Moritz	EPA	294-7517
Steve Richman	Advanemics	292-2322

ATTACHMENT B

NATURAL RESOURCES CONSERVATION COMMITTEE
MEETING AGENDA
11 December 1990

1. OPENING REMARKS BY COMMITTEE MEMBERS
2. U.S. FISH AND WILDLIFE SERVICE ACTIVITIES
3. RMA FACILITIES MAINTENANCE REPORT
4. COMPREHENSIVE MONITORING PROGRAM
5. SHELL/MKE PROGRAMS
6. PROPOSED WETLANDS DEVELOPMENT ON RMA
7. MISCELLANEOUS DISCUSSION ITEMS
8. ADJOURNMENT

NATURAL RESOURCES CONSERVATION COMMITTEE
MEETING MINUTES
12 February 1991

The meeting was convened at 1340 hours by Jim Green at the U.S. Fish and Wildlife Service (FWS) Visitors Center on Rocky Mountain Arsenal (RMA). A list of attendees and meeting agenda are provided as attachments A and B respectively.

1. Opening Remarks by Committee Members

Kurt Swingle announced that neither Jeff Edson nor Cynthia Vagelos would be able to attend the meeting. He expressed the State of Colorado's concern regarding whether the State would be able to comment on all plans.

- Kurt asked for details on the mitigation plans mentioned on page 2 of the minutes of the 11 December NRCC meeting. Larry Malone responded that these would involve general habitat enhancement efforts associated with remediation. Kurt asked how and when the State would be involved. Larry responded that once the plans had been written and the Army had reviewed them, they would be available for review. Kurt was assured that the State would have an opportunity to review plans before they were issued in final form.
- Kurt then inquired regarding mitigation associated with the Interim Response Actions (IRAs). John Fomous responded that FWS would provide general guidance on mitigation but that specific mitigation plans would be prepared by each project staff. Larry added that Bruce Hastings has the sole job of working up these plans for the FWS. Jim Green added that the specific mitigation plans for RMA would not be available until the Record of Decision (ROD).
- Kurt asked if there would be general mitigation prior to the ROD. Larry responded yes, that is what the FWS is planning. Mike Lockhart added that portion of the plan were done and would be made available to all parties as soon as they are ready.

A general discussion of what FWS plans would be available and when. Mike indicated that the January 14th plans that had been distributed were annual plans and stated that they could be modified in response to comments. Portions of the Five Year Management Plan for RMA, distributed earlier, are being assembled into a comprehensive document. Mike stated that this document would be available for comment as soon as the Army had reviewed it. In response to Kurt, Mike stated that the plan should be available within 60-90 days.

Dave Weber asked how this plan preparation related to the Sikes Act with respect to input from the State. John responded that this was why the State and other parties were getting these plans at this point. Dave stated that he was continuing to work on the wording for a cooperative agreement and was concerned about how to handle disagreements in the wording of this document. Mike responded that the State would have an opportunity to provide input into the Five Year Plan and would have an additional opportunity to review this document.

Kurt then asked for information on the status of the wetlands development plan. Mike stated that the Environmental Assessment (EA) had already be sent to agencies for formal review. Dave state that he had not seen it. Mike promised to check on this.

Larry added a correction to the minutes of the 11 December 1990 meeting. Task plans will be sent out for studies conducted by the Denver Museum of Natural History. John added that these plans will be sent out for review and comment within 30 days of the time they are submitted to the Army for review.

2. U.S. Fish and Wildlife Service Activities

Larry Malone reported on the current status and future plans for FWS activities on RMA.

o <u>Bald Eagle Program</u>

The effort for this year has been substantially reduced due to the termination of funding for the three year bald eagle regional study.

- Seven eagles have been trapped and equipped with radiotransmitters.
- Some eagle have moved off of RMA because of the prolonged period of recent prolonged period of mild weather.
- The artificial feeding station effort is being continued. Locations are approximately the same as those used last year. So far FWS has put out 12 deer carcasses (from roadkills off of RMA), about 500 lbs. of salmon, and 25 lbs. of carp. Use has been relatively light during periods of mild weather. However, up to 26 eagles have been observed using one station.
- Roost counts were less variable than last year. The peak number was 38 eagles observed on the roost on 27 January 1991. Age structure is about the same as in the past; ratio of 1:1 adult to subadult.

o <u>Deer</u>

Two aerial surveys were conducted on RMA along 1/4 mi. wide transect routes. Estimated differed between counts using a mark and resight estimation method. Estimates were: 335 mule deer and 125 whitetail.

- FWS is trying to tag at least 10% of the population and is having trouble catching bucks. Eighty-nine deer have been captured so far, and 44 of these were fitted with collars. FWS needs eight more to have a statistically adequate number of marked deer.

- FWS has evidence of at least three deer (2 mule deer, 1 whitetail) poached on RMA this winter. Two were shot by bow and one by rifle.

o Predators

A total of 16 coyotes and eight badger have been equipped with readiotransmitters. FWS estimates that about 50 coyotes use RMA; some are permanent residents and others move into and out of RMA.

o Prairie Dogs

The CSU relocation success study is scheduled to restart in February 1991. To date, 4,331 prairie dogs have been released on RMA (1,034 in 1989 and 3,297 in 1990). Prairie dogs are expanding their range and may include as much as 50% of the previously occupied area, but densities are considerably lower than before the plague.

Kurt asked if information on normal prairie dog population densities was available to compare with current RMA densities. Doug Reagan responded that data were available from the prairie dog studies that MKE had conducted on RMA and at the Plains Conservation Center during the Biota RI.

o Raptors

FWS is conducting weekly raptor counts. There were large numbers of ferruginous hawks on RMA in the fall, but numbers are now fairly low. These seems to be an increase in the number of prairie falcons on RMA, possibly as the result of the reduced number of ferruginous hawks.

o Waterfowl

FWS is conducting weekly waterfowl surveys from 12 permanent observation sites on RMA. So far 18 species (16 duck, 2 geese) have been noted.

o Contaminated Basin

Weekly surveys are being conducted in the vicinity of basins in sections 26 and 36 to document wildlife use. Water in Basins A and B is frozen, and these areas are not currently used by wildlife. Some prairie dogs had moved into section 36. These were extirpated by the Army in January. In response to questions by Kurt, Jim Green stated that the poison used was phostoxin and that 20 - 50 individuals were killed.

- Fisheries

  Fishing information for next year will be available on 25 February 1991. The fisheries sampling design for 1991 will be out soon.

  Angler data for 1990 showed that 602 anglers fished an average of 12 days each on RMA. Sampling indicated that each northern pike was caught an average of 2 - 3 times and bass 1- 2 times per year. Catch rate averaged 3.7 fish per hour. This is considered a moderate success rate for warm water fisheries.

  The RMA fishing club has met twice. Members recommended that barbless hooks be used, but that they not be required. Ron French asked how anglers disposed of injured fish. Mike responded that they were released anyway. Ron asked if fish injuries were reported. Mike responded that anglers were not required to report injuries.

- Mitigation

  Larry stated that FWS was hiring private contractors to implement reclamation projects. Current projects include the creation of wetlands, building prairie dog barriers in the northern portion of section 36, public use of the visitors center, landscaping near the Eagle Watch, and habitat enhancement for wildlife in section 34 near the old barracks. Native species will be reintroduced to RMA, as appropriate. FWS is photographing areas before, during, and after mitigation.

  Raptor electrocution prevention devices will be installed along powerlines on RMA. Studies are underway to determine where these modifications are needed.

- Public Outreach

  During December 1990 and 1991, 1,689 people participated in RMA tours and 1,239 visited the Eagle Watch. The open house on 8 December 1990 attracted over 5,000 visitors; 2,400 tok bus tours and 700 watched the slide presentations. FWS had a booth at the Denver Sportsman's show. About 35,000 people attended the show of which an estimated 6,000 visited the FWS booth. A total of 14,534 people were reached during December and January.

- Contamination Studies

  FWS is collecting and storing fortuitous samples. Future analyses depend on the development of appropriate analytical protocols and review by the Army. Post mortem examinations are conducted prior to freezing. Samples are stored in a freezer maintained at -90 degrees C.

Dave asked if delaying analyses would compromise the validity of analytical results, and added that it was important to determine how these animals died. Larry then presented the detailed results of the six animals on which post mortems had been performed since July 1990. Dave asked why only these animals had been studied. Patty Stevens replied that these were all of the specimens collected since the FWS toxicologists became involved.

Ron asked if there had been any fortuitous samples collected off post. Patty responded that none had been collected.

Kurt asked if the results of these necropsies would be released. Patty responded that the information could be incorporated into the CMP biota report, but that FWS had no plans to issue a formal release.

3. **RMA Facilities Engineer's Report**

Jim Green reported on current engineering activities on RMA including the status of construction in building #111, construction of potable water lines to support Basin F incineration, removal of old barracks, status of the asbestos removal from the old steam lines, continued work on upgrading the perimeter road to all weather status, tree trimming, crossing repairs, and potential problems with ditch burning in the spring because of the extended timing of Denver's clean air restrictions. Fence repair is continuing.

4. **Comprehensive Monitoring Program**

Jean Tate reported on the status of the Comprehensive Monitoring Program (CMP) for biota. All field sampling is complete. All chemical analyses are complete and have been through QA. Statistical analyses of 1990 data and for the 3 years of CMP are underway.

The blue cover (Army internal review) report will be out by late March or early April. The report will be at the same level of presentation as the 1989 report with additional comparisons of geographic areas. The report will include the prairie dog survey conducted in September.

Kurt asked if the CMP for biota would be continued. Jean responded that 1990 was the last year of sampling scheduled under the current program. Various representatives of the FWS stated that the FWS and Army were working on a longterm program and that this was not out for bid. Patty acknowledged that there were some budget problems associated with future planning. Kurt asked if the work would be performed by a private contractor. John, Patty, and Jim responded that a decision on this point had not yet been made.

5. Shell/MKE Programs

Carl Mackey stated that the Basin C Test plots had not yet been resampled. MKE was currently planning their involvement in habitat enhancement on RMA for the coming year.

Ron asked that EPA be notified in advance of introducing endangered species to RMA and requested a map of the locations where plants had been placed last year. Carl responded that EPA had been notified verbally at the NRCC meeting prior to introduction of the plants, that the plants were not endangered (only rare), and that he had already supplied a map of the plant locations to EPA. Carl offered a tour of the plant locations in May when the plants would be growing. Kurt and Ron restated their concern over the potential conflict of such plantings with any proposed remediation activities at RMA.

6. Miscellaneous Discussion Items

Carl Mackey provided information on upcoming meetings and seminars of potential interest to NRCC members.

Dave announced that as of March 1st, there would be a District Wildlife Manager, Larry Garcia, permanently assigned to replace Mark Lamb. He is continuing to work on the wording of a cooperative agreement and will take more action on it after Larry is on board.

Dave initiated a discussion on activities to get section 10 from the airport and back to RMA for use as wildlife habitat. He stated that the Colorado Division of Wildlife had just completed wildlife distribution maps for 17 species in the Denver metro area. He has suggested adding three others: prairie dogs, burrowing owls, and ferruginous hawks.

Dave stated that the CDOW Area Wildlife Manager, John Bradyhoff was called to active duty because of the crisis in the Persian Gulf and that he would be gone for a year. Gary Berlin will take is place in the meantime.

Jim Green asked that all committee members update the mailing list distributed by Doug so that a revised list could be assembled by the time of the next NRCC meeting.

Jim announced that the south gate on RMA would only be open from 0645 - 0815 and 1545 - 1730 hours in the future.

Major John Fomous stated that this was the last meeting of the NRCC that he would be attending. Lt. Col. Guilford will be his replacement at future meetings of the NRCC.

The next NRCC meeting will be held on Tuesday, 9 April 1991 at 1330 hours in the conference room of Building #111 (the White House).

The meeting was adjourned at 1515 hours.

Respectfully submitted: Doug Reagan

Douglas P. Reagan

ATTACHMENT A

Natural Resources Conservation Committee Meeting
12 February 1991

Name	Organization	Phone
[illegible signature]	Woodward-Clyde	694-2770
Patty Stevens	FWS	289-0232
[illegible signature]	FWS	289-0232
John Fomous	Army	289-0104
Dave Weber	CDOW	291-7231
Marion Fischel	Shell	713 241-0139
Carl Mackey	MK-ES	860-8621
Ed Benton	Shell	861-7000
Richard Johnson	MK-ES	860-8621
Ron French	CDM-EPA	298-1311
Kurt Swingle	GeoTrans	440-4556
D. Jean Tafe	Ebasco	980-3564
LARRY MALONE	USFWS	289-0232
Jim Groen	PMRMA	289-0115

ATTACHMENT B

NATURAL RESOURCES CONSERVATION COMMITTEE
TENTATIVE MEETING AGENDA
12 February 1991

1. OPENING REMARKS BY COMMITTEE MEMBERS

2. U.S. FISH AND WILDLIFE SERVICE ACTIVITIES

3. RMA FACILITIES ENGINEERS REPORT

4. COMPREHENSIVE MONITORING PROGRAM

5. SHELL/MKE PROGRAMS

6. MISCELLANEOUS DISCUSSION ITEMS

7. ADJOURNMENT

NATURAL RESOURCES CONSERVATION COMMITTEE
MEETING MINUTES
9 April 1991

The meeting was called to order at 1330 hours by Pete Gober who announced that he would be serving as meeting chairman as per the revised cooperative agreement between the Army and U.S. Fish and Wildlife Service (FWS). He then set the date for the next NRCC meeting as 9 July 1991, adding that meetings from now on would be quarterly, and that they would be held on the second Tuesday of the month as previously agreed. Marion Fischel indicated that she would be unable to attend the 9 July meeting. Pete responded that it was difficult to change meeting times to accommodate everyone's schedule, and that perhaps someone else could attend in her place.

The meeting agenda and list of attendees are provided as attachments A and B, respectively.

1. OPENING REMARKS BY COMMITTEE MEMBERS

Pete stated that the task plans for projects conducted by the Denver Museum of Natural History were ready and would be available for review soon. Persons conducting the studies were currently being trained by FWS; this training includes safety training.

Carl Mackey pointed out a correction on a statement made by him on p. 6 of the minutes of the last meeting; verbal notification of the planting of prairie gentians was given AFTER, not before they were in the ground.

Vera expressed her concern regarding biota management issues and coordination with contamination remediation activities on RMA. Pete stated that from now on all activities will follow the format presented in the new Army-FWS agreement. No activities will be conducted without approval through the FWS and the Army (Kevin Blose). Vera stated that she welcomed the idea of mitigation plans and stated that these should address some of the concerns that EPA has had over the issue of coordination.

2. U.S. FISH AND WILDLIFE SERVICE ACTIVITIES

Revised FWS-Army Cooperative Agreement: Pete updated the NRCC on the revised cooperative agreement between the Army and FWS. The agreement was signed on 22

March 1991 by the PMO Commander at RMA and the FWS Regional Director. The agreement provides for FWS mitigation plans and general wildlife management, all keyed to the 15 February budget process schedule. Activities will include the census and monitoring of wildlife populations, supervision of wildlife studies, coordination of day-to-day contractor activities, conduct habitat mitigation activities, and develop mitigation plans for disturbance activities indirectly related to contamination remediation.

FWS will also work with the Army's compliance officers. FWS will check for any conflicts between RMA activities (including contractors) and wildlife. Responsibilities will be to help develop and administer the Army's coordination plans for administration of Arsenal lands. FWS will have a desk across from the Army's desk for compliance. Compliance activities are under Lt. Col. Delemeter who reports directly to the Program Manager. Compliance Office decisions will guide all activity at the Arsenal.

FWS will also provide guidance and comments on cleanup activities at RMA in relation to wildlife exposure.

Pete indicated that FWS anticipated doing some of the wildlife collections for the comprehensive monitoring program (CMP) for biota for 1992. FWS will likely need contractors to collect samples in more contaminated areas because FWS personnel are not cleared to work in these areas. Kevin proposed that FWS serve as Contract Officers Representative (COR) for these activities. The scope of these activities must be approved by the Army. Vera asked if FWS would then be is a position to oversee its own work. Pete replied that all appropriate parties would have an opportunity to review the Scope of Work after the Army.

With respect to Interim Response Actions (IRAs), FWS may propose to do some revegetation. Other activities could include lakes and wetlands.

Community relations activities will continue under this agreement.

The agreement provides for 25 permanent FWS staff at RMA. FWS has committed to providing 10% of the necessary funding.

Dave Weber added that he was moving ahead with a draft of the wording of an agreement that would make the State of Colorado (through the Division of Wildlife) a part of the NRCC. He hoped to have the draft ready by next month.

Conservation Activities: Mike Lockhart reported on recent activities. The 1990-91 management plans are completed. The Bald Eagle Management Area opened on 22 March; the usual date is in early April (1-15), but the eagles left RMA early this year.

Mammalian predator, burrowing owl, deer, lagomorph, raptor, and fish studies were continuing as planned. Migratory bird and small mammal studies are being conducted by the Denver Museum of Natural History. Bald eagle studies were reduced in scope over previous years. Seven birds were trapped, 6 were tracked.

Two additional graduate students will be hired through Colorado State University to study conditions at the new wetlands being developed on RMA. One will investigate water quality entering and within wetlands; the other will be investigating the revegetation success of experimental plantings/management activities within wetlands.

A deer herd health study has been initiated. Twenty-three deer have been collected so far. Samples have been collected for purposes of examining health; no decision has been made to analyze samples for contaminants, although that is an option. Terry Spracker, wildlife pathologist at CSU, has examined the animals and indicated that the herd is healthy. Ron French asked what the selection process was for deer collected. Pete said that the samples were stratified by species, sex, and age.

Pete reported that 500 fishing permits had been issued for this year. Waders would be permitted only in Lake Ladora. Field dog trials were in operation on RMA and would continue through June. There have been 30,000 visitors to RMA in the past two years.

Dave reported on the Task Force looking at wildlife watching opportunities at RMA. Up to 25 people have participated; two meetings have been held. The groups is looking at areas like Lake Mary and Henderson Hill for development of additional public use facilities. A survey of Arsenal users is being conducted to elicit information on visitor preferences.

Pete indicated that Patty Stevens was involved in contamination reporting. She is preparing the Scope of Work for the CMP and will be taking over these activities. Vera asked for information on the connection between the CMP and the Record of Decision (ROD). Kevin responded that the CMP would collect data up to the ROD.

Vera then asked if the biota criteria being developed as part of the Endangerment Assessment (EAs) would be affected by new information developed from the future CMP work. Kevin responded that the Final EA would be issued in 1992.

3. RMA FACILITIES ENGINEER'S REPORT

Jim Green stated that the Army would be burning brush in the major ditches on RMA in the near future. Vera expressed concern regarding the burning in relation to contamination in Sand Creek Lateral. Jim indicated that the burning would not result in any soil disturbance within the ditch.

4. COMPREHENSIVE MONITORING PLAN

Jean Tate stated that the first draft of the CMP was already available to the Army and FWS for internal review. The blue cover document would be out soon. The CMP report would report on 1990 and earlier years. Statistics would cover differences in location and time. Jeff Edson asked id the technical plan for the next year of the CMP was available? Pete stated that it was not, but that it would be available to the Army. Vera asked if the individuals preparing the 1990 report had access to the surface soils data. Jean responded that they did have access to the data but that they did not use it.

5. SHELL/MKE PROGRAMS

Carl Makey reported that MKE was about half done with the seasonal programs for remediation plots. A draft plan for habitat improvements on RMA has been submitted to the Army for review. The area planned for revegetation related to the pipeline installed between the railyard and the Irondale treatment system may be seeded by spring. If the line is completed too late for immediate revegetation it will be covered with mulch and seeded by MKE in the fall when conditions are more favorable.

6. MISCELLANEOUS DISCUSSION ITEMS

Dave reported on the current status of events regarding new airport mitigation and the gateway development plan. The gateway area will have green space, but it will largely be in developed uses rather than wild. The agreement to remove the antelope herd inhabiting the airport area was not honored. Most of the antelope habitat within the area has been disturbed. Only 2 out of the herd of 50-70 individuals were seen in the area during a recent aerial survey.

Pete stated that Doug would continue to take the minutes of the NRCC meetings. Following a general discussion, it was agreed that the minutes would be available to NRCC members six weeks after each meeting. A meeting agenda would be sent to each member two weeks prior to the next meeting only if any new major items were added to the standard agenda.

The meeting adjourned at 1505 hours.

Respectfully submitted: Doug Reagan
Douglas P. Reagan

Date: 1 May 1991

Attachment A

NATURAL RESOURCES CONSERVATION COMMITTEE
TENTATIVE MEETING AGENDA
9 April 1991

1. OPENING REMARKS BY COMMITTEE MEMBERS

2. U.S. FISH AND WILDLIFE SERVICE ACTIVITIES

3. RMA FACILITIES ENGINEERS REPORT

4. COMPREHENSIVE MONITORING PROGRAM

5. SHELL/MKE PROGRAMS

6. MISCELLANEOUS DISCUSSION ITEMS

7. ADJOURNMENT

9 April 1991

Name	Organization	Phone
Larry Malone	U.S. Fish + Wildlife Service	289-0232
Larry Garcia	Colo. Div. of Wildlife	291-7227
Mike Lockhart	US FWS	289-0232
Vera Moritz	EPA	294-7517
Kurt Swingle	GeoTrans	440-4556
Kathleen Curry	State of CO AG	894-2299
[illegible]	[illegible]	[illegible]
Jim Green	RMA	289-0115
Richard Johnson	MK-ES	860-8621
Carl Mackey	MK-ES	860-8621
Brenda Beatty	CDM-FPC	232 0131
Ron French	CDM	298-1311
Marion Fischel	Shell	303 241-013
Kevin Blose	PM RMA	289-0201
Jean Tate	Ebasco	988-2202
Jeff Edson	State	331-4851
Thomas Cope	HRO	861-7000
Pete Gober	USFWS	2890232
[illegible]	Woodward-Clyde	740-3893

NATURAL RESOURCES CONSERVATION COMMITTEE
MEETING MINUTES
9 July 1991

The meeting was called to order at 1300 hours by Larry Malone at the Visitors Center at RMA. A list of meeting attendees and meeting agenda are provided as Attachments A and B, respectively.

1. OPENING REMARKS BY COMMITTEE MEMBERS

Larry distributed copies of the 1991 and five year management plans for U. S. Fish and Wildlife Service (FWS) activities at RMA to Shell, Colorado Division of Wildlife, and EPA. He stated the plans had already been approved by FWS.

Vera inquired regarding the status and availability of the task plans for projects conducted by the Museum of Natural History. EPA has not seen the plans and requested an update. Larry stated that they had been distributed as promised. Jeff and Carl indicated that they had received copies. FWS will check to see what happened to the copies for EPA.

Jeff inquired regarding the training provided by FWS to museum investigators on RMA. Larry replied that FWS provided RMA orientation and 40 hour hazardous waste training and that each were given physical examinations. Jeff asked what portions of the work were being done. Larry replied that all projects had been initiated and that the quarterly progress reports had just been received by FWS who must review them before they can be distributed.

2. U. S. FISH AND WILDLIFE SERVICE ACTIVITIES

Mike Lockhart reported on a variety of current FWS activities at RMA.

Breeding Raptor Surveys

All habitats on RMA were surveyed from April through the present time for raptor nests. Mike reported on the nesting of several species on RMA including red-tailed hawk, ferruginous hawk, Swainson's hawk, American kestrel, northern harrier, barn owl, burrowing owl, and great-horned owl. There is a graduate student from Texas Tech working on burrowing owls. Thirty-four burrows are in use, there have 21 nesting attempts, and more than 200 owls have been captured in 1990-91.

Prairie Dogs

FWS is still accepting prairie dogs on RMA. Two introduction sites are the main focus of these introductions. Population density surveys indicate about 30 individuals per hectare which are considered good.

Fisheries

Creel surveys indicate that fishing pressure was down in June to about 15 individuals per day. Gill netting and electrofishing studies were conducted in lakes that indicate that the bass size in Lake Mary is increasing.

Mitigation

Efforts are moving along. FWS is now quantifying and protecting areas. Single strand wire fences have been placed around some areas of some habitat in order to protect them from inadvertent disturbances.

Deer

Recent efforts have focused on fawn mortality. Fawns have been captured and marked and their survival has been monitored. Fawn mortality due to coyote predation has been high. The information developed from these studies will also be used to map important fawning areas on RMA.

Predator Studies

Eric Hine has finished his field work on these species.

Denver Museum of Natural History Studies

Their are five plans currently being implemented by the DMNH. These are: teaching videos, small rodent studies, small bird studies, lagomorph studies, and a ferruginous hawk investigation.

There were several questions regarding the purpose, current status, and results of the various studies. In response to various queries, Mike responded that:

- o There are currently about 50 coyotes on RMA.
- o All information on the 23 deer collected at RMA are not yet in, but that the population is in overall good health. FWS is still investigating possible abnormal antler growth and selenium effects. Analyses include blood, parasite surveys, tissue condition, lesions, necropsies, etc. that are standard for wildlife. Portions of tissue

are being saved for potential future contaminant analysis.

- o Vera Asked for a wetlands update. Mike stated that most construction was complete. The wetland area being developed in section 8 will have a clay lining and will have three islands. The study planned by Dr. Cooper has been delayed due to a problem with funding from Washington. Vera stated that she understood that the sand sage area had been damaged and requested an update on how this would be mitigated. Mike responded that this would be addressed in forthcoming plans.

Community Relations

Carol Moorhead reported that detailed figures were not compiled, but that FWS had already exceeded its goal of 35,000 for public participation for the year. The theme of the 1992 calendar will be the current research studies at RMA. Teacher packets and videos are currently being prepared for the region, but separate materials are being developed for RMA. Dave Weber offered help from the CDOW on developing these materials. Fishing training is being conducted for handicapped individuals and for scouts. Vera state that EPA would like to encourage more presentation of information contamination and the contamination cleanup at RMA to increase public awareness in this area.

3. FACILITIES ENGINEER'S REPORT

Jim Green was not present, and no report was provided.

4. COMPREHENSIVE MONITORING PROGRAM

Patty Stevens reported on the use of kestrel boxes on and near RMA from ongoing FWS studies. A draft of the CMP contract will go to the Army for review next week. The Army has constructed barriers around the Basin F waste piles. Bird mortality around Building 111 have decreased from previous years. One great blue heron was sent to CSU labs for analysis, but there are no results yet. One dead bald eagle was found below the roost; it had been dead 4-6 weeks.

Vera asked about continued field dog trials and use of RMA by scouts. Mike responded that RMA use for maneuvers and by scouts continues but has been reduced.. Lt. Col. Jeff Guilford stated that Col. Bishop has stated that there will be no Army maneuvers on RMA after 15 October 1991. Patty stated that the Biota CMP document should be available by the end of July.

5. SHELL/MKE PROGRAMS

Carl reported that MKE has prepared and submitted a health and safety plan for the Army's review, and that it should be finalized this week. Preliminary observations indicate that the needle and thread hay mulch application appears to be very successful (30+ stems/m^2). Sand dropseed is showing up as a volunteer. The establishment of arm season grasses was less successful. Ongoing activities include weed control and seeding programs.

Revegetation of the ROW between the Irondale treatment plant and the railyard is proceeding well, but there are a few bare spots. The well closure areas are reseeding is somewhat sparse, but there are some perennial grasses established.

The spillway has been seeded and live topsoil was used. Perennial forbs are present, but vegetation is still sparse.

Dave Weber requested that the State of Colorado be added to the regular agenda so that there would be scheduled input on activities near and relating to the Arsenal. Larry Malone indicated that this would be done for future meetings. Dave mentioned the Fish and Wildlife task force report and indicated that Rick Larsen would attend the next NRCC meeting to give a report. A brief discussion followed that addressed the artificial Swainson's hawk nest for the airport. Mike indicated that this was not done with airport funds and was done by FWS as a good faith gesture. Dave then requested information on the missing antelope herd that formerly inhabited the new airport site.

Jeff asked about the possible consideration of reintroducing black-footed ferrets to RMA, Mike responded that FWS was evaluating the possibility of using RMA as a step in reintroducing black-footed ferrets to the wild. He added that no decision will be made until next year.

Larry set the next NRCC meeting for October 8th at 1330 hours at the RMA Visitors Center. The meeting was adjourned at 1445 hours.

Respectfully submitted: Doug Reagan

Douglas P. Reagan

ATTACHMENT A

9 July 1991

Name	Org	Phone #
Patty Stevens	USFWS	289-0232
LTC JEFF GUILFORD	RMA	289-0147
VERA MORITZ	EPA	294-7517
Brenda Beatty	CDM-FPC	232-0131
DAVE MEYER	EBASCO Environmental	980-3531
Doug Reagan	Woodward-Clyde	740-3893
Mike Lockhart	USFWS	289-0232
Dave Weber	CDOW	291-7231
Kurt Swingle	Geo Trans	440-4556
Vicky Peters	Colorado	894-2289
Barbara Nabors	CDH	331-4829
[illegible]	FWS	289-0232
Jeff Edson	CDH	331-~~4464~~
LARRY [illegible]	FWS	289-0232
William [illegible]	Shell Oil	866-0694
Scott Klingensmith	MKE	860-8621
Rodney Gebhart	MKE	860-8621
CARL MACKEY	MKE	860-8621

ATTACHMENT B

NATURAL RESOURCES CONSERVATION COMMITTEE
TENTATIVE MEETING AGENDA
9 APRIL 1991

1. OPENING REMARKS BY COMMITTEE MEMBERS

2. U.S. FISH AND WILDLIFE SERVICE ACTIVITIES

3. RMA FACILITIES ENGINEERS REPORT

4. COMPREHENSIVE MONITORING PROGRAM

5. SHELL/MKE PROGRAMS

6. MISCELLANEOUS DISCUSSION ITEMS

7. ADJOURNMENT

APPENDIX B

TECHNICAL WORK PLAN
CONSTRUCTION OF A PRAIRIE DOG BARRIER ALONG THE NORTHWESTERN AND WESTERN BORDERS OF SECTION 36
USFWS HABITAT ENHANCEMENT PLAN 2

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

July 1991

1.0 INTRODUCTION

1.1 TASK DESCRIPTION

The U.S. Fish and Wildlife Service (Service) is conducting a prairie dog habitat enhancement program to facilitate recovery of prairie dog populations impacted by sylvatic plague and remedial cleanup activities on Rocky Mountain Arsenal (Arsenal, RMA). The project described below is designed to prevent prairie dogs from entering Section 36 and thereby becoming contaminated. Immigration into Section 36 would be arrested by construction of a permanent barrier around the western border as well as the western half of the northern border.

1.2 SITE DESCRIPTION/HISTORY

Basin A is located within Section 36 of RMA (Map 1). Millions of gallons of toxic waste from production of chemical weapons and pesticides were dumped into Basin A during the 1940's through the 1970's. Although most of the liquid waste has been removed, much of Section 36 is still highly contaminated.

The Service is concerned that prairie dogs entering Section 36 may become contaminated and be preyed upon by the endangered bald eagle or other predators. A solution to this problem is not only necessary for the protection of these predators, but protection of prairie dogs themselves is imperative to the Service's active program for reestablishing prairie dogs to RMA in the aftermath of a plague epidemic. The Service also predicts that many prairie dogs remaining in Section 36 could be destroyed by cleanup activities.

Most prairie dogs that occupy Section 36 are located in the northwestern corner. A vegetative barrier was planted in this area during 1990 to impede immigration by prairie dogs living in adjacent sections. However, additional prairie dogs entered the area before the vegetation was tall and unpalatable enough to prevent their movements.

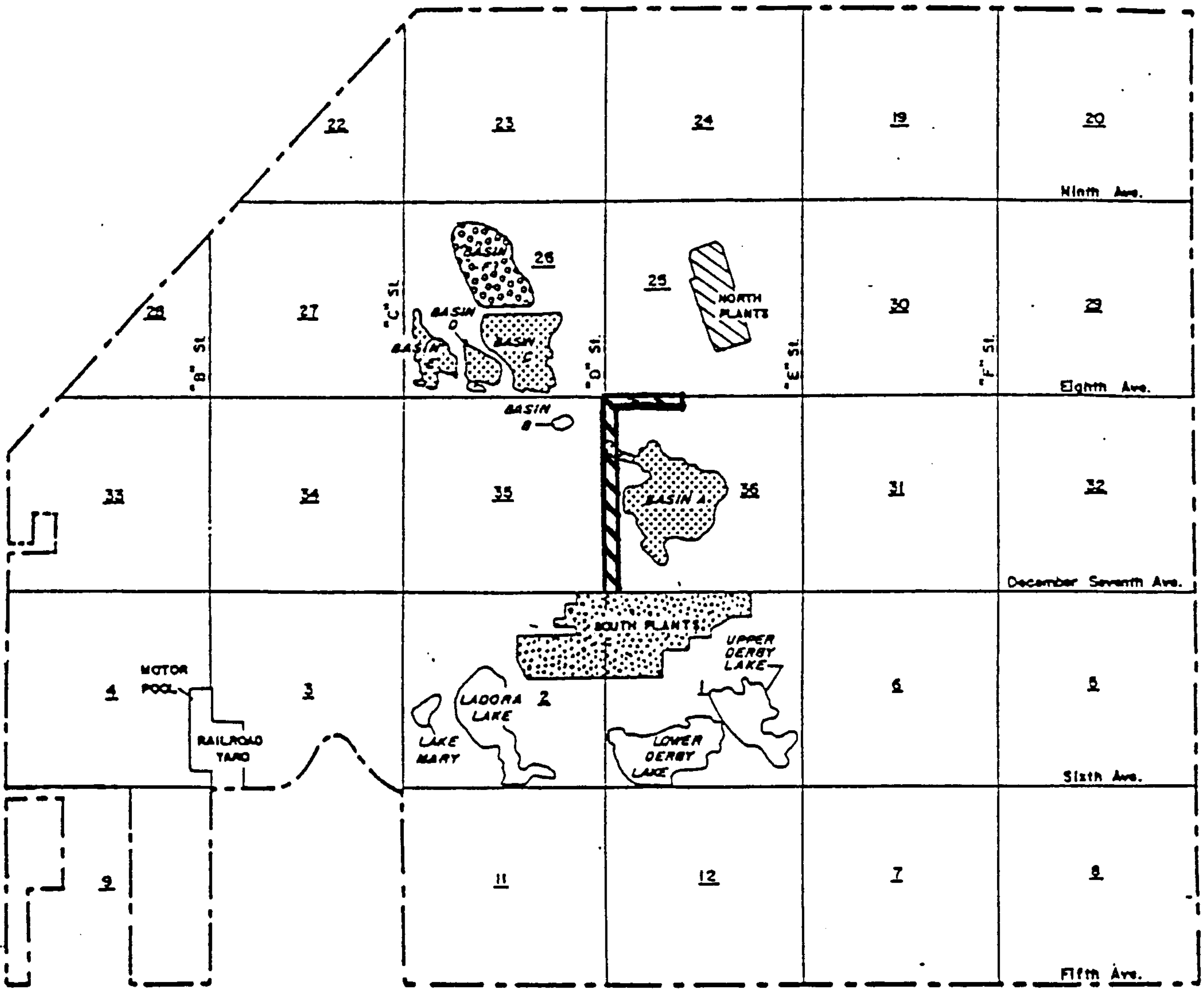
An above-ground pipeline along the western and northwestern borders of Section 36 (Map 2) was removed by Army during winter of 1991. The two rows of posts that supported the pipeline were left in place at the Service's request. The Service used these posts to support a temporary prairie dog barrier constructed during June 1991. Problems with wind damage have already occurred, further accentuating the need for a permanent barrier.

2.0 OBJECTIVES

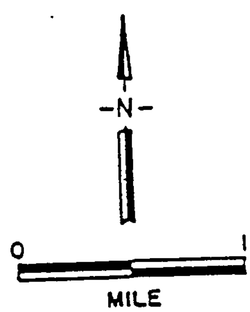
The objective of this project is prevent prairie dogs from using the northwestern portion of Section 36 by constructing a

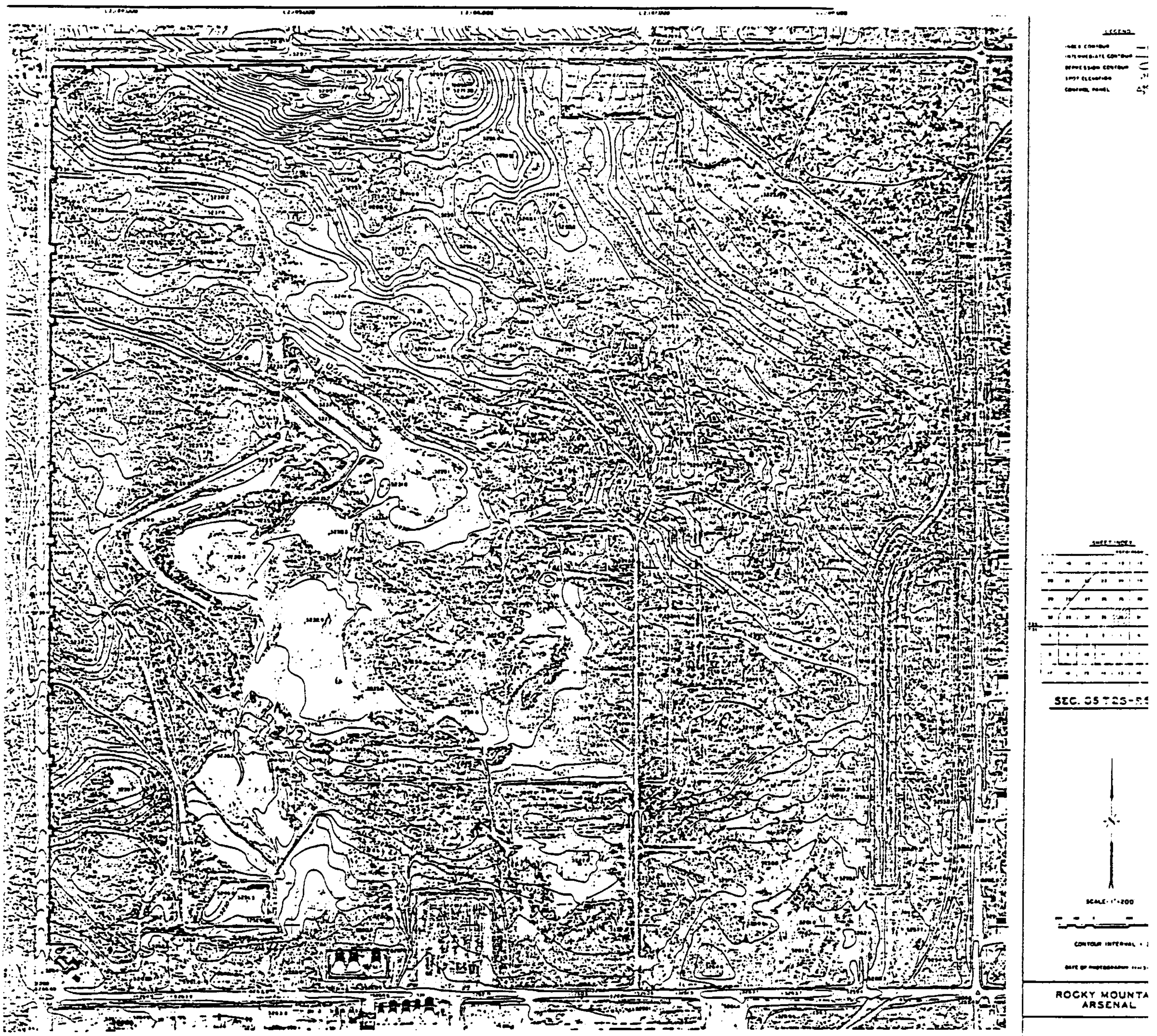
FISH AND WILDLIFE SERVICE
FISH AND WILDLIFE ENHANCEMENT
ROCKY MOUNTAIN ARSENAL FIELD OFFICE

Commerce City, Colorado



Map 1. Proposed location for prairie dog barrier for Task 2 (Construction of a Prairie Dog Barrier along the Northwestern and Western Borders of Section 36), Rocky Mountain Arsenal, 1991.





Map 2. Location of pipeline along western and northern borders of Section 36, Rocky Mountain Arsenal, 1991.

permanent physical barrier. Meeting this objective will in turn prevent (1) the contamination of prairie dogs, with ensuing management issues, and (2) the accidental destruction of these animals during cleanup efforts.

3.0 METHODS

1. The contractor must provide a health and safety plan specific to this project to supplement the contractor's "umbrella" health and safety plan.
2. The contractor will attach a permanent structure to the pipeline posts from the Fire Station north to the intersection of D Street and 8th Avenue. The structure will also be attached to the posts from the above named intersection east to the end of the posts in Section 36. The total distance of the barrier will be approximately 1.4 miles.
3. An estimated 270 additional posts will probably be necessary to fill in the gaps between current posts. These auxillary posts should be driven into the ground to prevent the necessity of digging in this area. The Service recommends the use of metal T-posts, but is open to alternatives.
4. The structure must be made of a nonreflective permanent material such as corrogated metal or hard plastic. The Service must review and approve the contractor's choice of material before its purchase.
5. The structure must be 36 inches in height.
6. The outside (i.e. street side) of the barrier must have 5-8 inches of soil placed at the base. The soil must originate from a site other than Section 36 and be uncontaminated.
7. The contractor must provide a task summary to the Service to complete this project. This summary will describe details such as what type of equipment was used, how many employees were used, how much time the job took, problems encountered, recommendations for the future, etc.

4.0 HEALTH AND SAFETY PLAN

The contractor will work under an "umbrella" health and safety plan which will encompass all of the contractor's projects. The contractor will also provide a health and safety plan specific to this project. This plan will be reviewed and approved by the Service's health and safety officer and Army's Health and Safety Office before work will be initiated.

TECHNICAL WORK PLAN
HABITAT MANIPULATIONS FOR BEMA SITE 1 -- SAND PRAIRIE -- 1991
USFWS HABITAT ENHANCEMENT PLAN 12

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

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Tel: (403) 284-9309

Rapifax-Rapicom
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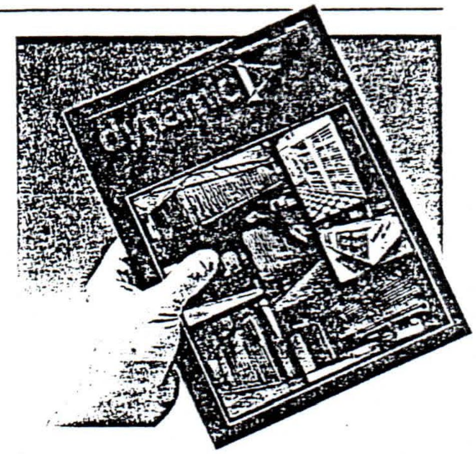

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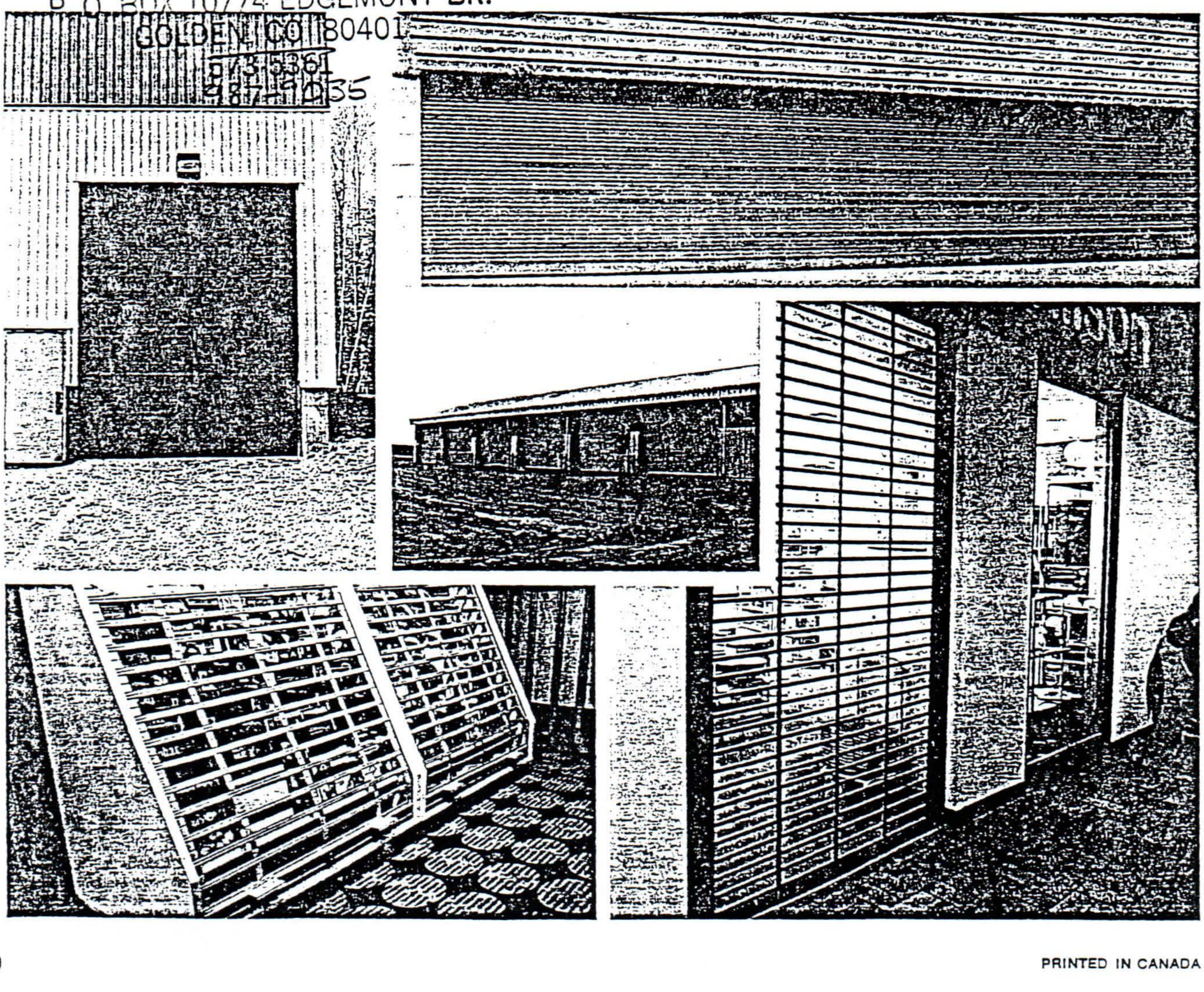


PRINTED IN CANADA

1.0 INTRODUCTION

1.1 PROGRAM/TASK DESCRIPTION

A vegetation management program was initiated at seven sites within the Bald Eagle Management Area (BEMA) of Rocky Mountain Arsenal (RMA, Arsenal) in 1989 to diversify the habitat and prey base for bald eagles and other raptors (Map 1). Fiscal Year 1991 marks the third year of this five-year enhancement project designed to mitigate losses that occurred when Arsenal property was leased to Stapleton International Airport. Fieldwork was initially conducted by Facilities Engineering during 1989 - 1990, but will be continued through Morrison-Knudson Environmental Services (a Shell contractor) for the duration of the program. The U.S. Fish and Wildlife Service (Service) will continue to serve as manager of the program. The specific task described herein is designed to create a sand prairie community in portions of Section 5 and Section 8.

1.2 SITE DESCRIPTION/HISTORY

Site 1 includes 1A in southeastern Section 5 and 1B in northwestern Section 8 (Map 1). Both areas are characterized by Bresser sandy loam soils.

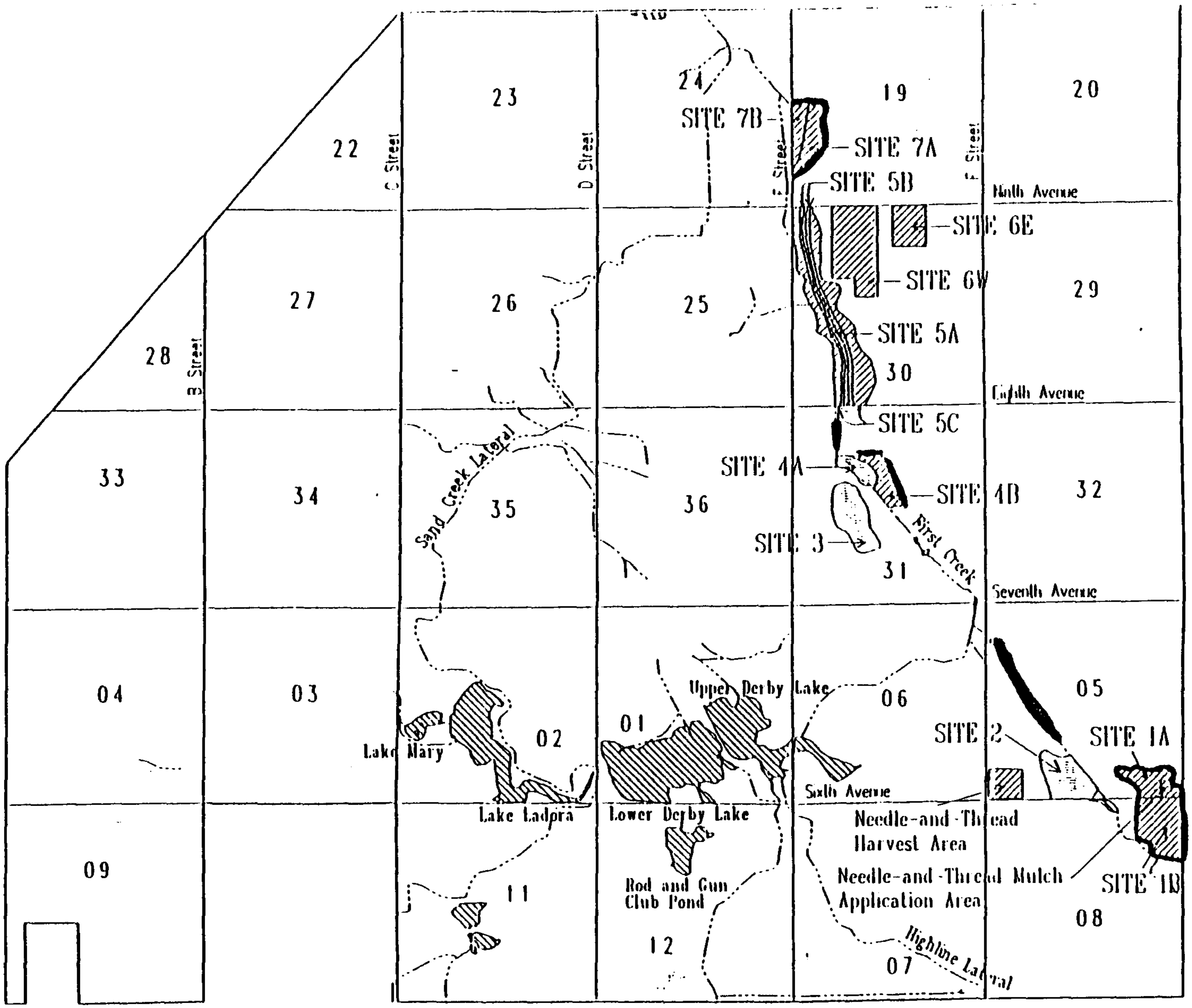
Site 1A encompasses 25 acres. The area was vegetated by cheatgrass and wild lettuce when first planted with a native seed mix in 1989. The seed mix included blue grama, needle-and-thread, sand bluestem, switchgrass, sand sagebrush, and fringed sagebrush. These desirable species are only sparsely established, and broadleaf weeds and cheatgrass remain major obstacles to establishing an appropriate sand prairie community. The area will need reseeding after weeds are controlled.

Site 1B includes 46 acres. This site was first planted with sorghum in 1990 to stabilize soils, provide winter forage and cover for wildlife, and provide competition for weedy plant species. Cheatgrass and annual and perennial broadleaf weeds persist and require additional control before seeding with native species.

2.0 OBJECTIVES

The objectives of this project are to:

1. diversify wildlife habitat and the raptor prey base by establishing sand prairie grasses, shrubs, and forbs,
2. learn more about the most appropriate methods for establishing a sand prairie community to promote efficiency during future RMA mitigation projects, and



Map 1. Habitat enhancement locations for Task 12 (Habitat Manipulations for BEMA Site 1 -- Sand Prairie -- 1991), Rocky Mountain Arsenal.

3. offset losses to wildlife habitat caused by leasing portions of the Arsenal to Stapleton International Airport.

3.0 METHODS

Service:

1. The Service shall provide oversight for this project. Service employees shall provide guidance during planning stages, advice during fieldwork, and periodic inspections of progress.

MK-Environmental Services (MK):

General:

1. The contractor shall provide recommendations for planning based on site-specific experience.

2. The contractor shall provide a health and safety plan specific to natural resource projects (including this task) to supplement the contractor's umbrella health and safety plan.

3. The contractor shall measure grass stands to quantitatively determine success.

4. The contractor shall inform the Service of any changes from the plan deemed necessary.

5. The contractor shall provide the Service with a report of the project results and recommendations for future work.

Site 1A:

1. The contractor shall apply Roundup in mid-May to control cheatgrass and annual broadleaf weeds.

2. The contractor shall apply 2,4-D in mid-July to control bindweed and other perennial broadleaf weeds.

3. The contractor shall chisel/disc in September for additional weed control.

4. The contractor shall interseed the following seed mix:

Prairie sandreed (Goshen)	1.0 lbs pls/ac
Sand bluestem (Woodward)	5.0 lbs pls/ac
Switchgrass (Nebraska)	0.3 lbs pls/ac
Sand sagebrush (Native)	0.05 lbs pls/ac
Fringed sagebrush (Native)	0.01 lbs pls/ac

5. The contractor shall apply 150 lbs/ac ammonium nitrate and 150 lbs/ac triple super phosphate as fertilizer.

Site 1B:

1. The contractor shall mow the sorghum during early May.

2. The contractor shall apply Roundup in mid-May to control cheatgrass and annual broadleaf weeds.

3. The contractor shall apply 2,4-D in mid-May and mid-July to control bindweed and other perennial broadleaf weeds.

4. The contractor shall chisel/disc in September for additional weed control.

5. The contractor shall use the following seed mix:

Blue grama (Hachita variety)	0.75 lbs pure live seed/acre
Prairie sandreed (Goshen)	1.0 lbs pls/ac
Sand bluestem (Woodward)	5.0 lbs pls/ac
Switchgrass (Nebraska)	0.3 lbs pls/ac
Sand sagebrush (Native)	0.05 lbs pls/ac
Fringed sagebrush (Native)	0.01 lbs pls/ac

6. The contractor shall apply and crimp a weed-free grass hay mulch after seeding.

4.0 <u>HEALTH AND SAFETY PLANS</u>

Service personnel shall abide by the Service's Station Safety Plan. MK personnel and their subcontractors shall work under MK's Health and Safety Plan. MK shall also provide and work under an additional health and safety plan specific to natural resource projects on the Arsenal.

5.0 <u>DELIVERABLES</u>

Three deliverable items are required to complete this project.

1. Planting of native seed mix in Site 1A.

2. Planting of native seed mix in Site 1B.

3. Report of project results with recommendations for future work.

6.0 SCHEDULE

Starting date:	April 15, 1991
Completion date (fieldwork):	September 30, 1991
Completion date (report):	November 30, 1991

1.0 INTRODUCTION

1.1 PROGRAM/TASK DESCRIPTION

A vegetation management program was initiated at seven sites within the Bald Eagle Management Area (BEMA) of Rocky Mountain Arsenal (RMA, Arsenal) in 1989 to diversify the habitat and prey base for bald eagles and other raptors (Map 1). Fiscal Year 1991 marks the third year of this five-year enhancement project designed to mitigate losses that occurred when Arsenal property was leased to Stapleton International Airport. Fieldwork will be conducted by Morrison-Knudson Environmental Services (a Shell contractor) for most tasks within the program. The U.S. Fish and Wildlife Service (Service) will serve as manager of the program. The specific task described herein is designed to create jackrabbit habitat in south-central Section 5. Unlike the other six tasks, this one will be conducted by Facilities Maintenance with guidance by Morrison-Knudson.

1.2 SITE DESCRIPTION/HISTORY

Site 2 is located west of First Creek in south-central Section 5. The site encompasses 20 acres and is characterized by Bresser sandy loam soils. It was vegetated mostly by crested wheatgrass and smooth brome when the project began in 1989. The area appears well suited for introduction of black-tailed jackrabbits because (1) woody vegetation provides cover immediately west of the site where a homestead once existed, (2) woody vegetation and tall grass along First Creek provide additional cover and shelter, and (3) an adequate food base exists in the form of grasses and forbs.

Mowing the vegetation and planting some shrubs was initiated in 1989 to provide additional aspects of the habitat that may have been missing previously. Mowing was completed for the majority of the site each year, but with some strips of tall vegetation left alone. Two hundred shrubs (50 of each species) of the following species were planted in clumps of 10 each and protected from premature browsing with wire cages:

Choke cherry	*Prunus virginiana*
American plum	*Prunus americana*
Snowberry	*Symphoricarpos occidentalis*
Three-leaf sumac	*Rhus trilobata*

2.0 OBJECTIVES

The objectives of this project are to:

1. diversify wildlife habitat and the raptor prey base by enhancing jackrabbit habitat,

5.0 DELIVERABLES

Three deliverable items are required to complete this project:

1. Site-specific health and safety plan.
2. Permanent prairie dog barrier with the specifications described above.
3. Task summary with the specifications described above.

6.0 SCHEDULE

Preferred project duration:	60 days from issuance of delivery order

TECHNICAL WORK PLAN
LANDSCAPING AND REVEGETATION AT THE EAGLE WATCH
STUDY AND RECOMMENDATIONS PLAN
USFWS HABITAT ENHANCEMENT PLAN 4A

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

July 1991

1.0 INTRODUCTION

1.1 TASK DESCRIPTION

This study is designed to evaluate the current status at the Eagle Watch area and make recommendations for improvements in landscaping, revegetation, and to a lesser extent interpretation. The contractor's role will be limited to these facets of the Eagle Watch alterations. Construction will be performed by a separate contractor at a later date under Wildlife Habitat Enhancement Task Plan 4B.

1.2 SITE DESCRIPTION/HISTORY

The U.S. Fish and Wildlife Service (Service) currently staffs a facility in the eastern portion of the Rocky Mountain Arsenal (Arsenal, RMA) for public viewing of a winter bald eagle roost and interpreting cleanup issues. This viewing blind, named the Eagle Watch, is located on a hill approximately 1/2 mile east of the communal roost in Section 5. The Eagle Watch was first constructed by the U.S. Army (Army) in 1989 and was renovated during fall of 1990. While the current blind is an excellent viewing facility, several aspects of the surrounding area need improvement.

The soils in the area are mostly variations of sandy loam. The vegetation is characterized by weedy forbs, cheatgrass, and some native perennial grasses. A problem plant species on the site is bindweed, which has severely damaged the asphalt path between the parking lot and the blind.

2.0 STUDY OBJECTIVES

The objectives of this project are to study the Eagle Watch area and make recommendations for improvements that would enhance esthetics, improve interpretive features, and prevent people from wandering out of public access areas (e.g. off the path). The following specific information will be addressed in the recommendations:

1. Type (e.g. gravel), shape, and size of parking lot.
2. Gates for entrance and for accessing perimeter road.
3. Type (e.g. portable) and location of restroom facilities.
4. Type (e.g. concrete) and location of handicap-accessible path from parking lot to blind.
5. Type of esthetic fence to encompass parking lot.
6. Necessity of fence to blind. If necessary, type of fence for the handicap-accessible trail.
7. Necessity and location of pullouts on trail.
8. Reseeding of native grasses and forbs on disturbed soil.
9. Landscaping of the top and sides of the blind, particularly with native shrubs.
10. Ideas on type and location of interpretive features to help Service staff interpret wildlife, native prairie, and cleanup issues.

3.0 STUDY APPROACH

The Service recommends that Dr. Merlyn Paulson of Colorado State University be contracted to plan this project. Dr. Paulson has considerable experience with this type of planning construction activities for public use facilities.

The contractor should first meet with Service staff from Mitigation and Community Relations divisions. This meeting should include a thorough tour of the site. Additional maps will be given to the contractor during this visit.

The contractor should make as many site visits as deemed necessary.

The contractor should discuss all aspects of the project with Service staff before making recommendations. In particular, the contractor should discuss species of plants with the Mitigation staff.

The contractor should write a task summary. This summary should report the study results, make recommendations for construction work to be done by a separate contractor, and provide a budget account.

4.0 HEALTH AND SAFETY PLAN

The contractor will receive a copy of the Service's Health and Safety Plan with the first meeting and will follow this plan explicitly. Specifically, the contractor will access the area by section roads only, will clear each site visit with either the Service's Activities Coordination Section or Army's Compliance Office before entering the area, and will not wander from the study location (i.e. Eagle Watch parking lot, path, and blind area) unless on official business and accompanied by appropriate Service staff.

5.0 DELIVERABLES

The only deliverable item is a task summary (i.e. final report). This summary should include:

1. Study results.
2. Recommendations for future construction.
3. Appropriate maps and\or drawings.
4. Budget account.

6.0 STUDY SCHEDULE

Preferred starting date: July 15, 1991
Preferred completion date: August 5, 1991

TECHNICAL WORK PLAN
LANDSCAPING, REVEGETATION, AND CONSTRUCTION AT THE EAGLE WATCH
USFWS HABITAT ENHANCEMENT PLAN 4B, PHASE 1

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

September 1991

1.0 INTRODUCTION

1.1 TASK DESCRIPTION

This project is designed to implement Phase 1 of Task 4B, i.e. landscaping, revegetation, and construction at the Eagle Watch area (Map 1) of Rocky Mountain Arsenal (RMA, Arsenal). Phase 1 will be limited to (1) renovation of the path to the Eagle Watch into a handicapped accessible walkway and (2) purchase and installation of a secure rolling grille over the front of the blind. Future phases will address more conventional landscaping and vegetation activities and will be initiated in Fiscal Year 1992. Most work from all phases will implement recommendations submitted by a landscape architect as completion of Task 4A. The entire project will serve as mitigation for losses to wildlife habitat during construction of the Submerged Quench Incinerator facility and immediate vicinity in Section 26.

1.2 SITE DESCRIPTION/HISTORY

The U.S. Fish and Wildlife Service (Service) currently staffs a facility in the eastern portion of the Arsenal for public viewing of a winter bald eagle roost and interpreting cleanup issues. This viewing blind, named the Eagle Watch, is located on the highest point in Section 5 (5320 ft elevation), approximately one half mile east of the communal roost. The Eagle Watch was first constructed by the U.S. Army (Army) in 1989 and was renovated during fall of 1990. While the current blind is an excellent viewing facility, several aspects of the surrounding area need improvement.

The soils in the area are mostly variations of sandy loam. A low area with almost level topography exists in front of (i.e. west of) the blind. A natural basin exists north of the center of the path. Numerous prairie dogs can be found near the path and west of the blind.

The vegetation is characterized by weedy forbs, cheatgrass, and some native perennial grasses. A problem plant species on the site is bindweed, which has severely damaged the asphalt path between the parking lot and the blind.

2.0 OBJECTIVES

The objectives of Task 4B (all phases) are to:

1. Mitigate for losses to wildlife habitat during the construction and operation of the Submerged Quench Incinerator facility.

2. Produce native vegetation for wildlife habitat.

3. Enhance esthetics, improve interpretive features, and control movements of visitors in the area.

The specific objectives for Phase 1 of the plan are to:

1. Construct an improved, handicapped accessible path that will improve distribution of visitors between the parking lot and the eagle blind.

2. Provide security for the equipment inside the blind by purchasing and installing a rolling grill security window for the front of the blind.

3.0 METHODS, PHASE 1

Service:

1. The Service shall accompany the contractor on a pre-work site visit or on the first day of work or both to provide information necessary to complete the project.

2. The Service shall provide regular inspections of the work to ensure adequate communication between the Service and the contractor.

Contractor:

1. The contractor shall provide a brief health and safety plan specific to this project to supplement the contractor's umbrella health and safety plan.

2. The contractor shall purchase and install a rolling grille for the front of the blind. The contractor shall consult the attached specifications for details.

3. The contractor shall remove the existing asphalt pathway between the blind and the parking area.

4. The contractor shall construct a path where the asphalt path now exists (Figure 1). The path shall extend 25 ft into the parking lot. The path shall have pullouts on both sides of the path at its entrance (Figure 2). An additional pullout shall be constructed at each of the two bends in the path (Figures 3-4). The path shall be approximately 8 ft wide except in bends where it will widen to approximately 10-12 ft. The path shall never exceed 3 degrees, in order to be handicapped accessible. Pullouts shall be graded for drainage only.

5. The contractor shall provide an aggregate base of 6-10 inches for all portions of the path and pullouts.

6. The contractor shall provide reinforcing welded wire for the path.

7. The contractor shall provide 6-8 inches of concrete (exposed aggregate not to exceed 3/8 inch size) on top of the base. The aggregate shall be in earthtones similar to the color of the soil in the vicinity of the path.

8. The contractor shall wash the surface of the concrete to expose the aggregate.

9. The contractor shall provide gentle swells in the soil beside the trail between the blind and the nearest bend in the path to carry water. The contractor shall also provide a small culvert to carry the water south of this portion of the trail under the path where it can runoff to the north.

10. The contractor shall avoid disturbance to existing shrubs and minimize disturbance to other vegetation when conducting Phase 1.

11. The contractor shall return to the Service any materials or equipment purchased for this project at project completion.

12. The contractor shall obtain prior permission to access portions of Section 5 on a weekly basis through the RMA Activities Coordination System.

13. The contractor shall make every reasonable attempt to complete Phase 1 work in Section 5 prior to October 15 (i.e. closing of the Bald Eagle Management Area). Use of Section 5 after October 15 shall be coordinated with the RMA Activities Coordination System if absolutely necessary, and then only on a limited time-of-day basis. Travel routes to the site after October 15 shall be limited to the northern and eastern perimeter roads or Buckley Road to avoid transversing the Bald Eagle Management Area.

4.0 HEALTH AND SAFETY PLAN

The contractor shall work under an "umbrella" health and safety plan which encompasses all of the contractor's work at the Arsenal. The contractor shall also provide a brief health and safety plan specific to this project. This plan shall be reviewed and approved by the Service Health and Safety Officer and Army's Health and Safety Office before work will be initiated.

5.0 DELIVERABLES, PHASE 1

Three deliverable items are required for the contractor to complete Phase 1:

1. A brief, site-specific health and safety plan.

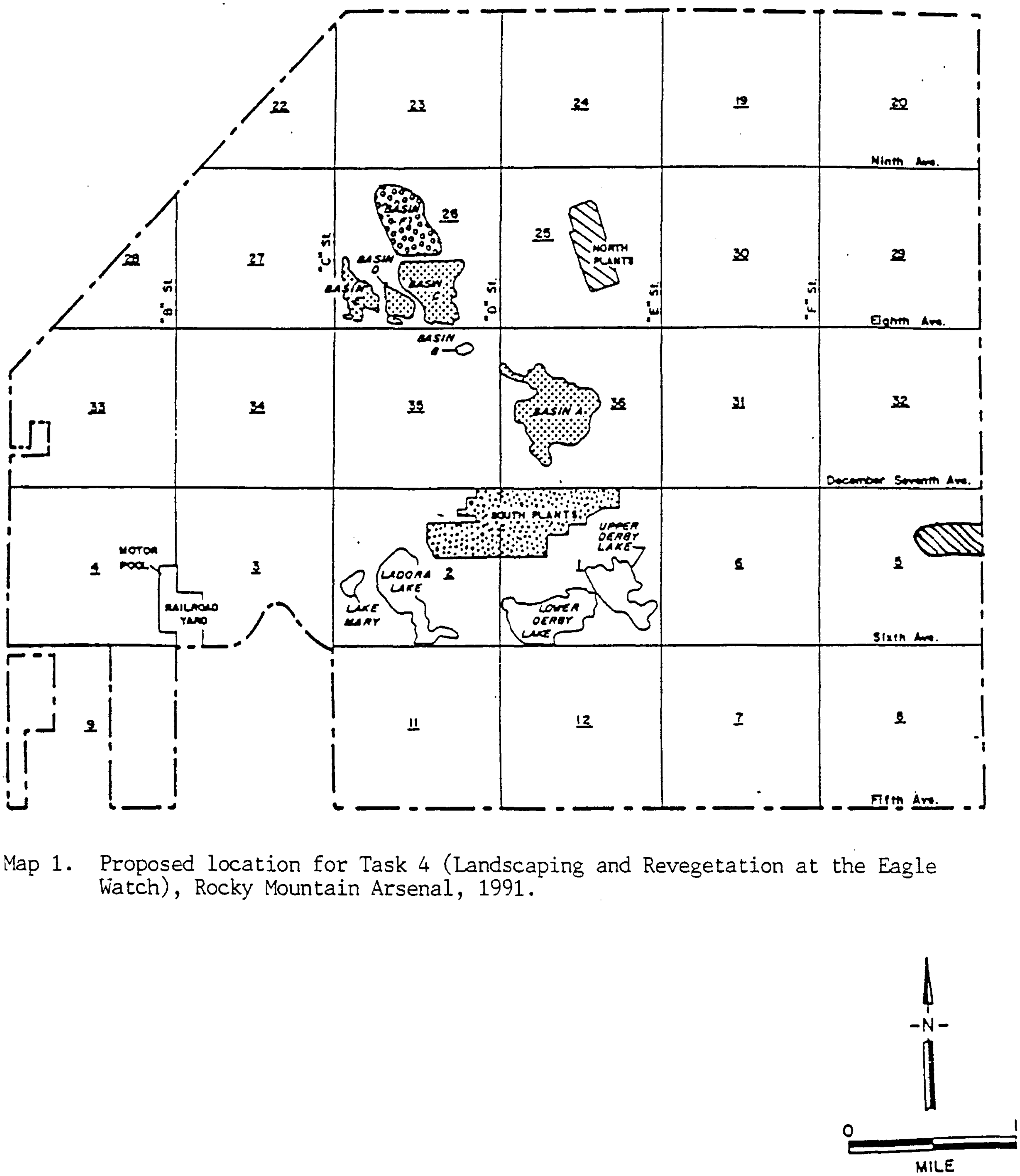
2. Purchase and installation of a rolling grille on the front of the blind for Security.

3. Replacement of the current asphalt path with a concrete aggregate path with pullouts, as described above.

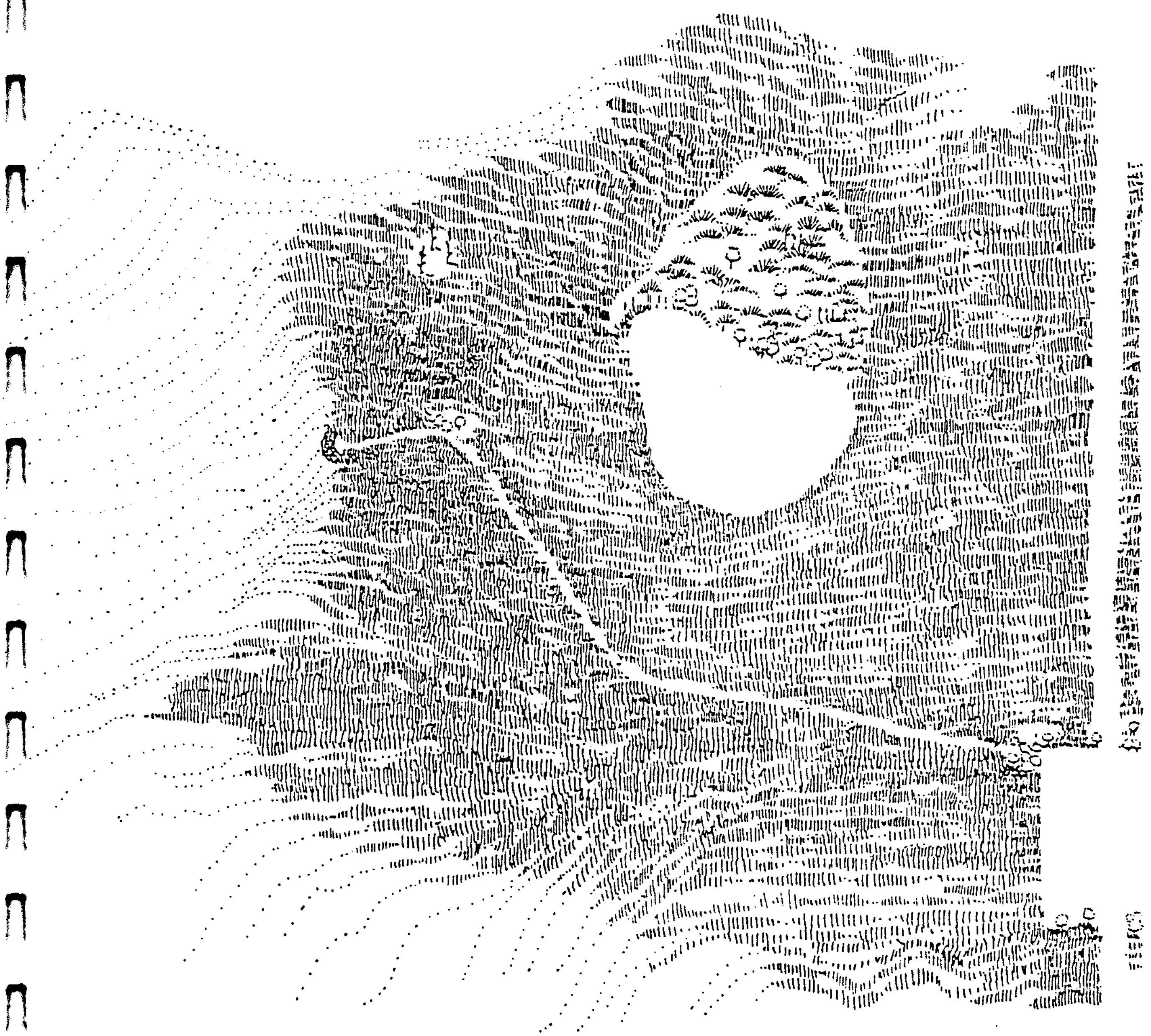
6.0 SCHEDULE, PHASE 1

Period of Performance:	30 calendar days from issuance of delivery order

Figure 1. Drawing of pathway between the parking lot and the Eagle Watch blind, Section 5, Rocky Mountain Arsenal, 1991.

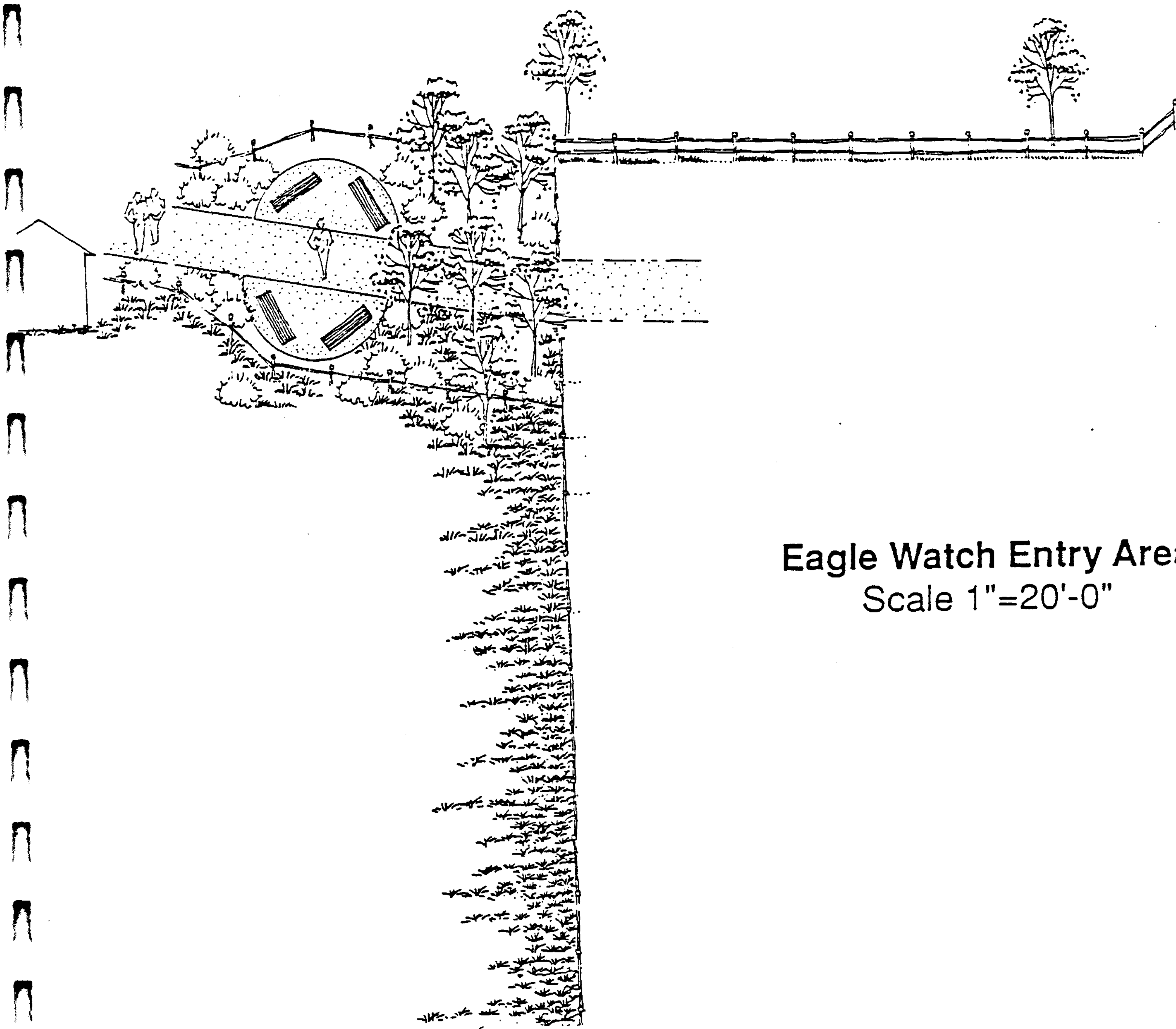


Map 1. Proposed location for Task 4 (Landscaping and Revegetation at the Eagle Watch), Rocky Mountain Arsenal, 1991.



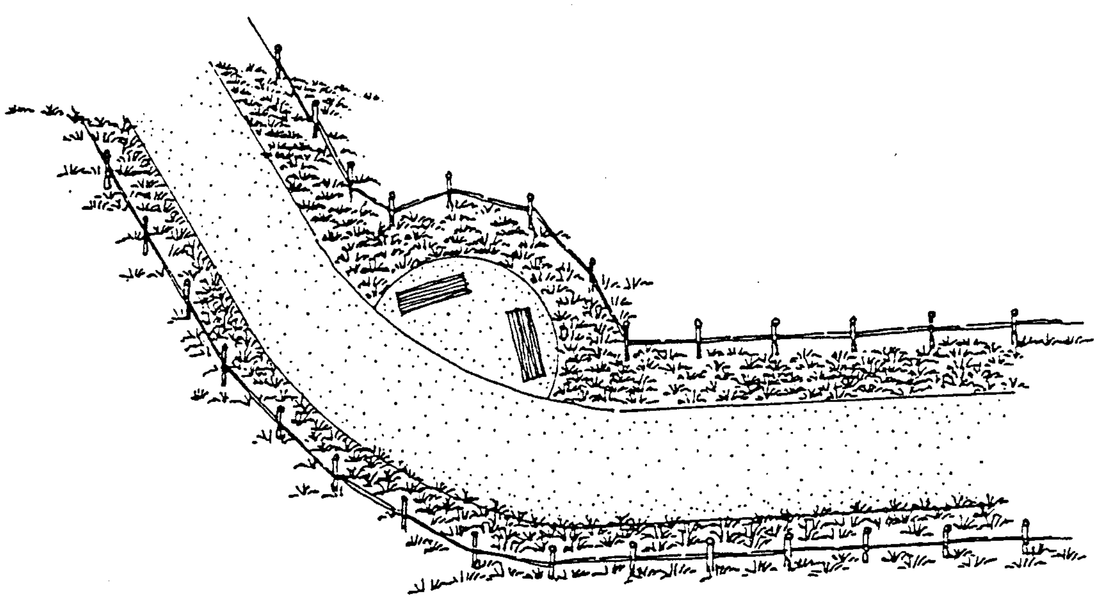
Eagle Watch Vicinity
Scale 1"=200'-0"

Figure 2. Pathway entrance at the Eagle Watch parking area, Section 5, Rocky Mountain Arsenal, 1991.



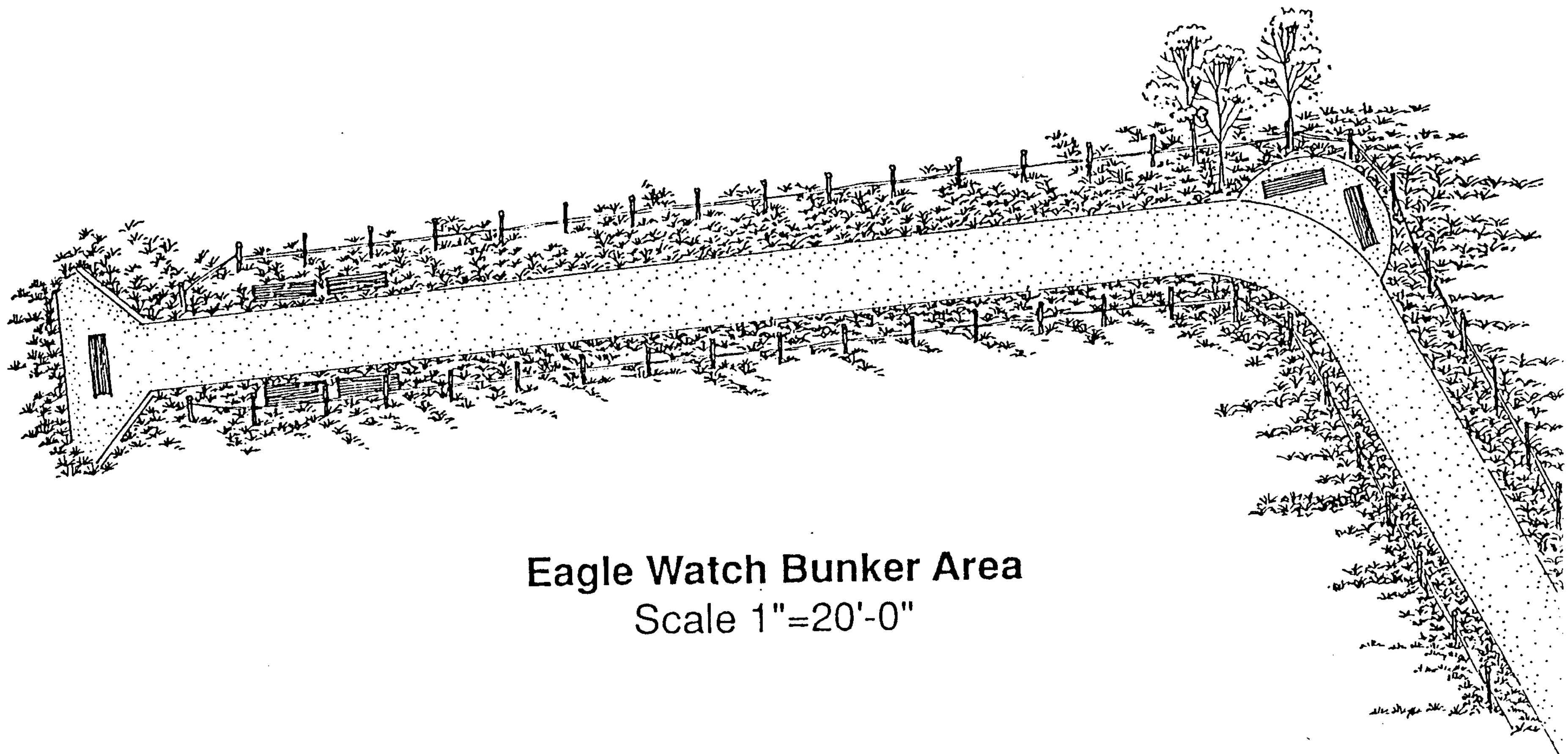
Eagle Watch Entry Area
Scale 1"=20'-0"

Figure 3. Pullout in middle of pathway between the parking area and Eagle Watch blind, Section 5, Rocky Mountain Arsenal, 1991.



Mid-Walk Pullout Area
Scale 1"=20'-0"

Figure 4. Pullout nearest the blind on pathway between parking lot and Eagle Watch facility, Section 5, Rocky Mountain Arsenal, 1991.



Eagle Watch Bunker Area

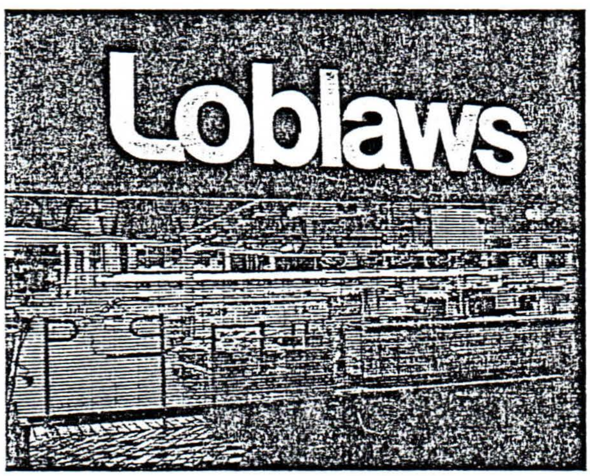
Scale 1"=20'-0"

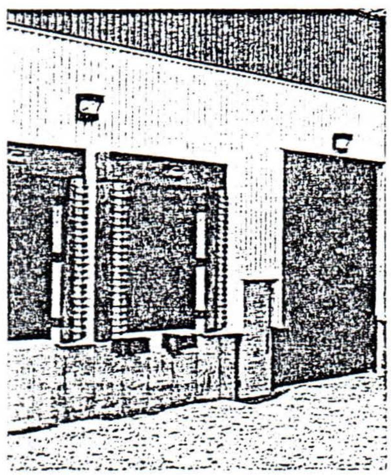
Attachment 1. Rolling grille materials for Eagle Watch facility, Section 5, Rocky Mountain Arsenal, 1991.

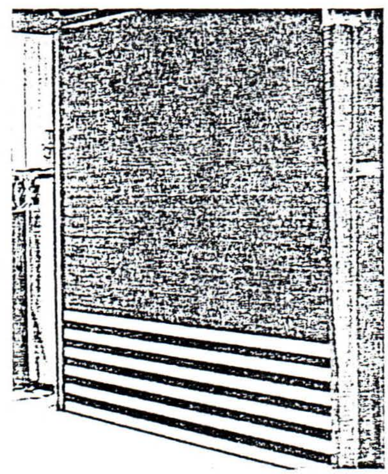
dynamic

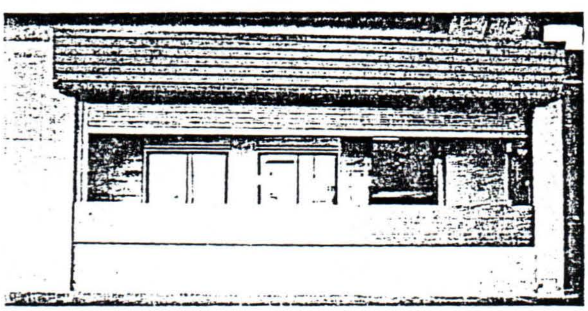
rolling service doors
rolling insulated doors
rolling fire doors
rolling counter shutters
rolling grilles & closures

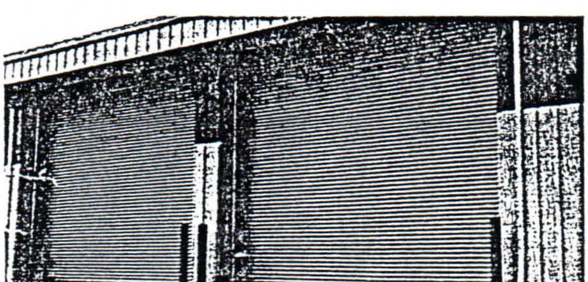
NEW!!!
INSUL-AIR™
2" THICK
INSULATED METAL ROLLING DOORS

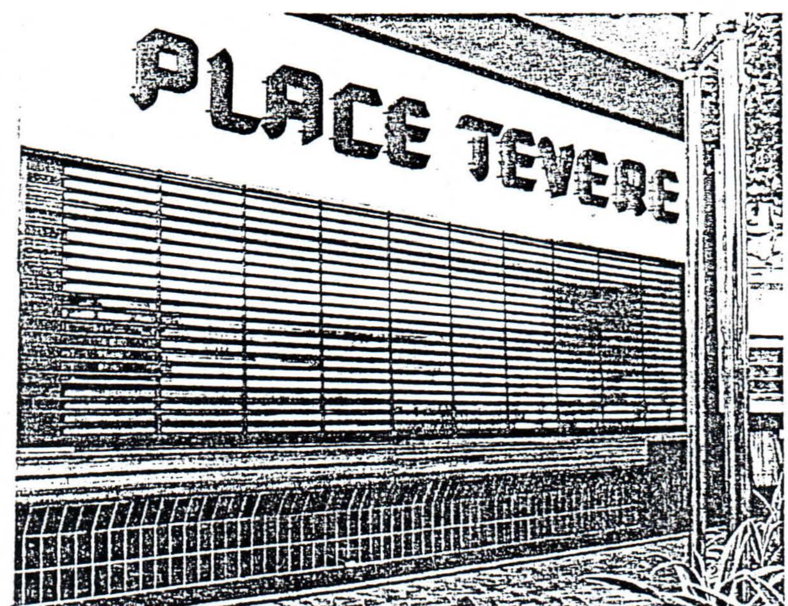










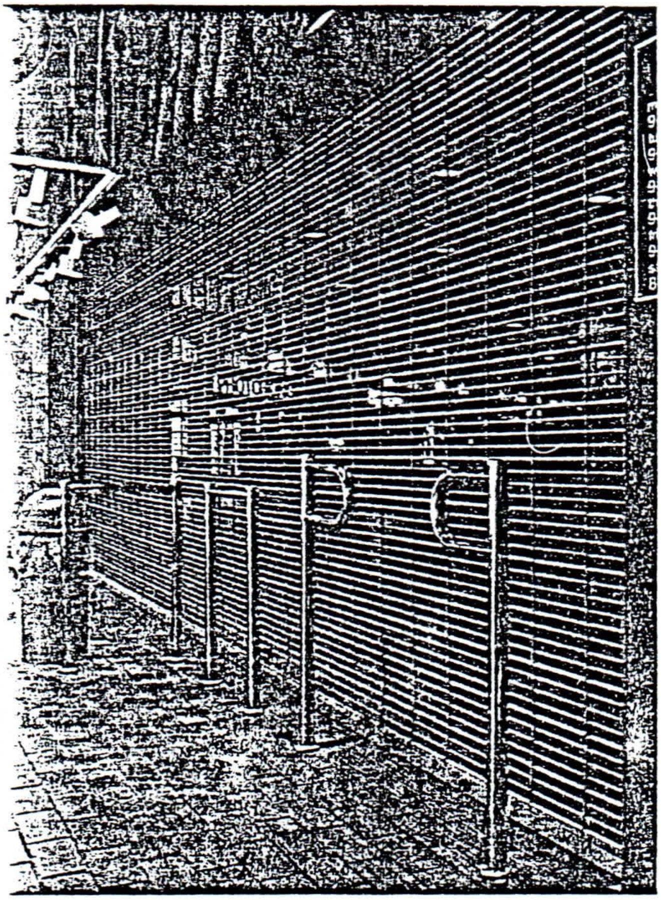


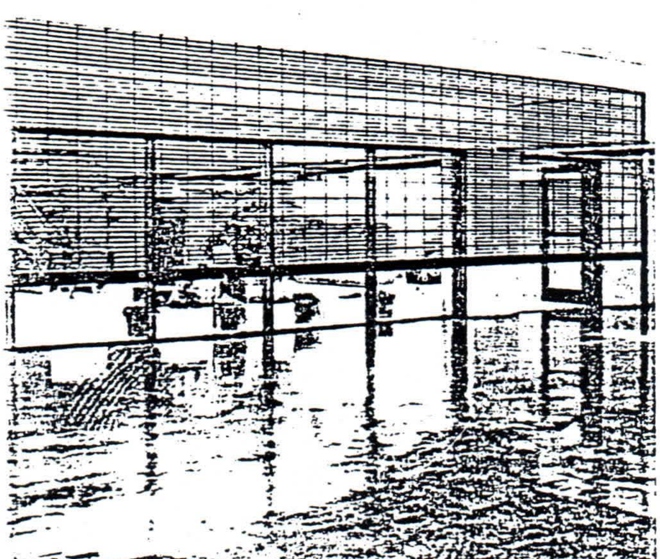
"Where Quality Is Locked In"

olling grilles

YNAIR

pen grille with no glazing





SPECIFICATIONS

Supply and install rolling closures where shown on drawings as manufactured by DYNAMIC CLOSURES CORP. (Tel. 516-654-9426).

Work excluded (unless otherwise specified): Preparation of openings, steel jambs or supports, trims, access panels, field painting. On motor operated grilles, field wire, wiring, conduit and disconnect switches.

Operation Manual push up (not recommended over one hundred and eight square feet – 16 m2); Crank operation; Motor-Operation, see page 7.

Counterbalance Shaft with oil tempered springs in pipe shafts shall be designed for deflection no greater than .03" per foot of width (2.5 mm per meter of width). Shaft shall be equipped with means of field adjustment.

Curtain (specify appropriate Model).

Guides shall be extruded aluminum with upset shoulders for curtain retention. Each guide shall be fitted with vinyl stripping for quiet operation.

Hoods on exposed coil installations, or removable soffits on flush ceiling conditions shall be of the same material and finish as the curtain, minimum #24 gauge. Hood brackets or stiffeners shall be provided.

Locking slide bolts on manual and hand crank operated grilles. Gear reducer and electro magnetic brake on motor operated grilles.

Finish Clear Anodized.

Optional Extras: Color finishes on aluminum grilles.

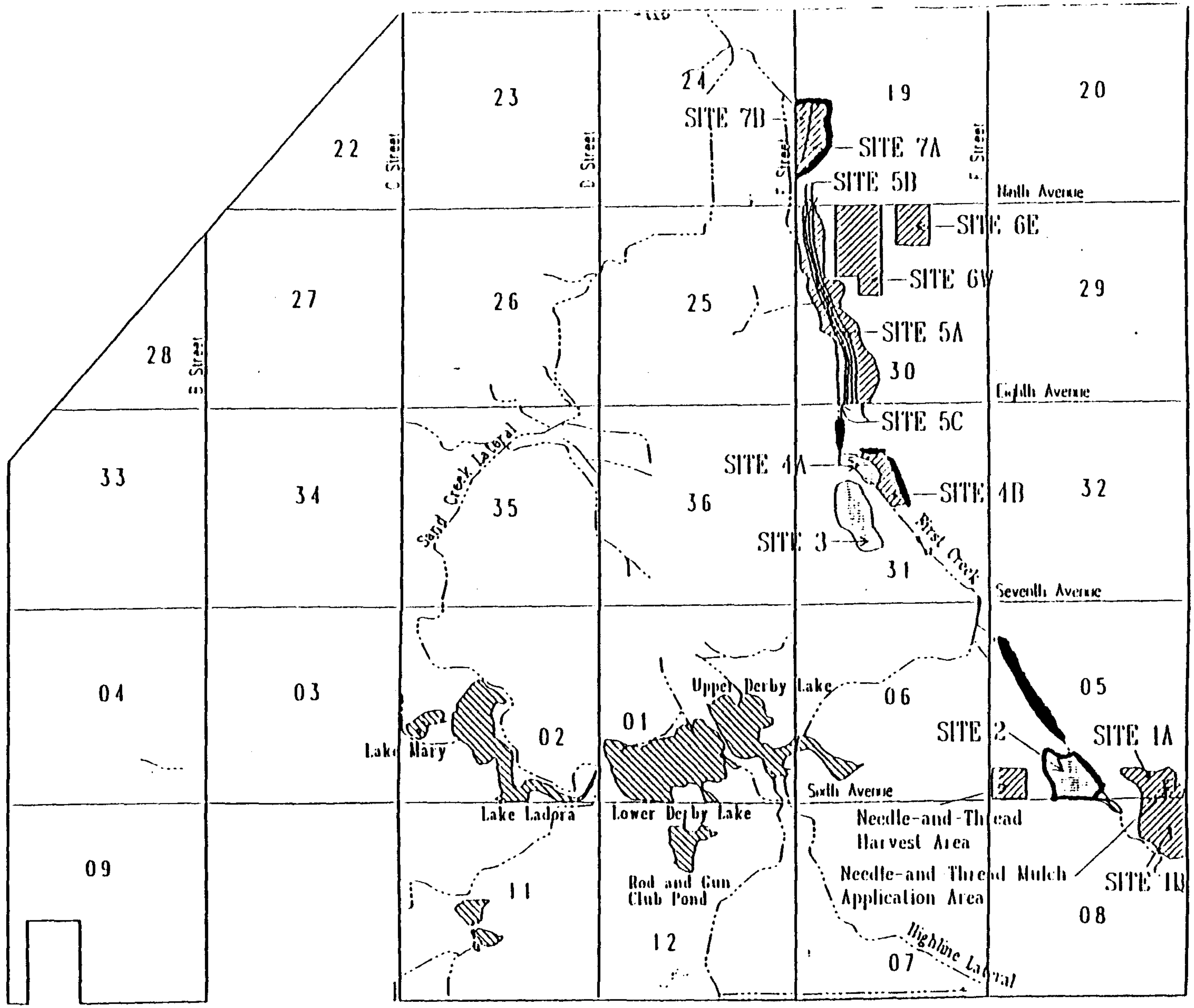
Safety Edge (Add)
Safety edges are to be furnished for motor operated doors. Upon contact with an obstruction the door should stop or reverse its travel. Specify electric or pneumatic edge.

Special Emergency Release
A manual release system to meet the exit requirements of building codes shall be furnished to manually open motor operated grilles for emergency exit. This device does not require electrical power to open grille.

"DYNAIR" GRILLE CURTAIN to be constructed of continuous aluminum flat vertical links 1/8" x 5/8" x 3 5/8" at 9" centers attached to and forming a rolling connection with 5/16" aluminum round bars. Horizontal members shall be spaced no greater than 1 1/2". Every double link center rod shall have a cover sleeve.

"DYNALEX" GLAZED WITH LEXAN. This curtain shall be fabricated using a continuous double channel extruded aluminum section with "V" groove line appearance on 3" centers. Aluminum and Lexan Panels shall be 12" x 5/8" x 1/16" in thickness. The aluminum panel connectors shall be 2 1/2" x 1".

"DYNAGLAS" GLAZED WITH TEMPERED GLASS. This curtain shall be fabricated using a continuous double channel extruded aluminum section with "V" groove line appearance on 3" centers. Glass shall be retained with specially designed vinyl compression gaskets. Ends of glass edges shall be encapsulated in rigid vinyl spline. Glass panels shall be 2 1/8" x 24" x 3mm tempered glass.



Map 1. Habitat enhancement location for Task 13 (Habitat Manipulations for BEMA Site 2 -- Jackrabbit Plot -- 1991), Rocky Mountain Arsenal.

2. learn more about the most appropriate methods for establishing a jackrabbit habitat in order to save time and money during future RMA mitigation projects for cleanup, and

3. mitigate losses to wildlife habitat caused by leasing portions of the Arsenal to Stapleton International Airport.

3.0 METHODS

Service:

1. The Service shall provide oversight for this project. Service employees shall provide guidance during planning stages and inspection of the project.

Morrison-Knudson (MK):

1. The contractor shall provide recommendations for planning based on site-specific experience.

2. The contractor shall provide a health and safety plan specific to natural resource projects (including this task) to supplement the contractor's umbrella health and safety plan.

3. The contractor shall inform the Service of any changes from the plan deemed necessary.

4. The contractor shall provide the Service with a report of the project results and recommendations for future work.

Facilities Maintenance (FM):

1. FM shall mow the area during mid-May.

4.0 HEALTH AND SAFETY PLANS

Service personnel shall abide by the Service's Station Safety Plan. MK personnel shall work under MK's Health and Safety Plan and a supplemental plan specific to natural resource projects on the Arsenal. Facilities Maintenance personnel shall abide by their Army health and safety plan.

5.0 DELIVERABLES

Two deliverable items are required to complete this project for FY 91.

1. Mowing of appropriate mosaic pattern.

2. Report of project results with recommendations for future work.

6.0 SCHEDULE

Starting date:	May 10, 1991
Completion date (fieldwork):	May 31, 1991
Completion date (report):	November 30, 1991

TECHNICAL WORK PLAN
HABITAT MANIPULATIONS FOR BEMA SITE 4 -- TALLGRASS PRAIRIE -- 1991
USFWS HABITAT ENHANCEMENT PLAN 14

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

1991

1.0 INTRODUCTION

1.1 PROGRAM/TASK DESCRIPTION

A vegetation management program was initiated at seven sites within the Bald Eagle Management Area (BEMA) of Rocky Mountain Arsenal (RMA, Arsenal) in 1989 to diversify habitat and the prey base for bald eagles and other raptors (Map 1). Fiscal Year 1991 marks the third year of this five-year enhancement project designed to mitigate losses that occurred when Arsenal property was leased to Stapleton International Airport. Fieldwork was initially conducted by Facilities Engineering during 1989 - 1990, but will be continued through Morrison-Knudson Environmental Services (a Shell contractor). The U.S. Fish and Wildlife Service (Service) will continue to serve as manager of the program. The specific task described herein is designed to create a tallgrass prairie community in Section 31.

1.2 SITE DESCRIPTION/HISTORY

Site 4 includes 4A and 4B, both of which are located in central Section 31 east of First Creek (Map 1). Both areas are characterized by aquic haplustoll soils.

Site 4A encompasses 9 acres. The area was vegetated with a very tall, dense stand of Canada thistle and smooth brome before being treated with herbicides and planted with cereal rye in 1989 to stabilize the soil and outcompete weeds. Big bluestem, switchgrass, Indian grass, sideoats grama, and prairie cordgrass were planted in 1990 to establish a lowland tallgrass prairie community. Progress will be measured during summer and fall of 1991 to determine future needs for the area.

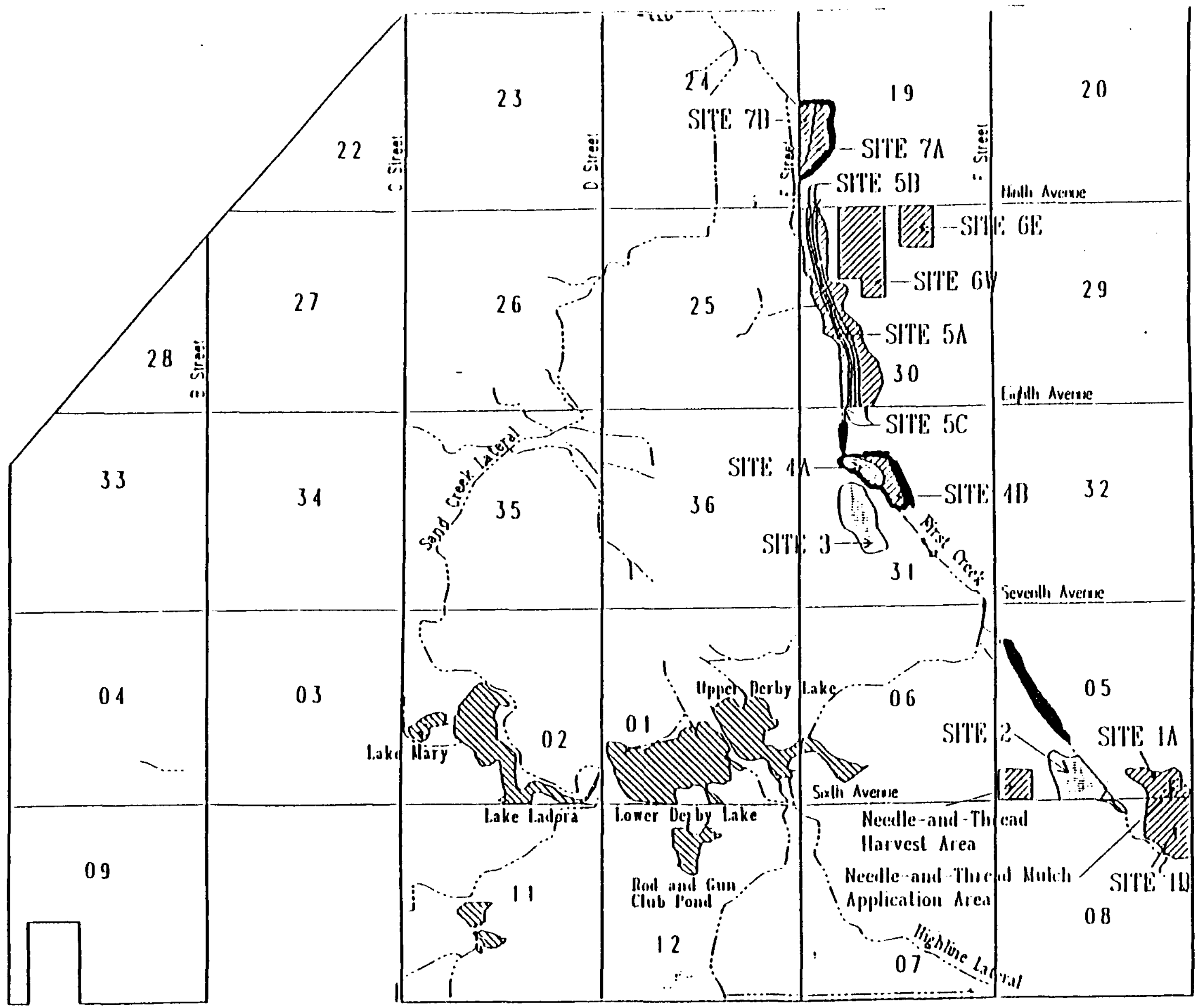
Site 4B includes 15 acres bordering 4A to the east and south. A similar strategy was used for 4B as was described for 4A except that the process began 1 year later. Cheatgrass remains a weed problem and must be chemically controlled.

2.0 OBJECTIVES

The objectives of this project are to:

1. diversify wildlife habitat and the raptor prey base by establishing a tallgrass prairie community,

2. learn more about the most appropriate methods for establishing a tallgrass prairie community in order to save time and money during future RMA mitigation projects for cleanup, and



Map 1: Habitat enhancement locations for Task 14 (Habitat Manipulations for BEMA Site 4 -- Tallgrass Prairie -- 1991), Rocky Mountain Arsenal.

3. offset losses to wildlife habitat caused by leasing portions of the Arsenal to Stapleton International Airport.

3.0 METHODS

Service:

1. The Service shall provide oversight for this project. Service employees shall provide guidance during planning stages, advice during operation, and periodic inspections of progress.

Morrison-Knudson (MK):

General:

1. The contractor shall provide recommendations for planning based upon site-specific experience.

2. The contractor shall provide a health and safety plan specific to natural resource projects (including this task) to supplement the contractor's umbrella health and safety plan.

3. The contractor shall measure vegetation stands to quantitatively determine success.

4. The contractor shall inform the Service of any changes from the plan deemed necessary.

5. The contractor shall provide the Service with a report of the project results and recommendations for future work.

Site 4A:

1. The contractor shall mow during late July for weed control.

2. The contractor shall then interseed with the following seed mix:

Big bluestem (Kaw variety)	3.4 lbs pure lv seed/ac
Little bluestem (Pastura)	1.7 lbs pls/ac
Yellow Indiangrass (Holt)	3.4 lbs pls/ac
Switchgrass (Nebraska 28)	1.1 lbs pls/ac

Site 4B:

1. The contractor shall apply Roundup around May 1 prior to flower formation by cheatgrass.

2. The contractor shall apply 2,4-D around mid-July to control perennial weeds, especially Canada thistle.

3. The contractor shall retain an appropriate buffer zone (as determined by the literature) between herbicide applications and water sources.

4. The contractor shall chisel/disc in September to prepare the soil for seeding.

5. The contractor shall use the following seed mix:

Big bluestem (Kaw variety)	3.4 lbs pure lv seed/ac
Little bluestem (Pastura)	1.7 lbs pls/ac
Yellow Indiangrass (Holt)	3.4 lbs pls/ac
Switchgrass (Nebraska 28)	1.1 lbs pls/ac
Side-oats grama (Vaughn)	2.3 lbs pls/ac

6. The contractor shall apply 150 lbs/ac ammonium nitrate and 150 lbs/ac triple super phosphate as fertilizer.

7. The contractor shall apply and crimp a weed-free grass hay mulch after seeding.

4.0 HEALTH AND SAFETY PLANS

Service personnel shall abide by the Service's Station Safety Plan. MK personnel and their subcontractors shall work under MK's Health and Safety Plan. MK shall also provide and work under an supplemental health and safety plan specific to natural resource projects on the Arsenal.

5.0 DELIVERABLES

Three deliverable items are required to complete this project.

1. Mowing and interseeding of native seed mix in Site 4A.

2. Weed control and native seed planting in Site 4B.

3. Written report of project results with recommendations for future work.

6.0 SCHEDULE

Starting date:	May 10, 1991
Completion date (fieldwork):	September 30, 1991
Completion date (report):	November 30, 1991

TECHNICAL WORK PLAN
HABITAT MANIPULATIONS FOR BEMA SITE 5 -- MIXED GRASS PRAIRIE -- 1991
USFWS HABITAT ENHANCEMENT PLAN 15

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

1991

1.0 INTRODUCTION

1.1 PROGRAM/TASK DESCRIPTION

A vegetation management program was initiated at seven sites within the Bald Eagle Management Area (BEMA) of Rocky Mountain Arsenal (RMA, Arsenal) in 1989 to diversify the habitat and prey base for bald eagles and other raptors (Map 1). Fiscal Year 1991 marks the third year of this five-year enhancement project designed to mitigate losses that occurred when Arsenal property was leased to Stapleton International Airport. Fieldwork was initially conducted by Facilities Engineering during 1989 - 1990, but will be continued through Morrison-Knudson Environmental Services (a Shell contractor) for the duration of the program. The U.S. Fish and Wildlife Service (Service) will continue to serve as manager of the program. The specific task described herein is designed to create a mixed grass prairie community in a portion of Section 30.

1.2 SITE DESCRIPTION/HISTORY

Site 5 includes three subsites located east of First Creek in western Section 30 (Map 1). Site 5A lies between two narrow strips of Site 5B, which in turn lies inside of the two 5C strips. All sites are approximately 1 mile in length and are characterized by mostly by Ascalon sandy loam but with some Nunn clay, Santana, and Weld loams. All sites were characterized by cheatgrass and weedy forbs at the beginning of the project. Initial work was to control weedy species and establish a shortgrass prairie. Early management indicated that a mixed grass prairie was more realistic for soil and soil moisture conditions at the site.

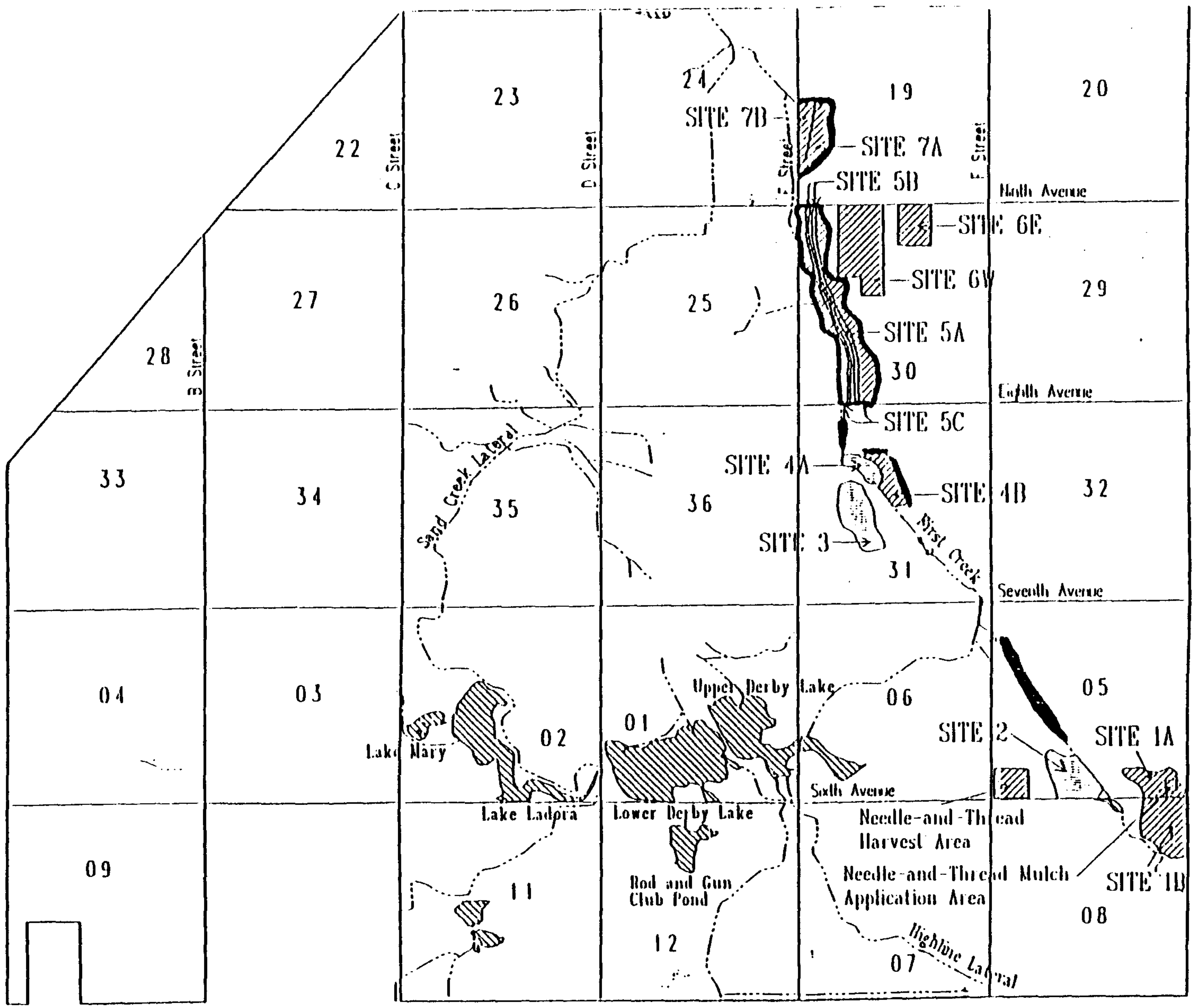
Site 5A encompasses 12 acres. Native prairie has been established on much of this site. Canada thistle, however, remains as a menace which will need to be controlled chemically.

Site 5B and 5C includes 22 and 62 acres respectively. Weeds on these two sites also need to be controlled chemically. Unlike 5A, these sites need to be reseeded during 1991.

2.0 OBJECTIVES

The objectives of this project are to:

1. diversify wildlife habitat and the raptor prey base (and more specifically to create sufficient cover and food for reintroduction of jackrabbits) by establishing a mixed grass prairie community,



Map 1. Habitat enhancement locations for Task 15 (Habitat Manipulations for BEMA Site 5 -- Mixed Grass Prairie -- 1991), Rocky Mountain Arsenal.

2. learn more about the most appropriate methods for establishing a mixed grass prairie community in order to improve efficiency during future RMA mitigation projects, and

3. offset losses to wildlife habitat caused by leasing portions of the Arsenal to Stapleton International Airport.

3.0 METHODS

Service:

1. The Service shall provide oversight for this project. Service employees shall provide guidance during planning stages, advice during fieldwork, and periodic inspections of progress.

Morrison-Knudson (MK):

General:

1. The contractor shall provide recommendations for planning based on site-specific experience.

2. The contractor shall provide a health and safety plan specific to natural resource projects (including this task) to supplement the contractor's umbrella health and safety plan.

3. The contractor shall retain an appropriate buffer zone (as determined by the literature) between herbicide applications and water sources.

4. The contractor shall measure grass stands to quantitatively determine success.

5. The contractor shall inform the Service of any changes from the plan deemed necessary.

6. The contractor shall provide the Service with a report of the project results and recommendations for future work.

Site 5A:

1. The contractor shall apply 2,4-D around June 10 to eliminate perennial weeds.

Site 5B:

1. The contractor shall apply Roundup in early May to control cheatgrass and annual broadleaf weeds.

2. The contractor shall apply 2,4-D around July 10 to control perennial broadleaf weeds, especially bindweed and Canada thistle.

3. The contractor shall mow once during August to help control weedy vegetation.

4. The contractor shall use the following seed mix following complete weed control:

Slender wheatgrass (Revenue)	1.4 lbs pls/ac
Western wheatgrass (Arriba)	6.9 lbs pls/ac
Thickspike wheatgrass (Critana)	2.8 lbs pls/ac
Side-oats grama (Vaughn)	2.1 lbs pls/ac
Fringed sagebrush (Native)	0.01 lbs pls/ac
Blanket flower (Native)	0.01 lbs pls/ac
Yarrow (Native)	0.01 lbs pls/ac
Black-eyed Susan (Native)	0.01 lbs pls/ac
Blue flax (Native)	0.01 lbs pls/ac

5. The contractor shall apply 150 lbs/ac ammonium nitrate and 150 lbs/ac triple super phosphate as fertilizer.

Site 5C:

1. The contractor shall apply Roundup in early May to control cheatgrass and annual broadleaf weeds.

2. The contractor shall apply 2,4-D around July 10 to control perennial broadleaf weeds, especially bindweed and Canada thistle.

3. The contractor shall chisel/disc once during September to help control weedy vegetation.

4. The contractor shall use the following seed mix following complete weed control:

Blue grama (Hachita variety)	0.5 lbs pure live seed/acre
Slender wheatgrass (Revenue)	1.4 lbs pls/ac
Western wheatgrass (Arriba)	6.9 lbs pls/ac
Thickspike wheatgrass (Critana)	2.8 lbs pls/ac
Side-oats grama (Vaughn)	2.1 lbs pls/ac
Fringed sagebrush (Native)	0.01 lbs pls/ac
Blanket flower (Native)	0.01 lbs pls/ac
Yarrow (Native)	0.01 lbs pls/ac
Black-eyed Susan (Native)	0.01 lbs pls/ac
Blue flax (Native)	0.01 lbs pls/ac

5. The contractor shall apply 150 lbs/ac ammonium nitrate and 150 lbs/ac triple super phosphate as fertilizer.

6. The contractor shall apply and crimp a weed-free grass hay mulch after seeding.

4.0 HEALTH AND SAFETY PLANS

Service personnel shall abide by the Service's Station Safety Plan. MK personnel and their subcontractors shall work under MK's Health and Safety Plan. MK shall also provide and work under a supplemental health and safety plan specific to natural resource projects on the Arsenal.

5.0 DELIVERABLES

Four deliverable items are required to complete this project.

1. Weed control in Site 5A.

2. Weed control and planting of native seed mix in Site 5B.

3. Weed control and planting of native seed mix in Site 5C.

4. Report of project results with recommendations for future work.

6.0 SCHEDULE

Starting date:	May 1, 1991
Completion date (fieldwork):	September 30, 1991
Completion date (report):	November 30, 1991

TECHNICAL WORK PLAN
HABITAT MANIPULATIONS FOR BEMA SITE 6 -- WESTERN WHEATGRASS -- 1991
USFWS HABITAT ENHANCEMENT PLAN 16

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

1991

1.0 INTRODUCTION

1.1 PROGRAM/TASK DESCRIPTION

A vegetation management program was initiated at seven sites within the Bald Eagle Management Area (BEMA) of Rocky Mountain Arsenal (RMA, Arsenal) in 1989 to diversify the habitat and prey base for bald eagles and other raptors (Map 1). Fiscal Year 1991 marks the third year of this five-year enhancement project designed to mitigate losses that occurred when Arsenal property was leased to Stapleton International Airport. Fieldwork was initially conducted by Facilities Engineering during 1989 - 1990, but will be continued through Morrison-Knudson Environmental Services (a Shell contractor) for the duration of the program. The U.S. Fish and Wildlife Service (Service) will continue to serve as manager of the program. The specific task described herein is designed to establish western wheatgrass vegetation as prairie dog habitat in a portion of Section 30.

1.2 SITE DESCRIPTION/HISTORY

Site 6 includes two subsites located in north-central Section 30 (Map 1). Both sites are characterized by Weld loam, Santana loam, and Ascalon sandy loam soils. Although they were dominated by native perennial grasses prior to initiation of this project, the plant species involved were characteristic of highly disturbed land and were considered undesirable for many wildlife species. This area was intensively farmed before being purchased by the U.S. Army in 1942.

Site 6W consists of approximately 46 acres. Weed control and seeding were not successful in 1989 and 1990, and will require further work.

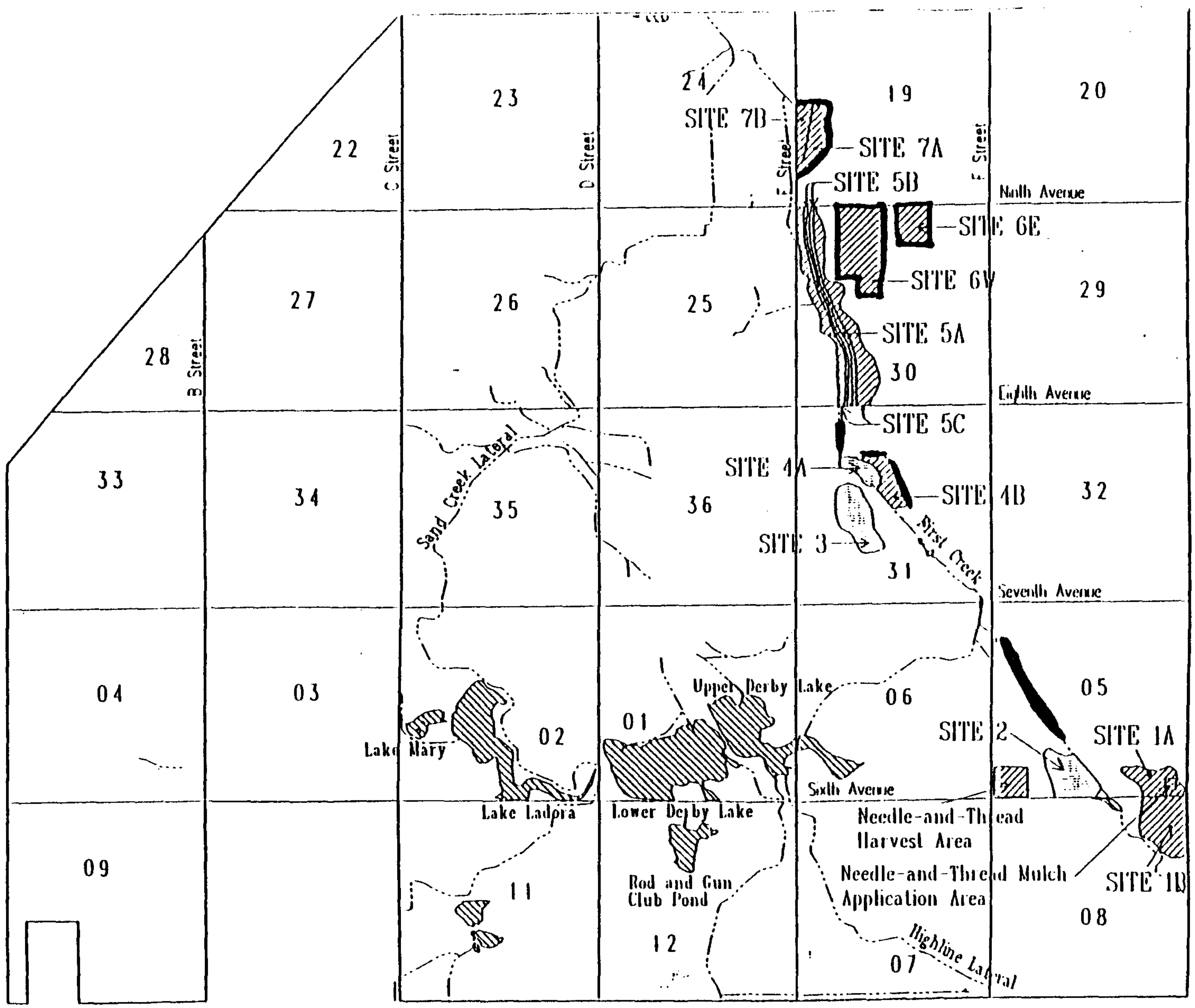
Site 6E encompasses a 24 acre plot east of 6W. A stand of western wheatgrass has been established. Only a modified approach will be needed to improve the stand.

2.0 OBJECTIVES

The objectives of this project are to:

1. diversify wildlife habitat and the raptor prey base (and more specifically to improve forage for prairie dogs) by establishing a stand of western wheatgrass,

2. learn more about the most appropriate methods for establishing western wheatgrass in order to improve efficiency during future RMA mitigation projects, and



Map 1. Habitat enhancement locations for Task 16 (Habitat Manipulations for BEMA Site 6 -- Western Wheatgrass -- 1991), Rocky Mountain Arsenal.

3. offset losses to wildlife habitat caused by leasing portions of the Arsenal to Stapleton International Airport.

3.0 METHODS

Service:

1. The Service shall provide oversight for this project. Service employees shall provide guidance during planning stages, advice during fieldwork, and periodic inspections of progress.

Morrison-Knudson (MK):

General:

1. The contractor shall provide recommendations for planning based on site-specific experience.

2. The contractor shall provide a health and safety plan specific to natural resource projects (including this task) to supplement the contractor's umbrella health and safety plan.

3. The contractor shall retain an appropriate buffer zone (as determined by the literature) between herbicide applications and water sources.

4. The contractor shall measure grass stands to quantitatively determine success.

5. The contractor shall inform the Service of any changes from the plan deemed necessary.

6. The contractor shall provide the Service with a report of the project results and recommendations for future work.

Site 6W:

1. The contractor shall harrow to 2 inches in March or April to rejuvenate existing clones of western wheatgrass by breaking thatch.

2. The contractor shall fertilize some clones with 150 lbs ammonium nitrate/acre to monitor effectiveness.

3. The contractor shall apply 2,4-D around June 10 and September 20 to control perennial broadleaf weeds, while carefully avoiding rabbitbrush and research sites.

4. The contractor shall mow around August 1 to help control weedy vegetation, while carefully avoiding rabbitbrush and research sites.

5. The contractor shall then disperse western wheatgrass (Arriba variety) at 19.8 lbs pure live seed per acre.

Site 6E:

1. The contractor shall fertilize the site by broadcasting 150 lbs ammonium nitrate/acre in early May.

4.0 HEALTH AND SAFETY PLANS

Service personnel shall abide by the Service's Station Safety Plan. MK personnel and their subcontractors shall work under MK's Health and Safety Plan. MK shall also provide and work under a supplemental health and safety plan specific to natural resource projects on the Arsenal.

5.0 DELIVERABLES

Four deliverable items are required to complete this project.

1. Weed control and planting of western wheatgrass seed in Site 6W.

2. Fertilization of Site 6E.

3. Report of project results with recommendations for future work.

6.0 SCHEDULE

Starting date:	March 20, 1991
Completion date (fieldwork):	September 30, 1991
Completion date (report):	November 30, 1991

TECHNICAL WORK PLAN
HABITAT MANIPULATIONS FOR BEMA SITE 7 -- MIXED GRASS PRAIRIE -- 1991
USFWS HABITAT ENHANCEMENT PLAN 17

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

1991

1.0 INTRODUCTION

1.1 PROGRAM/TASK DESCRIPTION

A vegetation management program was initiated at seven sites within the Bald Eagle Management Area (BEMA) of Rocky Mountain Arsenal (RMA, Arsenal) in 1989 to diversify the habitat and prey base for bald eagles and other raptors (Map 1). Fiscal Year 1991 marks the third year of this five-year enhancement project designed to mitigate losses that occurred when Arsenal property was leased to Stapleton International Airport. Fieldwork was initially conducted by Facilities Engineering during 1989 - 1990, but will be continued through Morrison-Knudson Environmental Services (a Shell contractor) for the duration of the program. The U.S. Fish and Wildlife Service (Service) will continue to serve as manager of the program. The specific task described herein is designed to establish a mixed grass prairie community in a portion of Section 19.

1.2 SITE DESCRIPTION/HISTORY

Site 7 includes three subsites located in western Section 19 (Map 1). Both sites are characterized by Nunn clay loam, aquic haplustoll, and Ascalon sandy loam soils. The areas were dominated by smooth brome and thistles before revegetation efforts were initiated.

Site 7A consists of approximately 11 acres. Weed control and seeding of slender wheatgrass, western wheatgrass, thickspike wheatgrass and fringed sage began in 1989 and was repeated in 1990. A good stand of native grass has been established.

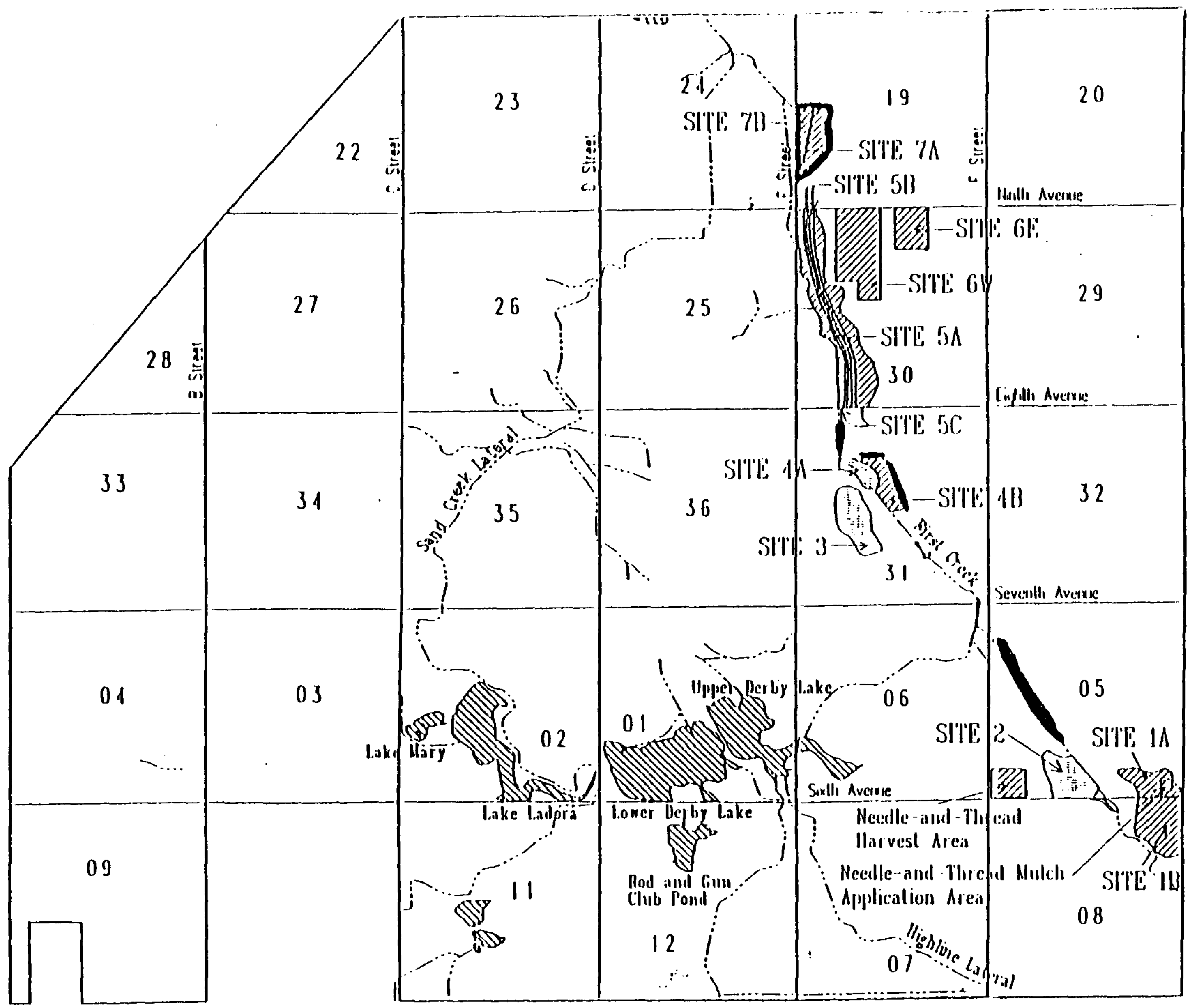
Site 7B encompasses 18 acres between Site 7A and E Street. A similar strategy was initiated here in 1990, but resulted in a stand of cheatgrass (a weedy exotic) and sand dropseed (a desirable native). An appropriate choice of herbicide and careful timing of its use will be required to eliminate the cheatgrass without removing the sand dropseed.

The third site exists just east of Site 7A and consists entirely of cottonwood poles that were planted in 1989 to increase diversity along the old First Creek channel. None of the plants survived, probably due to not being planted deep enough to reach ground water.

2.0 OBJECTIVES

The objectives of this project are to:

1. diversify wildlife habitat and the raptor prey base by establishing a mixed grass prairie community,



Map 1. Habitat enhancement locations for Task 17 (Habitat Manipulations for BEMA Site 7 -- Mixed Grass Prairie -- 1991), Rocky Mountain Arsenal.

2. learn more about the most appropriate methods for establishing a mixed grass prairie in order to improve efficiency during future RMA mitigation projects, and

3. offset losses to wildlife habitat caused by leasing portions of the Arsenal to Stapleton International Airport.

3.0 METHODS

Service:

1. The Service shall provide oversight for this project. Service employees shall provide guidance during planning stages, advice during fieldwork, and periodic inspections of progress.

Morrison-Knudson (MK):

General:

1. The contractor shall provide recommendations for planning based on site-specific experience.

2. The contractor shall provide a health and safety plan specific to natural resource projects (including this task) to supplement the contractor's umbrella health and safety plan.

3. The contractor shall retain an appropriate buffer zone (as determined by the literature) between herbicide applications and water sources.

4. The contractor shall measure grass stands to quantitatively determine success.

5. The contractor shall inform the Service of any changes from the plan deemed necessary.

6. The contractor shall provide the Service with a report of the project results and recommendations for future work.

Site 7A:

1. The contractor shall apply 150 lbs/acre ammonium nitrate and 150 lbs/acre triple super phosphate during early May.

Site 7B:

1. The contractor shall apply Diquat during early May to control cheatgrass and annual weeds.

2. The contractor shall "spot apply" 2,4-D during mid-July to control broadleaf weeds.

3. The contractor shall evaluate the site during late summer to recommend the most appropriate action for future planting.

Cottonwood Pole Plantings:

1. The contractor shall search the literature to determine the best procedure for establishing cottonwoods within the constraints of Site 7.

4.0 HEALTH AND SAFETY PLANS

Service personnel shall abide by the Service's Station Safety Plan. MK personnel and their subcontractors shall work under MK's Health and Safety Plan. MK shall also provide and work under a supplemental health and safety plan specific to natural resource projects on the Arsenal.

5.0 DELIVERABLES

Three deliverable items are required to complete this project.

1. Fertilization of Site 7A.

2. Control of weeds in 7B.

3. Report of project results with recommendations for future work.

6.0 SCHEDULE

Starting date:	April 10, 1991
Completion date (fieldwork):	September 30, 1991
Completion date (report):	November 30, 1991

TECHNICAL WORK PLAN
CONSTRUCTION OF A FENCE AROUND SAND BLUESTEM AREA IN SECTION 4
USFWS HABITAT ENHANCEMENT PLAN 18

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

August 1991

1.0 INTRODUCTION

1.1 TASK DESCRIPTION

The U.S. Fish and Wildlife Service (Service) proposes to protect a significant natural resources area from inadvertent and unnecessary disturbance. The sensitive area is located in Section 4 of Rocky Mountain Arsenal (RMA, Arsenal) and is characterized by several native sand prairie species, including sand bluestem. A one-strand wire fence with appropriate signs is recommended as partial mitigation for cleanup activities on the Arsenal.

1.2 SITE DESCRIPTION/HISTORY

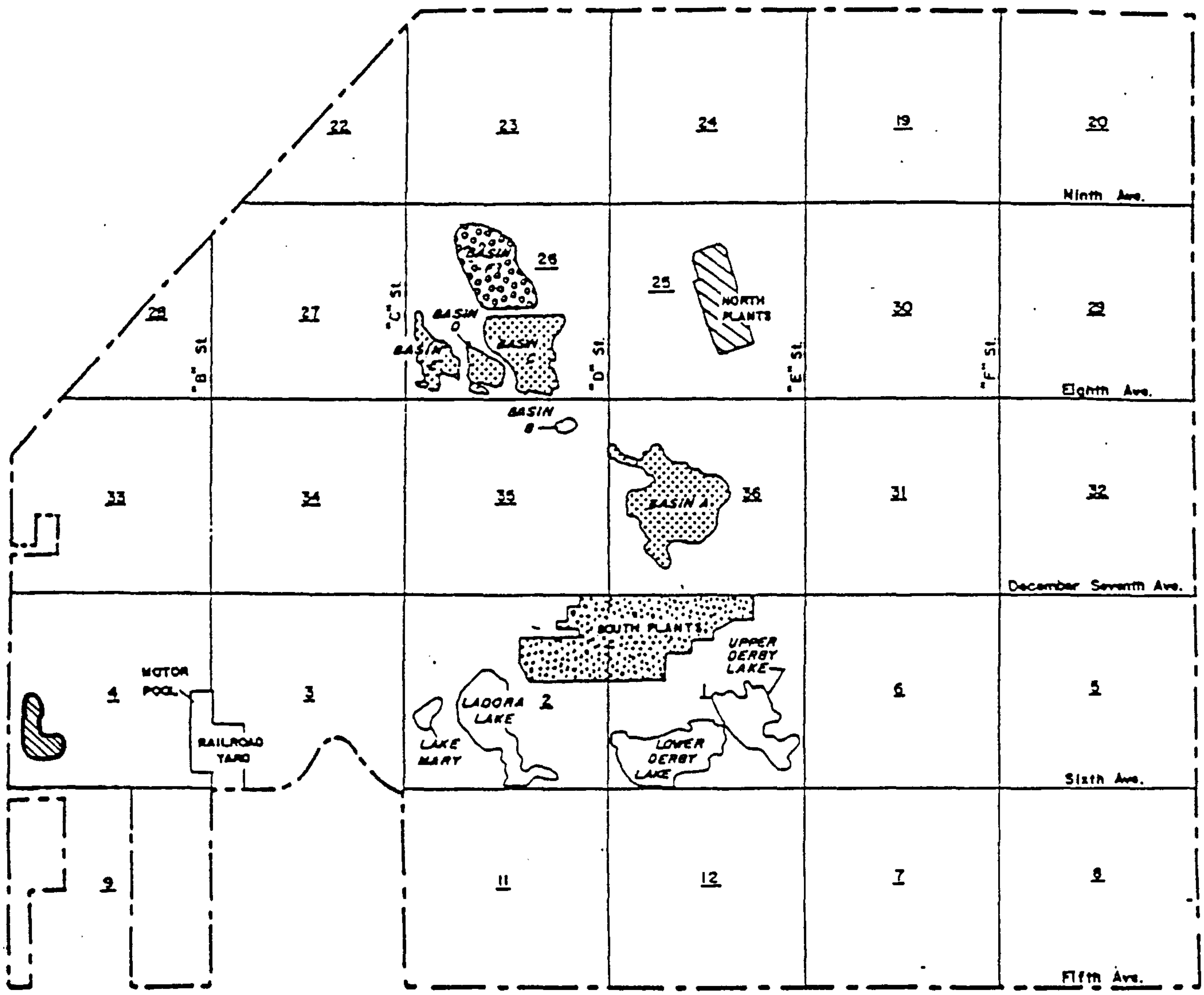
The Arsenal's current mission is to clean up contamination that resulted from on-site production of chemical weapons and pesticides following its initial purchase and development in 1942. Restoration of the Arsenal to a clean, safe environment will lead to some wildlife habitat destruction, including in the area of the Motor Pool in Sections 3 and 4 (Interim Response Action L-MP). The Service proposes to partially mitigate the effects of this cleanup action by protecting an important natural resource area near the Motor Pool.

The area is located in the western portion of Section 4 (Map 1) and is approximately 23 acres in size. The soil is mostly characterized by sandy loam and loamy sand. A two-track north-south road goes through the site but can be fenced because (1) the area is accessible from either side of the fence (i.e. the road traverses the entire section) and (2) the road is unnecessary to cleanup or base operations in the sand bluestem area.

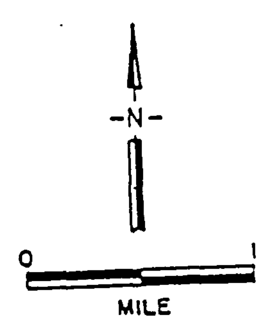
The site has been termed "the sand bluestem area" because of the presence of this somewhat uncommon plant. Several other native sand prairie species exist in the area including sand dropseed, sand sage, needle-and-thread grass, and prairie sandreed. This site may be the most significant stand of native plants on the Arsenal.

2.0 OBJECTIVE

The objective of this project is to protect the sand prairie community and associated wildlife species in Section 4 from inadvertent and unnecessary disturbance during cleanup and base operations by fencing the site and attaching appropriate signs.



Map 1. Area to be fenced for Task 18 (Construction of Fence around Sand Bluestem Area in Section 4), Rocky Mountain Arsenal, 1991.



3.0 METHODS

Service personnel will perform all necessary work associated with this project. Specifically, they will:

1. Buy all necessary materials.
2. Construct the fence with:

    a. Steel tee posts,
    b. 9 ga. galvanized brace wire,
    c. 12 ga. twisted barbless wire, and
    d. 8' X 4' pressure-treated round wooden posts.

3. Reinforce the fence corners with corner posts.
4. Place the tee posts approximately 12 feet apart.
5. Attach the wire approximately 4 feet above ground.
6. Have metal signs printed to keep unnecessary personnel out of the area. Include the Service's phone number for more information.
7. Attach approximately 10 signs directly to the wire. Space the signs such that at least one sign can be seen from anywhere along the fence. Place signs on the fence at its intersections with the two-track road.

4.0 HEALTH AND SAFETY PLAN

The Service employees will work under the Service's RMA Station Safety Plan. Personnel will be particularly cautious regarding use of cable-stretching equipment and the potential for rattlesnakes to inhabit the area.

5.0 DELIVERABLES

Three deliverable items are required to complete this project:

1. Construction of the fence.
2. Attachment of the signs.
3. Task summary (general report and budget account).

6.0 SCHEDULE

Preferred completion date (fence and signs):	August 30, 1991
Preferred completion date (task summary):	Sept. 30, 1991

TECHNICAL WORK PLAN
HABITAT MANIPULATIONS FOR BEMA SITE 2 -- JACKRABBIT PLOT -- 1991
USFWS HABITAT ENHANCEMENT PLAN 13

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

1991

TECHNICAL WORK PLAN
ENHANCEMENT OF WILDLIFE HABITAT IN NORTHWEST CORNER OF SECTION 2
USFWS HABITAT ENHANCEMENT PLAN 19

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

August 1991

1.0 INTRODUCTION

1.1 TASK DESCRIPTION

The U.S. Fish and Wildlife Service (Service) proposes to provide irrigation, mulching, and fencing for shrubs and trees previously planted in Section 2 of Rocky Mountain Arsenal (RMA, Arsenal). This action would counteract some of the deleterious effects on wildlife habitat anticipated by cleanup activities at the Arsenal (Interim Response Action L-FP: South Tank Farm Plume). The Service expects this project to improve wildlife habitat for a variety of mammalian and avian species.

1.2 SITE DESCRIPTION/HISTORY

The Service and the U.S. Army (Army) cooperatively planted 190 trees and shrubs in the northwestern portion of Section 2 (Map 1) on May 3, 1991. This project provided wildlife habitat in an uncontaminated portion of the Arsenal while serving a key position in Army's RMA Earth Day Celebration. However, the plants have not received the care expected due to unforeseen circumstances. A few of the trees have died from lack of water and many of the shrubs have been browsed heavily. Replacements for dead trees have already been purchased and will be planted by the Service, but all trees and shrubs should be mulched, watered regularly, and protected from wildlife damage during the first 2 years.

The site is located north of the Visitor Center. The soils in this area are mostly sandy loams. The vegetation is mostly characterized by weedy forbs and cheatgrass although small patches of native grasses and a few shrubs were observed in the area before six species of additional shrubs and trees were planted (Map 2). The area has been tested for contamination and was determined to be within safe limits of chemicals that were found.

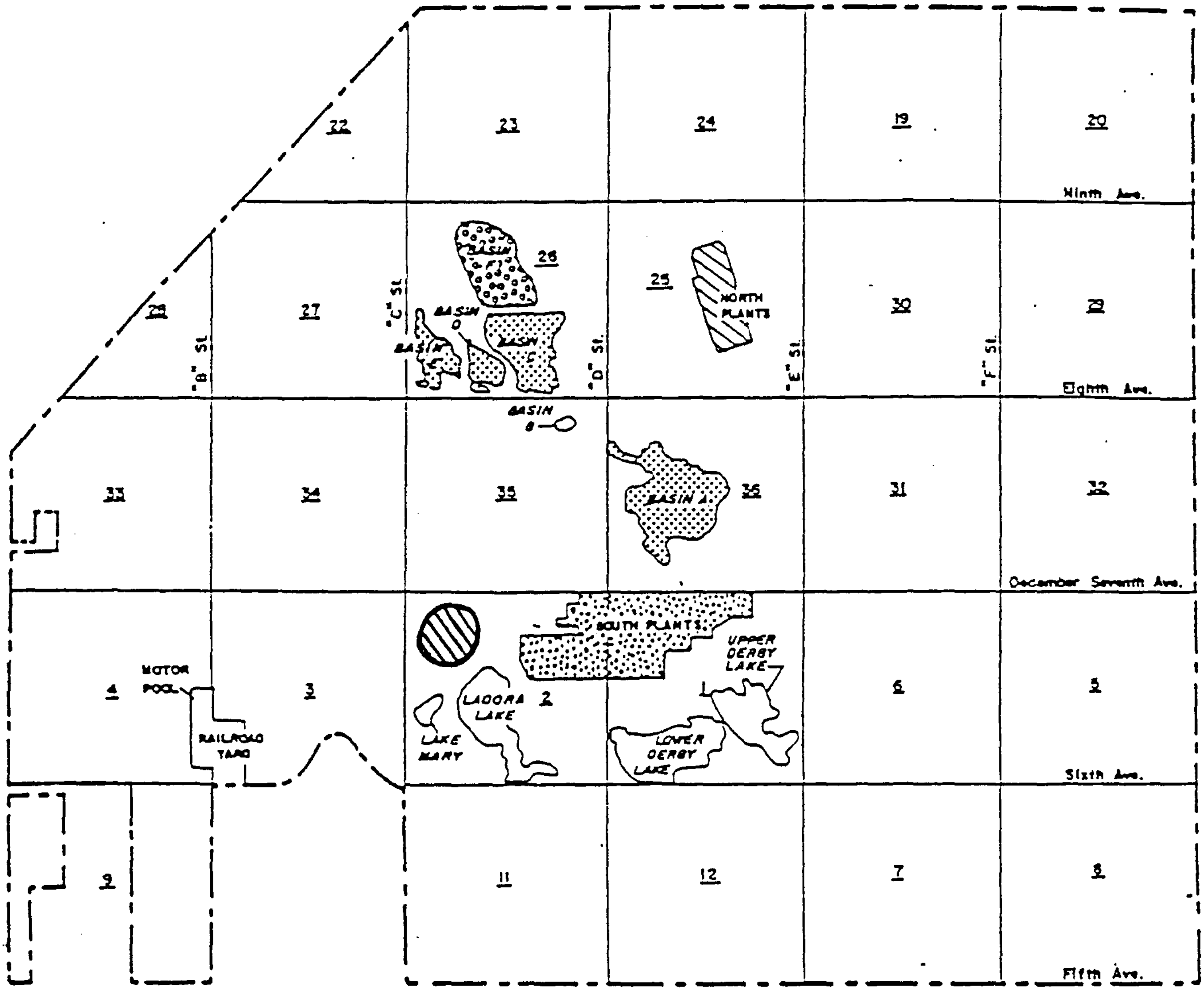
2.0 OBJECTIVES

The objectives of this project are to:

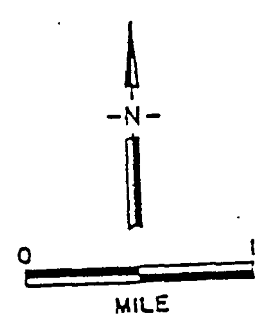
1. Offset losses to wildlife habitat caused by cleanup activities, and
2. Increase the survival of native trees and shrubs previously planted in the area.

FISH AND WILDLIFE SERVICE
FISH AND WILDLIFE ENHANCEMENT
ROCKY MOUNTAIN ARSENAL FIELD OFFICE

Rocky Mountain Arsenal
Commerce City, Colorado



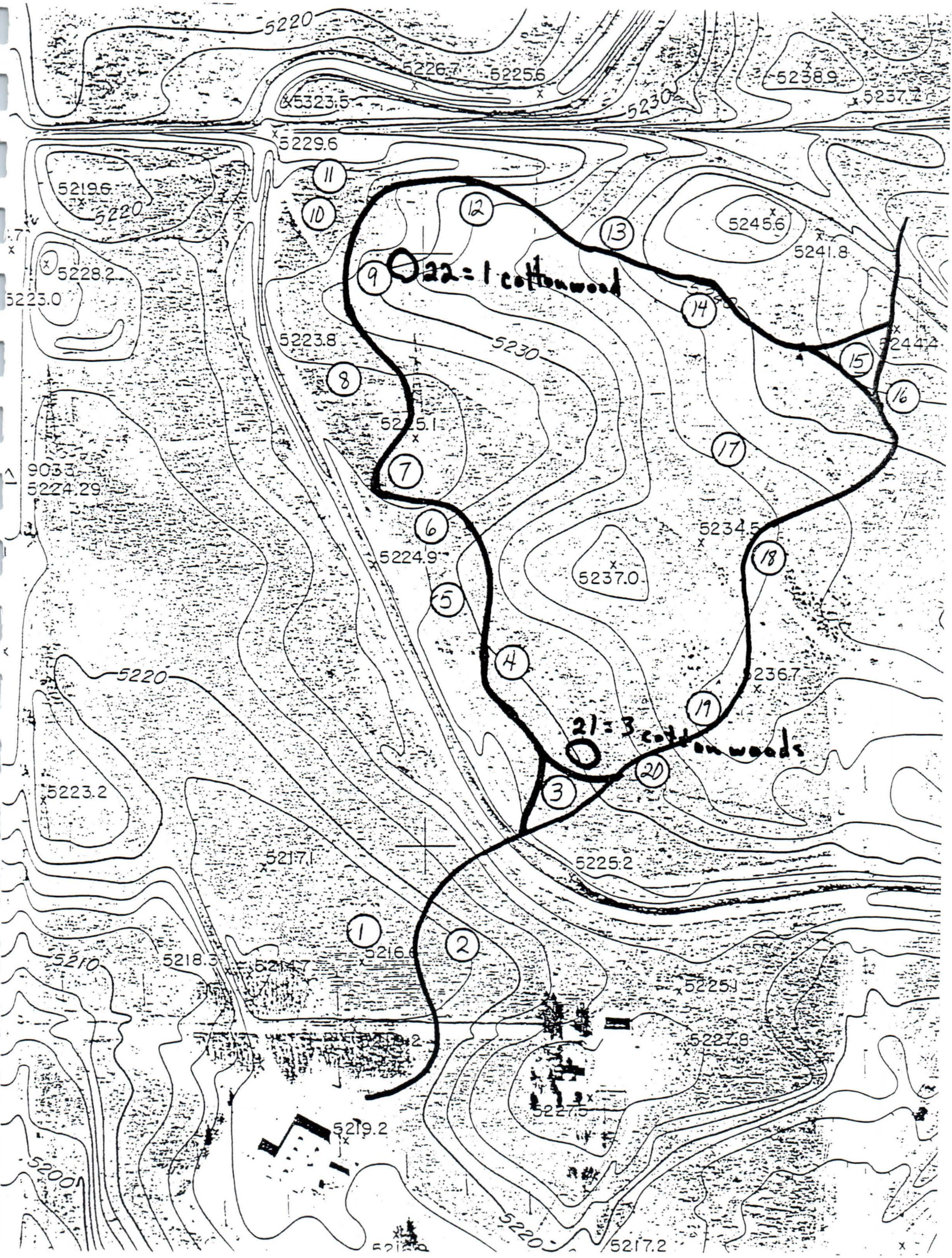
Map 1. Location for Task 19 (Enhancement of Wildlife Habitat in Northwest Corner of Section 2), Rocky Mountain Arsenal, 1991.



Map 2. Location and number of plants for Task 19 (Enhancement of Wildlife Habitat in Northwest Corner of Section 2), Rocky Mountain Arsenal, 1991.

LEGEND

1. Golden current (20 plants)
2. American plum (20)
3. Cottonwood (1)
4. Cottonwood (3)
5. Rubber rabbitbrush (20)
6. Cottonwood (3)
7. Cottonwood (3)
8. Chokecherry (20)
9. Cottonwood (3)
10. Three-leaf sumac (20)
11. American plum (20)
12. Cottonwood (3)
13. Sand cherry (20)
14. Cottonwood (3)
15. Cottonwood (1)
16. Cottonwood (3)
17. Four-wing saltbush (20)
18. Cottonwood (3)
19. Cottonwood (2)
20. Cottonwood (3)


5220
5226.7
5225.6
5238.9
5237.7
5323.5
5230
5229.6
5219.6
5220
5245.6
5241.8
5228.2
5223.0
22 = 1 cottonwood
5223.8
5230
5244.4
9033
5224.29
5234.5
5224.9
5237.0
5220
5236.7
21 = 3 cottonwoods
5223.2
5217.1
5225.2
5210
5218.3
5214.7
5216.6
5225.1
5227.8
5227.5
5219.2
5200
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3.0 METHODS

Service:

1. The Service shall provide an employee to accompany the Service's contractor on a pre-work site visit or on the first day of work or both, to identify the plant locations and to answer any questions.

2. The Service shall replace 20 cottonwood trees that died previously.

3. The Service shall ensure that weeds do not outcompete the shrubs/trees before they can be mulched.

4. The Service shall provide regular inspections of the contractor's work to ensure adequate communication between the Service and the contractor.

5. The Service shall remove the fencing when deemed appropriate.

Service Contractor:

1. The contractor shall provide a brief health and safety plan specific to this project to supplement the umbrella health and safety plan.

2. The contractor shall mulch each plant site with wood chips. Each cottonwood tree shall receive mulch within 18 inches of its base. Mulch shall be spread evenly throughout the clumps of shrubs (versus around the individual plants). The wood chips shall be 4-6 inches deep.

3. The contractor shall protect each cluster of shrubs and each individual cottonwood tree from wildlife damage (e.g. browsing from rabbits and deer, antler scraping by deer). Fences shall surround each clump; the mesh size shall not exceed 3 inches, the height shall be at least 6 feet above the ground, and the bottom shall be flush with the ground. An inexpensive gate system shall be available for each fence to allow maintenance of the irrigation system.

4. The contractor shall return to the Service at project completion all equipment and materials (e.g. augur and bit) purchased for this project.

Army:

1. The Army shall provide drip irrigation to the shrubs and trees. The Service recommends that water be acquired from the well located directly between the Visitor Center and Building 111 for planting sites 2-16 and from the vicinity of the Volunteer House for planting sites 1 and 17.

2. The Army should water each plant with 3 gallons/plant. Plants should be irrigated on the following schedule:

1991	Aug - Sept	5 waterings/week for cottonwoods; 1-5 waterings/wk for shrubs on an "as needed" basis.
	Oct - Dec	1 watering/month for all plants.
1992	Jan - Apr	1 watering/month for all plants.
	May - Sept	2-3 waterings/week for cottonwoods; 1-3 waterings/wk for shrubs on an "as needed" basis.
	Oct - Dec	1 watering/month for all plants.
1993	Jan - May	1 watering/month for all plants.
	June - Aug	1-2 waterings/week for all plants.

4.0 HEALTH AND SAFETY PLAN

The Service's employees shall work under the Service's Station Safety Plan.

The Service's contractor shall work under an "umbrella" health and safety plan which will encompass all of the contractor's project. The Service's contractor shall also provide a brief health and safety plan specific to this project. This plan will be reviewed and approved by the Service Health and Safety Officer and Army's Health and Safety Office before the contractor initiates its portion of this project.

The Army shall work under its appropriate divisional health and safety plan.

5.0 DELIVERABLES

Service:

1. Replacement of 20 dead cottonwoods.
2. Reduction of competition from weeds.
3. Removal of fencing when appropriate.

Service's Contractor:

1. Brief Health and Safety Plan.
2. Mulching of 190 shrubs and trees.
3. Fencing around each clump of shrubs.
4. Fencing around each individual tree.

Army:

1. Provision of drip irrigation for all plants.

TECHNICAL WORK PLAN
VEGETATIVE BARRIERS
USFWS HABITAT ENHANCEMENT PLAN 20

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

1991

1.0 INTRODUCTION

1.1 TASK DESCRIPTION

Several sites on Rocky Mountain Arsenal require barriers to prevent prairie dogs from entering the sites and either becoming contaminated or obstructing cleanup activities, e.g. burrowing into subsurface dams at groundwater treatment facilities. Attempts were made during 1989 and 1990 to establish vegetative barriers at four of these sites by planting a mixture of species that would be too tall and unpalatable to attract prairie dogs. The specific task described herein is designed to enhance these vegetative barriers and to quantitatively measure their success. Fieldwork will be conducted by Morrison-Knudson Environmental Services (a Shell contractor), while project oversight is the responsibility of the U.S. Fish and Wildlife Service (Service).

1.2 SITE DESCRIPTION/HISTORY

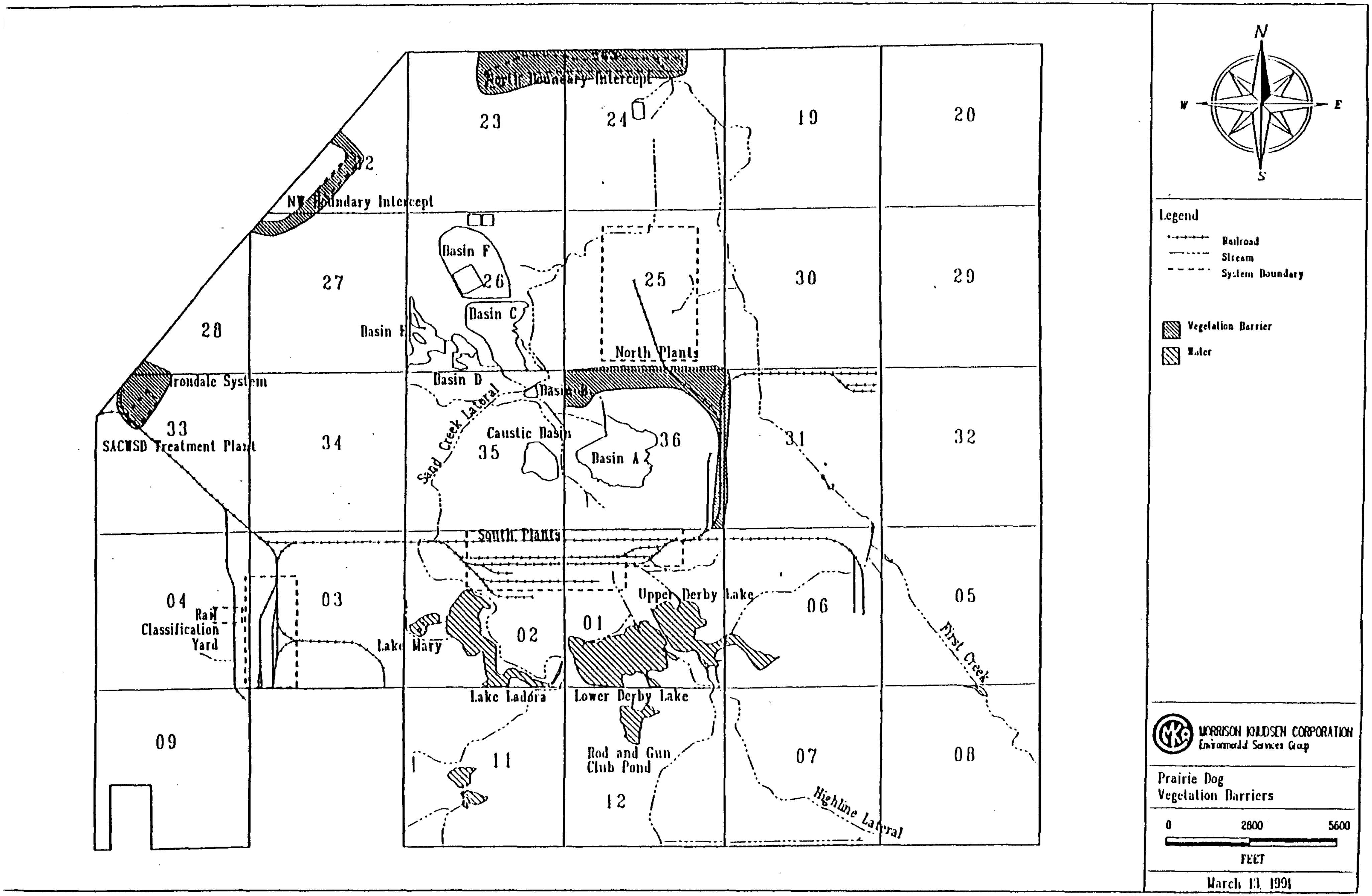
The four sites are located in Section 36 and three boundary treatment systems (Map 1). The Section 36 site consists of 104 acres along the northern and western borders; the soils consist mostly of Weld loam and Ascalon sandy loam. The North Boundary System consists of 175 acres of mostly Weld loam and aquic haplustolls in the northwestern portion of Section 24 and the northeastern portion of Section 23. A 29 acre vegetative barrier surrounds the Northwest Boundary System in Sections 22 and 27, and grows almost exclusively in Weld loam soil. A 55 acre vegetative barrier covers the entire Irondale Treatment System in Sections 33 and 28, and is mostly confined to Ascalon sandy loams.

Hycrest crested wheatgrass, tetraploid perennial rye, and pubescent wheatgrass were planted in each location. These species were originally chosen for their combined characteristics of providing (1) tall vegetation that would impede prairie dog immigration into an area and (2) unpalatability during much of the year. Early results indicate that very little rye has survived, although the wheatgrasses have been relatively successful when prairie dogs were removed from a site prior to early growing stages of the plants. Plant growth has been successful enough to limit work in FY 1991 to fertilizing and monitoring. No further seedings of these areas are needed at this time.

2.0 OBJECTIVES

The general objectives of this project are to:

1. impede prairie dog expansions into contaminated or treatment areas,



Map 1. Location of vegetative barriers for Task 20, Rocky Mountain Arsenal, 1991.

2. identify the most appropriate methods for establishing vegetative barriers and therefore improve efficiency during future RMA mitigation projects, and

3. provide on-site mitigation for construction of treatment systems. (Off-site mitigation will also be needed to offset losses to wildlife habitat.)

The specific objectives of this project for FY 1991 are to:

1. Improve the growth of the wheatgrasses within the barriers and

2. Monitor the effectiveness of the barriers.

3.0 METHODS

Service:

1. The Service shall provide oversight for this project. Service employees shall provide guidance during planning stages, advice during fieldwork, and periodic inspections of progress.

Morrison-Knudson (MK):

1. The contractor shall provide recommendations for planning based on site-specific experience.

2. The contractor shall provide a health and safety plan specific to natural resource projects (including this task) to supplement the contractor's umbrella health and safety plan.

3. The contractor shall fertilize the vegetative barriers on treatment facilities with 100 lbs/acre of ammonium nitrate.

4. The contractor shall fertilize the vegetative barrier within Section 36 with 75 lbs/acre of ammonium nitrate.

5. The contractor shall measure grass stands and determine stand composition to quantitatively determine success.

6. The contractor shall provide the Service with a report of the project results and recommendations for future work.

4.0 HEALTH AND SAFETY PLANS

Service personnel shall abide by the Service's Station Safety Plan. MK personnel and their subcontractors shall work under MK's Health and Safety Plan. MK shall also provide and work under a supplemental health and safety plan specific to natural resource projects on the Arsenal.

5.0 DELIVERABLES

Three deliverable items are required to complete this project.

1. Fertilization of all sites.
2. Measurement and determination of composition for all stands.
3. Report of project results with recommendations for future work.

6.0 SCHEDULE

Starting date:	April 15, 1991
Completion date (fieldwork):	September 30, 1991
Completion date (report):	November 30, 1991

TECHNICAL WORK PLAN
ESTABLISHMENT OF NEEDLE-AND-THREAD HAY AS A SEED SOURCE
USFWS HABITAT ENHANCEMENT PLAN 22

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

1991

1.0 INTRODUCTION

1.1 TASK DESCRIPTION

A desirable native species of grass for Rocky Mountain Arsenal is needle-and-thread. The species can already be found on part of the Arsenal but should be planted in additional areas. Needle-and-thread is very difficult to obtain commercially; therefore, an attempt was made in 1990 to use an existing stand as hay for other plantings thus providing mulch and seed simultaneously. The project described herein is designed to control weedy species within the source of hay and to monitor the success of (1) weed control and (2) establishment of needle-and-thread where mulched. Fieldwork will be conducted by Morrison-Knudson Environmental Services (a Shell contractor), while project oversight is the responsibility of the U.S. Fish and Wildlife Service (Service).

1.2 SITE DESCRIPTION/HISTORY

The source of needle-and-thread is a 20 acre parcel located in the southwestern corner of Section 5 (Map 1). The soils consist of Bresser sandy loam. Cheatgrass was partially controlled in 1990 through application of atrazine. Needle-and-thread grass was then mowed, raked into rows for field drying, baled, and spread and crimped into the soil in a 2 acre parcel in the southeastern corner of Section 5. Monitoring of both sites and further weed control at the seed source are needed.

2.0 OBJECTIVES

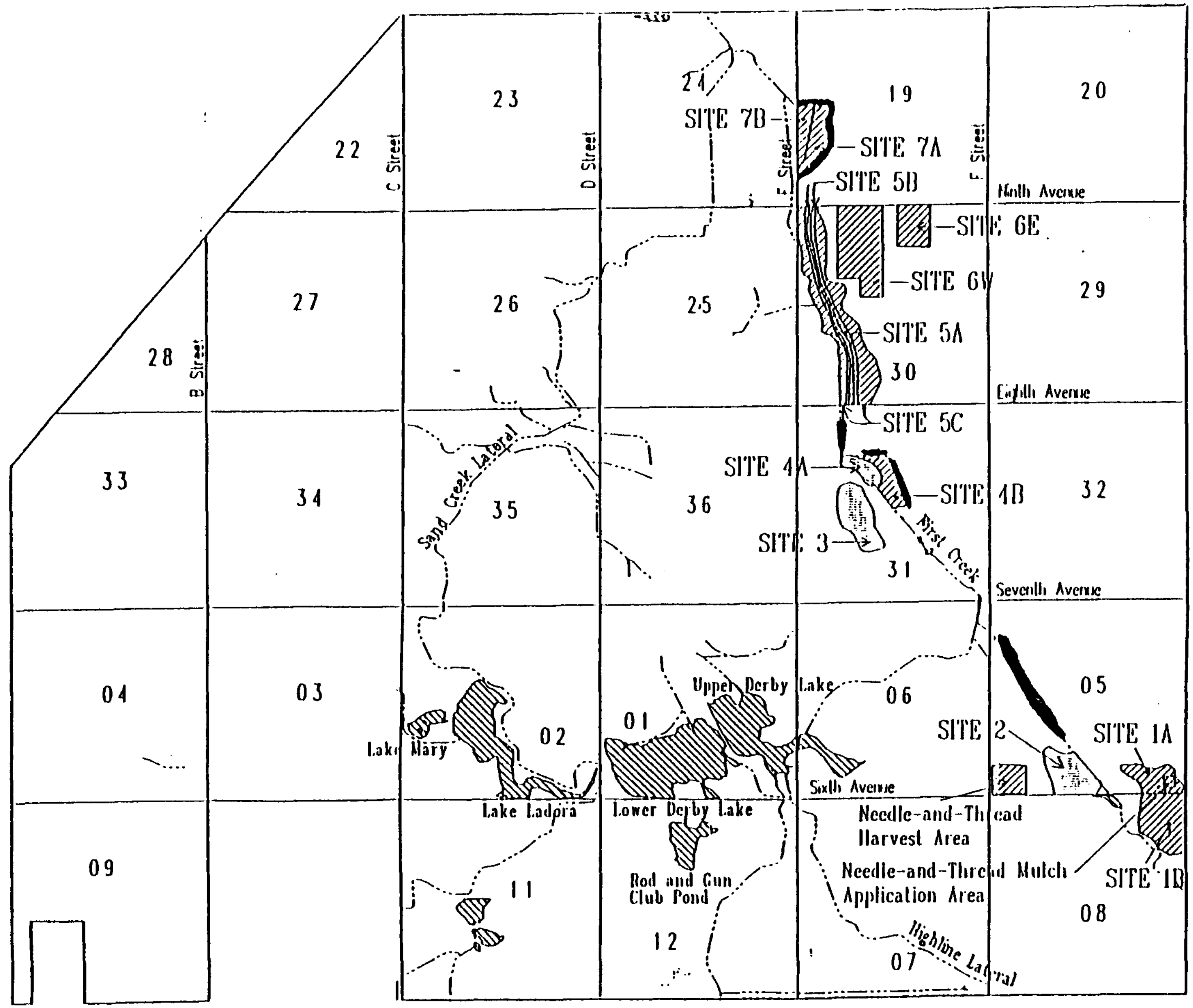
The objectives of this project are to:

1. control weedy species in the area of seed source,
2. monitor the success of weed control, and
3. monitor the success of needle-and-thread hay as a seed source.

3.0 METHODS

Service:

1. The Service shall provide oversight for this project. Service employees shall provide guidance during planning stages, advice during fieldwork, and periodic inspections of progress.



Map 1. Harvest and mulch areas for Task 22 (Establishment of Needle-and-Thread Hay as a Seed Source), Rocky Mountain Arsenal, 1991.

Morrison-Knudson (MK):

1. The contractor shall provide recommendations for planning based on site-specific experience.

2. The contractor shall provide a health and safety plan specific to natural resource projects (including this task) to supplement the contractor's umbrella health and safety plan.

3. The contractor shall apply Roundup to the seed source in early summer to control cheatgrass.

4. The contractor shall apply 2,4-D to the seed source in July to control broadleaf weeds.

5. The contractor shall mow the seed source in mid-July to further impact weedy species.

6. The contractor shall bale the mowed grass to provide hay for future seeding projects.

7. The contractor shall measure grass stands and determine stand composition of the seed source to quantitatively determine success of weed control.

8. The contractor shall measure the stand where needle-and-thread has been used as a seed source to quantitatively determine success of using needle-and-thread hay as a seed source.

9. The contractor shall provide the Service with a report of the project results and recommendations for future work.

4.0 HEALTH AND SAFETY PLANS

Service personnel shall abide by the Service's Station Safety Plan. MK personnel and their subcontractors shall work under MK's Health and Safety Plan. MK shall also provide and work under a supplemental health and safety plan specific to natural resource projects on the Arsenal.

5.0 DELIVERABLES

Three deliverable items are required to complete this project.

1. Control of weeds at the seed source.

2. Measurement and determination of composition for both the seed source and application site.

3. Report of project results with recommendations for future work.

6.0 SCHEDULE

Starting date:	April 15, 1991
Completion date (fieldwork):	September 30, 1991
Completion date (report):	November 30, 1991

TECHNICAL WORK PLAN
AUGURING OF ARTIFICIAL PRAIRIE DOG BURROWS IN SECTION 27
USFWS HABITAT ENHANCEMENT PLAN 24

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

July 1991

1.0 INTRODUCTION

1.1 TASK DESCRIPTION

The U.S. Fish and Wildlife Service (Service) is conducting a prairie dog habitat enhancement program to facilitate recovery of prairie dog populations impacted by sylvatic plaque and remedial cleanup activities. The project described below is designed to provide 1,500 artificial burrows for prairie dogs being introduced to Section 27 (Map 1) in the northwestern portion of Rocky Mountain Arsenal (Arsenal, RMA) as one part of the overall enhancement program. The burrows will be augured at an angle and depth appropriate for at least temporary protection from predators and climatic conditions. The Service anticipates that numerous prairie dogs will transform artificial burrows into normal burrow systems.

1.2 SITE DESCRIPTION/HISTORY

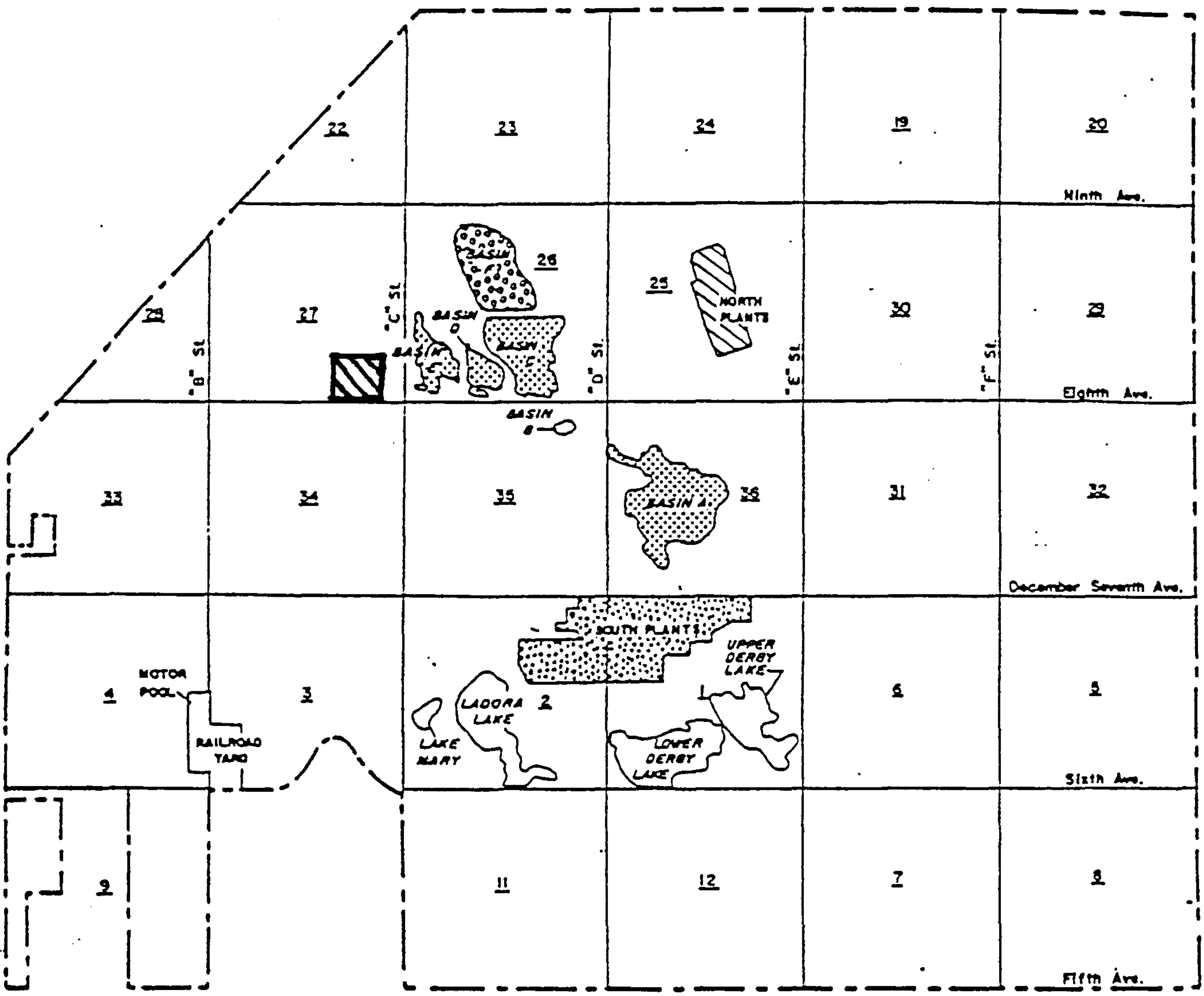
The Arsenal was home to approximately 40,000 - 50,000 prairie dogs during the mid to late 1980's. A correspondingly large population of predators including the endangered bald eagle was attributed to these large numbers of prey. However, a plague epidemic swept through most of the prairie dog colonies during 1988 - 1989 and eliminated as much as 95% of the population. After the plague was under control, the Service began reintroducing prairie dogs to previously occupied areas, although many of these sites were lost to remedial actions and base operations before reintroductions occurred. The Service and four private organizations concerned for prairie dog have released over 4,500 prairie dogs into RMA during 1989-1991. The animals have been released into abandoned burrows during the past, but most burrows in appropriate areas have either become occupied or have collapsed. Therefore, artificial burrows are now needed.

The site is located in the southeastern quadrant of Section 27 (Map 2). Most soils appear to be sandy loams. The vegetation class is considered to be mostly native perennial grasslands. A small prairie dog colony (approximately 40 animals) currently resides in the area.

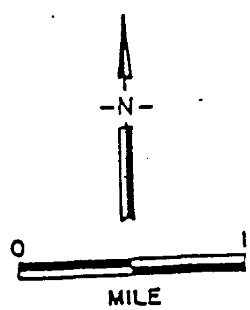
2.0 OBJECTIVES

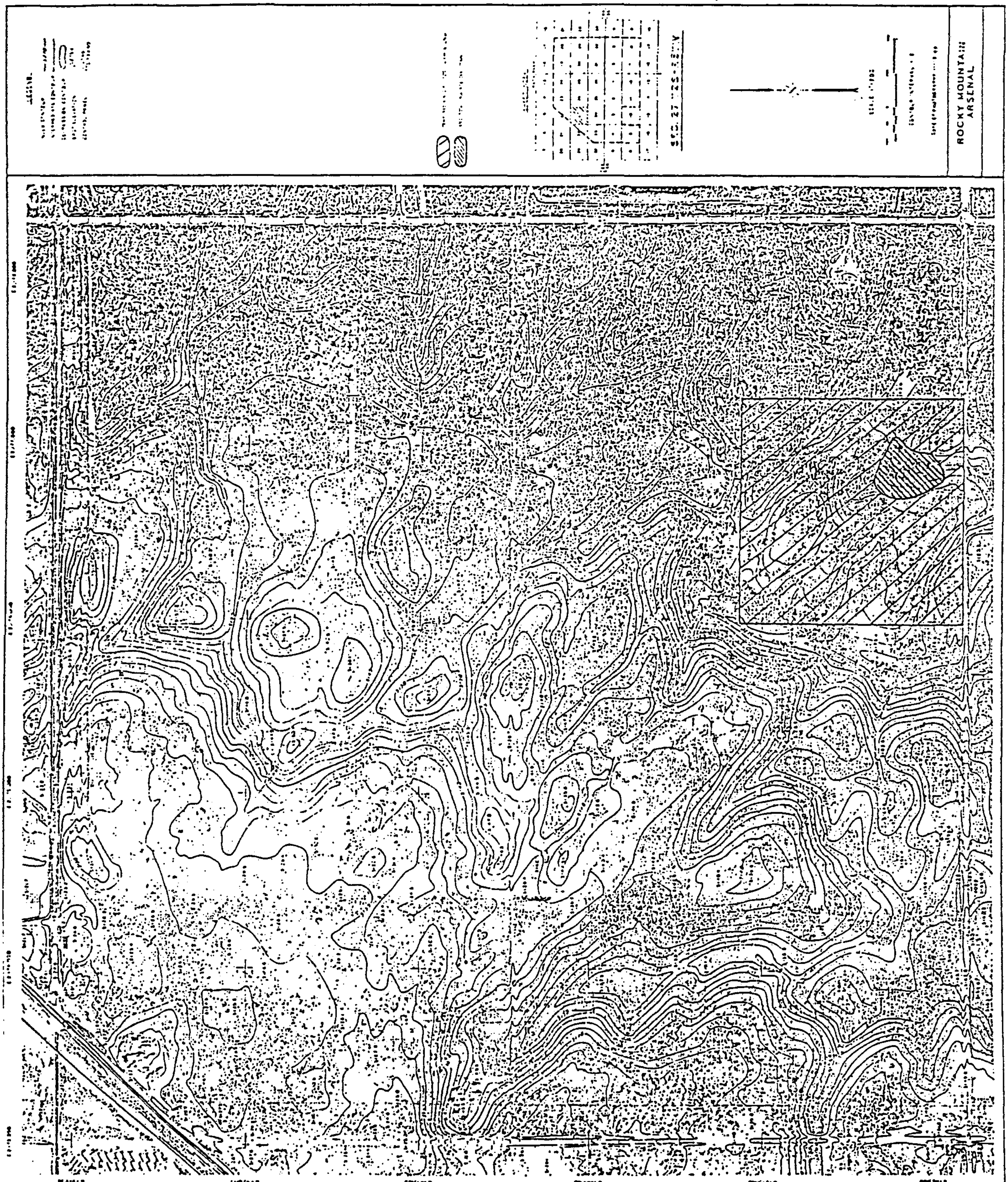
The objective of this project is to create artificial burrows for facilitation of prairie dog reestablishment on Rocky Mountain Arsenal. These burrows will be a combination of:

1. completely artificial burrows, and
2. newly augured entrances for abandoned, collapsed burrows.



Map 1. Proposed location for burrow auguring for Task 24 (Auguring of Artificial Prairie Dog Burrows in Section 27), Rocky Mountain Arsenal, 1991.





Map 2. Proposed location of artificial burrows and current location of active prairie dog town, Section 27, Rocky Mountain Arsenal, 1991.

3.0 METHODS

Service

1. The Service will clearly mark the relocation site (approximately 40 acres).
2. The Service will clearly mark any collapsed burrows that should be provided with an artificial entrance.
3. A qualified Service employee will accompany the contractor on the first day to answer any questions.
4. The Service will provide regular inspections of the work to ensure appropriate communication between the Service and the contractor.

Contractor

1. The contractor will provide a brief health and safety plan specific to this project to supplement the overall health and safety plan. The plan will emphasize precautions for potential contact with plague.
2. The contractor will mow the area to 6 inches.
3. The contractor will auger a total of 1,500 holes.
4. The contractor must avoid destroying shrubs or yucca plants in the area during mowing and augering procedures.
5. Augured holes will be 5-6 inches in diameter.
6. Holes will be augered to a depth of 6-10 feet, unless the contractor is making an entrance to a collapsed burrow whereupon the depth can vary.
7. Holes will be augered on approximately a 45 degree angle (40-50 degrees).
8. Holes should be augered at a distance of approximately 30 feet apart, unless:
   (a) the contractor needs to vary the distance to make entrances to collapsed burrows, or
   (b) the contractor needs to increase the distance to avoid destroying shrubs or yucca plants.
9. Holes will not be augered inside the perimeter of the active prairie dog colony unless directed to do so by Service personnel.
10. The contractor must provide a task summary to the Service for completion of the project. This summary will express details such as what type of equipment was used, how many employees were used, how much time the job took, problems encountered, recommendations for the future, etc.

4.0 HEALTH AND SAFETY PLAN

The contractor will work under an "umbrella" health and safety plan which will encompass all of the contractor's projects. The contractor will also provide a brief health and safety plan specific to this project (e.g. emphasizing precautions for potential contact with plague). This plan will be reviewed and approved by the Service Health and Safety Officer and Army's Health and Safety Office before work will be initiated.

5.0 DELIVERABLES

Two deliverable items are required to complete this project:

1. 1,500 prairie dog burrows.
2. Task summary (see Methods for details).

6.0 SCHEDULE

Preferred project duration:	30 days from issuance of delivery order
Preferred starting date:	August 12, 1991
Preferred completion date:	September 11, 1991

TECHNICAL WORK PLAN
HEALTH AND SAFETY PLANNING, TRAINING, AND PHYSICALS
FOR TOTAL TERRAIN, A USFWS CONTRACTOR
TO CONDUCT
USFWS HABITAT ENHANCEMENT PROJECTS

U.S. Fish and Wildlife Service
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

July 1991

1.0 INTRODUCTION

1.1 TASK DESCRIPTION

This task is designed to provide the U.S. Fish and Wildlife Service's (Service) contractor, Total Terrain, with appropriate health and safety planning, training, and physicals. The Health and safety plan is designed as an "umbrella" plan to encompass all projects that Total Terrain might conduct for the Service on Rocky Mountain Arsenal (Arsenal, RMA).

1.2 SITE DESCRIPTION/HISTORY

The Arsenal encompasses 17,000 acres of land and is located approximately 10 miles northeast of downtown Denver. The Arsenal's current mission is to clean up contamination that resulted from on-site production of chemical weapons and pesticides.

The soils on the Arsenal vary considerably, but mostly consist of sandy loams and clay loams. A large buffer zone of prairie vegetation surrounds the more contaminated interior areas. The major vegetation types are weedy forbs/cheatgrass (40%), native perennial grasslands (21%), crested wheatgrass communities (18%), shrublands/succulents (7%), wetlands (4%), tree groves (1%), and other miscellaneous communities. Numerous species of wildlife use these vegetation types for food and cover.

A portion of the Service's mission on RMA is to mitigate losses of wildlife habitat caused by cleanup activities. The Service has therefore contracted Total Terrain to conduct reclamation related projects (Contract No. 14-16-0006-91-015).

2.0 OBJECTIVES

The objective of this task is to provide Total Terrain with adequate measures for health and safety (see attached letter). More specifically, this task addresses:

1. Health and safety plan
2. OSHA safety training
3. Physicals.

3.0 APPROACH

1. Total Terrain must provide an "umbrella" health and safety plan for the company's work at the Arsenal. This plan must provide sufficient detail to withstand review by Service and Army health and safety officials before work can begin. In particular, the plan should

specify that work will be limited to Level D PPE, unless a modified Level C is required and covered by a separate, site-specific health and safety plan. The plan may be written by outside sources, e.g. qualified OSHA training instructors. (Total Terrain must also provide brief site-specific health and safety plans for each individual project to supplement the umbrella plan; these plans will be budgeted with respective project budgets and separately from the umbrella health and safety plan.)

2. Most of Total Terrain's employees who will work at RMA must have OSHA safety training. Supervisors (e.g. company president) who are only on site occasionally (e.g. 1-2 days/week) must have the 24-hour OSHA training course. On-site supervisors (e.g. superintendents) who will work at RMA 40 hrs/week must have the 24-hour OSHA training course plus the 8-hour OSHA supervisor's course. Additional administrators (e.g. purchasers, estimators, off-site project managers) who rarely visit the site (e.g. 1-6 days/mo) will not be required to take OSHA training unless their role at RMA changes. Other on-site workers must take the 40-hour OSHA safety training course prior to initiating projects at RMA. In addition, all Total Terrain employees must attend an on-site health and safety lecture and tour provided by the Service and/or Army.

   All OSHA courses must be taught by certified instructors who can demonstrate skills and knowledge of applicable subject matter. The instructional groups proposed by Total Terrain in the attached letter (Urie Environmental Health, Front Range Community College, Pueblo Community College) will all be acceptable provided the instructors are qualified to teach OSHA.

3. All of Total Terrain's employees who will be required to take any OSHA training must also have a thorough entry physical. Any of these employees who permanently leaves Total Terrain's RMA projects during FY 1991 (i.e. before October 1, 1991) must also be provided the same exit physical. (Exit and annual physicals for employees working or leaving after September 30 will be addressed during FY 1992.)

4.0 DELIVERABLES

1. List of employee names, titles, estimated hours per week or month at RMA, and type of training needed based on above criteria.
2. Copy of the final health and safety plan.

3. Copy of each OSHA training certificate for each employee required to take training.
4. Copy of results for each employee's physical.

5.0 SCHEDULE

PROJECT	PREFERRED COMPLETION DATE
List of names, etc.	July 29, 1991
Health and safety plan	August 5, 1991
OSHA training	August 12, 1991
Physicals (entry)	August 12, 1991

GOVERNMENT ESTIMATE

HEALTH AND SAFETY PLANNING, TRAINING, AND PHYSICALS
FOR TOTAL TERRAIN, A USFWS CONTRACTOR
TO CONDUCT
USFWS HABITAT ENHANCEMENT PROJECTS

JULY 22, 1991

Product/Service	Quantity	Cost	Extended Cost
List			
Project Manager	2 hours	$ 45.33/hr	$ 135.96
Clerk	2 hours	$ 20/hour	$ 40.00
		Subtotal	$ 175.96
Health and Safety Plan	1 plan	$ 2,450/plan	$ 2,450.00
OSHA Training			
40-hour training	8 people	$ 550/person	$ 4,400.00
24-hour training	4 people	$ 400/person	$ 1,600.00
8-hour sup. trn.	2 people	$ 160/person	$ 320.00
		Subtotal	$ 6,320.00
Physicals	12 people	$ 632/person	$ 7,584.00
Certificates			
Clerk	8 hours	$ 20/hour	$ 160.00
Postage and Materials	-	-	$ 20.00
		Subtotal	$ 180.00
H&S Lectures & Tours			
Supervisors/Project Managers (3)	8 hrs/ea	$ 45.33/hour	$ 1,087.92
Superintendents (2)	8 hrs/ea	$ 39.64/hour	$ 634.24
Other Administr. (2)	8 hrs/ea	$ 40.00/hour	$ 320.00
Labor, Group 1 (5)	8 hrs/ea	$ 23.94/hour	$ 957.60
Pwr Equip Opr 3 (1)	8 hrs/ea	$ 33.47/hour	$ 267.76
Truck Driver 5 (1)	8 hrs/ea	$ 30.38/hour	$ 243.04
Cement Mason (1)	8 hrs/ea	$ 35.43/hour	$ 283.44
		Subtotal	$ 3,794.00
		TOTAL	**$ 20,503.96**

APPENDIX C

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STATUS OF VEGETATION MANAGEMENT ACTIVITY IN THE BALD EAGLE MANAGEMENT AREA, ROCKY MOUNTAIN ARSENAL, 1991 ANNUAL REPORT

PREPARED FOR:
HOLME, ROBERTS AND OWEN AND
SHELL OIL COMPANY
DENVER, COLORADO

DECEMBER 1991

MK-ENVIRONMENTAL SERVICES
1700 LINCOLN STREET, SUITE 4800
DENVER, COLORADO 80203

EXECUTIVE SUMMARY

The vegetation management program for the Bald Eagle Management Area at Rocky Mountain Arsenal (RMA) was initiated in fall 1988. Field work began in spring 1989. The overall objective of the project is to improve habitat which will support a diverse prey base. Initial funding was provided by Stapleton International Airport as compensation for habitat lost when the airport expanded onto RMA. Subsequent funds have been provided by Shell Oil Company and the Army.

In 1991, seeding was completed on 150 acres. The process for seeding includes initial vegetation control, fertilization, soil preparation, seeding, and mulching. In addition, 170 acres revegetated in previous years were managed to encourage the rate and development of desirable habitat. Management activity included fertilization, mowing, applying herbicides and over-seeding.

To date, 320 acres have been revegetated with native prairie vegetation; an additional 25 acres have been managed to develop a seed source for needle-and-thread grass, and the structure of about 10 acres has been modified by mowing annually to provide habitat more suitable for prey species, especially jackrabbits. Data collection has occurred each fall in order to monitor success and trends in vegetation community development.

Although the process of restoring native prairie to RMA is still evolving, three years of activity and monitoring has provided a basic understanding of efforts necessary to improve habitat at the Arsenal. Additional methods recommended for investigation in 1992 include: the potential of sprinkler irrigation for establishment of both grasslands and shrublands from seed; establishment of shrubs from contract grown container material and use of drip irrigation; and deep plowing for vegetation control by burying surface seeds to depths that would not allow seedling establishment.

INTRODUCTION

The vegetation management program for the Bald Eagle Management Area (BEMA) at Rocky Mountain Arsenal (RMA) was initiated in the fall of 1988 by the U. S. Fish and Wildlife Service (FWS). Initial funds were provided by Stapleton International Airport as compensation for loss of prey habitat resulting from expansion onto RMA. Funding has also been provided by the Army and Shell Oil Company.

The basic objective of the program is to diversify the prey base. Restoration of native prairie in areas dominated by weedy vegetation, and structural modification of existing vegetation are the basic methods used to provide more appropriate habitat for a variety of prey species. Four topo-edaphic prairie types are represented in the restoration effort. Establishment of sand prairie species is the goal for areas of sandy soils. Tall grass prairie species are restored to bottomland areas of deep loam soils and shallow water table. Mixed grass prairie species have been established in shallow loam soils with less water availability. Short grass species are adapted to the driest upland sites. Vegetation structure is modified by mowing or planting of shrubs.

Activity that occurred during 1991 included expansion of areas established during previous years, control of undesirable vegetation in previously seeded areas, and fertilization of established stands to provide added growth and vigor.

METHODS

This program involves both agricultural activity to establish prairie species and ecological data collection to evaluated the status of the seeded vegetation community. The following discusses the general methods employed. Specific activities are listed in log form in Appendix A.

Agricultural Methods

The program has established a process for establishment of prairie species. Initial efforts are aimed at control of undesirable vegetation. This is followed by preparation of soil for seeding and incorporation of fertilizer. Seeding is followed by application of grass hay mulch.

Vegetation Control. Control methods for undesirable vegetation target cool season weedy species including cheatgrass, bindweed, and Canada thistle. These species are of concern because of their propensity to deplete the surface soil of moisture or their extreme competitive effects. These species pose the most serious threat to establishment of seeded species.

Control is accomplished using a variety of methods in combination. Areas are tilled at appropriate stages in the target species phenology to gain the greatest detriment. Herbicides are also utilized in situations where bare soils cannot be tolerated for long periods of time, i.e. months, or where tilling is ineffective or inappropriate.

Soil Preparation. Soil is prepared for seeding with a variety of tillage operations. Areas are initially chiseled to a depth of 12 inches to relieve any compaction that may exist. Following this operation, areas are disced to break up large soil clumps. A second discing or harrowing operation may be preformed if needed. Fertilizer is spread prior to the final soil preparation operation.

Seeding. Seeding of native species is accomplished by both drill seeding and broadcast seeding followed by light harrowing. Species are separated based upon seed size and density.

Mulching. Weed free grass hay mulch is spread over the seeded area at a rate of 2 tons per acre. This provides nearly 100% cover of the soil surface. Mulch is crimped into the soil surface so that it is not displaced.

Data Collection Methods

Vegetation cover data are collected annually for each seeded area on RMA. Permanent 50 meter transects are established at each site (coordinates are given in Appendix B). Permanent line-point transects (Bonham 1989) allow for status and trend information to be interpreted for the developing vegetation community. Observations are made at each meter along the transect. Data are recorded for each species encountered, litter, and bare soil (rocks are rare on the surface at RMA). A species list is also made for species observed at the site, but not encountered along the transects. These are entered in the process of data summary as having less than 1% cover. Revegetation Information Monitoring and Analysis (RIMA) version 2.00 has been used to summarize data.

STATUS

Seven sites (Figure 1) were established in 1988. Specific locations and other details regarding these sites has been provided in previous annual reports (Cooper and Mackey 1989; Mackey 1990).

Site 1

This site is divided into two areas. Area 1A was seeded in 1989, and therefore has completed two growing seasons. Few seeded perennial grasses and shrubs established the first year. In fact, the seeding was considered a complete failure until August of the second growing season. During 1991, a summer of above average precipitation (see Appendix C) stimulated excellent growth of seeded species.

Data collected in the Fall of 1991 (Appendix A) indicate a substantial increase in cover by all perennial grasses, but especially warm season grasses seeded at this location. These increased from a mean cover of 2.8% in 1990 to 21.7% in 1991. Total vegetation cover also increased substantially from a mean of 46.8% to 64.7%. Bare soil followed the trend in vegetation development and decreased from a mean of 19.2 in 1990 to 9.7% in 1991.

Weed control was moderately successful at this area. Cover by cheatgrass (Anisantha tectorum) was reduced from a mean of 13.2% to 3%. Bindweed (Convolvulus arvensis) decreased from 4.8% to 1.3%. Cover by annual and biennial forbs doubled during the two growing seasons due to a great increase in cover by warm season forbs.
No seedling of fringed sage (Artemisia frigida), a half-shrub included in the seed mix for this area, were observed.

A 2 acre sub-section of area 1A was disced in the fall of 1990. Needle-and-thread hay was spread over the area as mulch and crimped into the soil. The objective of this project was to establish needle-and-thread from seeds harvested in the hay (Mackey 1991). Data collected in July 1991 indicate that this approach was very successful. There was a mean of 30 needle-and-thread seedling per square meter. The area was mowed for control of competing vegetation. This site will continue to be monitored to determine the persistence of needle-and-thread established by this method. It is expected that this species will dominate the area with time.

Weed control efforts conducted at area 1B were considered excellent. In the fall 1991, cover by cheatgrass was 4.8%; by bindweed >1%; and by Canada thistle (Cirsium arvense) 1.2%. At the time of soil preparation, the area was unexpectedly dominated by sand dropseed (Sporobolus cryptandrus); a native grass that volunteered from the soil seed bank at this location. Mean cover by this warm season species was 41.2% and it accounted for almost 67% of relative cover. Apparently the regime of summer precipitation favored the development of warm season species. Although an excellent stand of sand dropseed had established, diversity was very low. In order to increase diversity, the area was disced and seeded in the Fall of 1991. It was assumed that sand dropseed will persist at this location and that seeding would increase the diversity of sand prairie species. Mulch was applied to only half of the area, however, due to weather conditions and the presence of winter bald eagles.

Site 2

The status of this site is unchanged from 1990. Mowing has provided diversity to the structure of the otherwise uniform height of the crested wheatgrass and smooth brome that dominates the area. The survival of shrubs planted in 1989 remains high. Fencing placed around the shrubs to protect them from deer browsing is still in place and may be hindering growth of shrubs at this time.

Site 3

No activity or monitoring occurred at this site during 1991. The goal for this area is to increase the coverage of rubber rabbitbrush. Areas disturbed and seeded in 1989 remain dominated by weedy species and sand dropseed. No evidence of spread by rubber rabbitbrush was noted. A literature review to develop a strategy for establishment of this shrub species is ongoing.

Site 4

Site 4 is divided into two areas. Area 4A was seeded in 1990. As at all other sites, warm season species flourished during the wet summer of 1991. However, of species seeded, only side-oats grama (Bouteloua curtipendula) provided a significant amount of cover (8.8%). Black bindweed (Fallopia convolvulus), a warm season annual, also provided significant cover with a mean of 17.6%. The area was dominated by annual forbs which accounted for 66.4% of relative cover. This area represents an early stage of plant community development in that it is dominated by annuals, but has a perennial grass component that should dominate with time and proper management activity.

Vegetation control for area 4B was excellent. The area was seeded and mulch applied in fall 1991.

Site 5

Site 5 is divided into three sections; 5A, 5B, 5C. In fall, 1990, area 5A was dominated by seeded species, especially slender wheatgrass (Elymus trachycaulus) which had a mean cover of 50.4% and composed nearly 65% of cover by all vegetation at this site. This may have been an artificially high amount of cover by this species. In the fall, 1989 the area was mistakenly seeded twice with two different seed mixes which both included slender wheatgrass. In spring, 1991 a considerable amount of the slender wheatgrass occurring at this site died. In the fall, mean cover by slender wheatgrass was only 4.4%, and it accounted for only 11% of the total vegetation. Reasons for the demise of this species at this site include: sever competition within an overly dense stand, the short lived nature of slender wheatgrass, and application of an herbicide (Oust) which may have affected slender wheatgrass contrary to labeling information for the chemical. A combination of these factors is the most likely explanation. The drastic reduction in slender wheatgrass at this location is not necessarily detrimental. Other species including blue grama (Chondrosum gracile), Canada wildrye (Elymus canadensis), western wheatgrass (Pascopyrum smithii), and sand dropseed were able to increase cover as the dominance of slender wheatgrass declined, cover by these species combined increased from 8% in 1990 to 20% in 1991.

Area 5B was seeded in spring, 1990. Few seeded species were evident in the fall of 1990. Mean cover by desirable perennial grasses was only 3.6%. Cover did not increase measurable by spring or early summer of 1991. However, by the fall of 1991, mean cover by desirable perennial grasses had increased to 26%, 18.6% of which was accounted for by warm season perennial grasses. This area was over-seeded in fall 1991 as an effort to increase diversity and cover by desirable species.

Area 5C was seeded in fall, 1991, and will be monitored during 1992. It is expected that with adequate moisture and vegetation control efforts successful establishment of desirable vegetation will be achieved in this area.

Site 6

This site is divided into two areas, 6 east and 6 west. The goal of establishing western wheatgrass as a food source for prairie dogs was considered achieved at 6 east in 1990. In 1991, the area was fertilized to promote growth of established western wheatgrass in order to lessen the impact of encroaching prairie dogs. This strategy has been successful. Prairie dogs are established in the area and the cover by western wheatgrass increased significantly in 1991 (40%) compared to the previous year (17.2 %). Plant diversity in the area remains low, however. Of total cover by vegetation 91% is accounted for by western wheatgrass and summer cypress (Bassia sieversiana), and the mean number of species per transect was only 3.4.

Area 6 west was over-seeded with western wheatgrass in 1989. This approach did not result in establishment of much new cover by this species through 1990. In 1991, the area was chiseled to relieve thatch that had accumulated in clones of western wheatgrass. Weed control was also conducted during 1991. These activities combined with the excellent precipitation received during the summer resulted in establishment of numerous western wheatgrass plants and production of copious amounts of seed by established plants. The area was mowed and harrowed to incorporate the newly produced seed into the soil. In fall, 1991, cover by western wheatgrass was 8%. The plan to reseed the area was abandoned. Annual weedy vegetation is still dominant at this location. Mean cover by annuals is 46.4% which accounts for 74% of the total vegetation cover at this area.

Site 7

There are two areas at site 7. Area 7A was seeded in 1989. An excellent stand of grass had established by 1990. In 1991, the only management activity was fertilizing in spring. Cover by slender wheatgrass was less in 1991 (20.4%) than in 1990 (29.6%). However, cover by western wheatgrass increased from 2.8% in 1990 to 18% in 1991. Cover by cheatgrass also decreased significantly in 1991 from 23.6% to 2%. This area remains in excellent condition.

Area 7B was seeded in 1990. In 1991, management efforts resulted in an increase of desirable species and a decrease in species targeted for control. Mean cover by both cool and warm season perennial grasses rose from 20% in 1990 to 33.2% in 1991, whereas, cover by annual grasses, annual forbs and perennial forbs decreased from 38.4% to 24%. This area should require only minimal management efforts in 1992 to maintain the trend in vegetation development.

Cottonwood poles were planted at this site in 1989. Although initial success of this technique was high, none has survived due to abuse by deer.

Needle-and-thread Harvest Area

This area is being managed for production of needle-and-thread grass (Stipa comata) seed. The hay which was spread over a 2 acre portion of Area 1A was harvested from this location. Specific management efforts have targeted control of cheatgrass which matures seed at about the same time as needle-and-thread, and methods to increase the amount of needle-and-thread in the area. These have generally been successful. Cheatgrass has decreased from a mean cover of 47% in 1989 to almost zero in 1991. Needle-and-thread may have increased slightly during that time. Cover by sand dropseed increased dramatically over the management period from 3.5% to 29.6%. This increase is not problematic because sand dropseed is also a desirable native species.

DISCUSSION

Several techniques have proven especially useful for achieving the goals of this program and accelerating the rate and direction of plant community development at Rocky Mountain Arsenal. During 1991, the greatest achievements may have been a result of increased precipitation received during July and August. Warm season species responded very positively to the distribution of moisture received during that time. These results indicate that supplemental irrigation during summer of most years would benefit the establishment of warm season species from seed.

Strategic use of herbicides produced intended and unintended results worthy of note. At area 7B, cheatgrass remained a large component of the plant community in the Spring of 1991. It composed about 20% of the vegetation cover. Also included in the area were desirable grasses which composed about 34% of the vegetation cover. In order to decrease cheatgrass and stimulate perennial grasses, Diquat was sprayed in spring when cheatgrass was growing vigorously and perennial grasses were just beginning to break dormancy. Diquat is a desiccant that "burns" all vegetation to ground level. It also is very strongly attracted to soil particles so that it does not move in soil and is not taken up by plant roots. The general effect is to kill annual species. Above ground growth of perennial species is killed to ground level, but energy reserves allows perennial species to recover from the treatment. With competition from cheatgrass decreased, desirable species flourish. The result at this site was to decrease cheatgrass from 20% to 10% and increase perennial grasses from 34% to 58% of the vegetation cover. Applying Diquat to areas which have a preponderance of cheatgrass and other annual weeds dominating the perennial species can reduce competition from annuals and stimulate the desirable species.

A similar, but unexpected result was achieved by applying Glyphosate, a broad-spectrum, translocated herbicide to area 5B. Although this area had been seeded in 1990, cover by seeded species totaled <2% in spring 1991. Cover by undesirable species totaled 55% and made up 80% of all vegetation cover. The seeding was considered a failure, and it was decided to over-seed the area in fall 1991. As preparation for seeding, a mixture of Glyphosate, 2,4-D, and Banvel herbicides was applied in May. The objective was to kill all vegetation in the area, but leave a standing stubble to prevent soil erosion. A second application of Banvel and Ally to further control broadleaf vegetation was made in July.

In September, the results of these treatments were unexpected. Cover by desirable species totaled 26% and composed 70% of all cover by vegetation. Whereas, cover by weedy species was only 11%, or 30% of all vegetation cover. An increase in cover by warm season species was especially dramatic. These rose from <2% to almost 50% of vegetation cover. Glyphosate obviously did not kill the perennial grasses.

Over-seeding is drill seeding into standing stubble or existing vegetation without extensive soil preparation. This technique appears to be a viable method for establishment of western wheatgrass. Many of the seedlings of western wheatgrass observed in fall 1991 at site 6 west were planted in fall 1989, but did not germinate until summer 1991. The timing of precipitation during this period may be the best explanation of these results. Vegetation control is a necessary component of the over-seeding process. It is essential to eliminate as much competition from undesirable plants as possible in order to establish seedlings. Shallow chiseling of the soil to relieve compaction may also be necessary.

Another viable technique for habitat improvement on Rocky Mountain Arsenal is to harvest needle-and-thread grass hay in early July and re-spread it as mulch over an area to be seeded. The results of implementing this technique on a limited area of Site 1 were very encouraging. Although the summer precipitation appears to be largely responsible for results in other aspects of the BEMA habitat improvement program, the wet summer was not responsible for establishment of needle-and-thread seedlings. These plants had already established prior to summer rain. In fact, the early spring was relatively dry, and yet, over 30 seedlings per square meter had established in the area where needle-and-thread hay mulch had been spread. It is necessary to spread only weed free hay. Producing weed seed free hay requires management of the harvest area for at least one year prior to harvest.

Not all projects within this program were ideally successful. Two objectives require further investigation: establishment of tall grass prairie species in bottomland sites and establishment of shrubs from seeding and planting of container material.

Site 4 is located in Section 31 on bottomland adjacent to First Creek. Soils are deep loams and the water table is shallow. These conditions are appropriate for establishment of species that have a higher moisture requirement than those for upland locations. However, of the five species seeded at area 4A in 1990, only two [switchgrass (Panicum virgatum) and side-oats grama (Bouteloua curtipendula)] were observed in fall 1991; of these, only side-oats grama provided significant cover (11%).

The seed mix for this site included extraneous material that limited the flow of the mix through the seed drill. Numerous passes were made in the attempt to plant the seed. This may have effected establishment. In 1991, the same seed mix was planted in area 4B. No problems were encountered during the seeding of this area. Continued monitoring of these two areas will provide more information about the appropriateness of these species for use on RMA.

Shrubs have been planted at RMA as seed and as containerized material and bare root stock. Containerized material (5 and 1 gallon size) and, to a lesser extent, bare root material, has generally been established successfully if irrigation is provided for the first growing season. As it has been conducted at RMA, this is a relatively expensive, labor intensive process, and not suited to shrub establishment over large areas (i.e. acres). There has been virtually no success in establishing shrubs from seed at RMA. Even a summer of excellent precipitation, which produced unprecedented establishment of shrubs from seed at off-post locations (Keammerer 1991), did not result in any observed shrub seedlings at RMA. Shrub seed has been mixed with the other species in the various seed mixes used in the BEMA vegetation management program. This may have resulted in shrub seed being planted too deeply for successful germination and establishment. The viability of seed of the species required at RMA is of short duration. The seed used in the initial attempts may have been too old for success.

In fall 1991 these deficiencies were considered when shrubs were seeded at Site 1. Freshly harvested seed was broadcast on the surface of the soil and the area lightly harrowed to incorporate seed into soil. This technique may increase the establishment of shrubs from seed.

Other techniques for shrub establishment are being planned for 1992. These include planting of tublings with drip irrigation to reduce the cost of shrub planting and maintenance, and sprinkler irrigation of areas where shrubs seeds have been broadcast. It should be noted that before irrigation is initiated, water rights privileges and restrictions should be thoroughly investigated and documented.

One last point should be noted. Seeded areas should be given at least two growing/management seasons before decisions are made regarding success or failure. Patience is a necessary quality.

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RECOMMENDATIONS

1. Continue monitoring of sites 1, 4, 5, 6, and 7 with the goal of determining trends in vegetation community development.

2. Continue vegetation control at Site 6 west to allow western wheatgrass to continue development.

3. Continue mowing pattern at site 2 and incorporated this activity into studies being conducted by the Denver Museum of Natural History. Remove fencing from around shrubs.

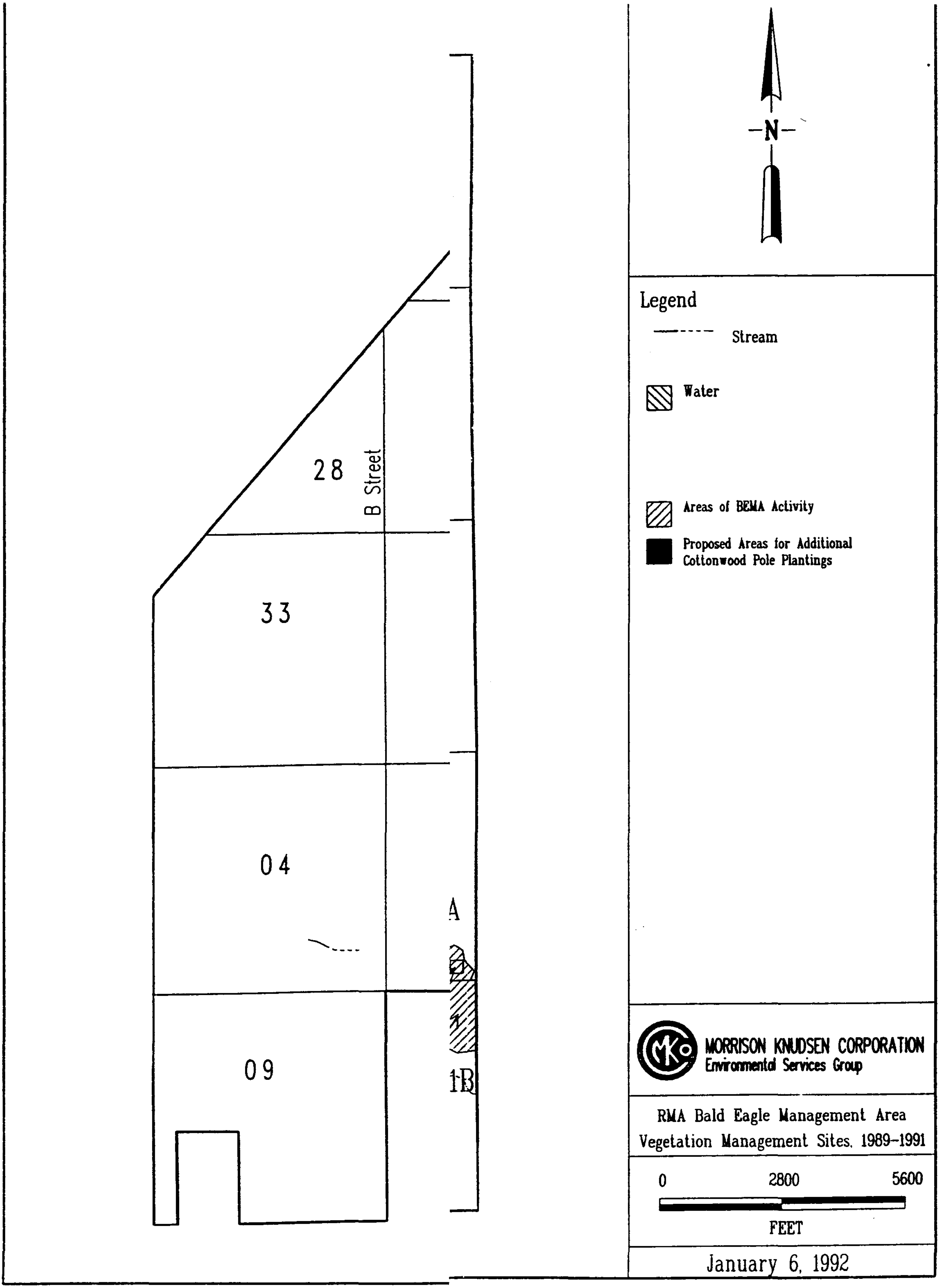
4. Investigate use of sprinkler irrigation for grassland and shrubland establishment.

5. Investigate planting of tublings and drip irrigation for shrub establishment.

6. Expand sites 1, 4, 6, and the area managed for needle-and-thread seed harvest.

7. Investigate deep plowing (12"-14") as a method for vegetation control. The objective would be to bury weed seeds in surface soil and prevent germination.

8. Plant and protect from deer cottonwood pole cuttings at Site 7.



MORRISON KNUDSEN CORPORATION
Environmental Services Group

RMA Bald Eagle Management Area
Vegetation Management Sites, 1989-1991

January 6, 1992

APPENDIX A: LOG OF ACTIVITY

BEMA SITE 1A MANAGEMENT PRACTICES FOR 1991.
25 acres

DATE	MANAGEMENT PRACTICE
5/17/91	Herbicide application. Herbicide applied to all of 1A except the needle and thread grass mulch area (23 acres). Target species: cheatgrass(residual), annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.27 pints/acre
2,4-D (#6)	0.97 pints/acre
Banvel	0.23 pints/acre
Surfactant	0.48 pints/acre

DATE	MANAGEMENT PRACTICE
7/19/91	Herbicide application. Herbicide applied to all of 1A except the needle and thread grass mulch area (23 acres). Target species: All broadleaves.

Herbicide	Rate
Banvel	1.05 pints/acre
Ally	0.84 pints/acre
Surfactant	0.15 pints/acre

DATE	MANAGEMENT PRACTICE
7/30/91	Mowed the needle and thread grass mulch area (2 acres) within 1A.
11/6/91	Over-seeded. See Appendix D for seed mix and seeding rates.

BEMA SITE 1B MANAGEMENT PRACTICES FOR 1991.
46 ACRES

DATE	MANAGEMENT PRACTICE
5/1/91	Sorghum cover crop mowed to 4" height.
5/8/91	Herbicide applied to 36 ares of 1B. The remainder (approx 10 acres) was too wet. Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.7 pints/acre
2,4-D (6#)	1.2 pints/acre
Banvel	0.4 pints/acre
Surfactant	0.7 pints/acre

5/17/91 Herbicide applied to the 10 acres that was too wet for earlier herbicide application.
Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.5 pints/acre
2,4-D (6#)	1.1 pints/acre
Banvel	0.4 pints/acre
Surfactant	0.7 pints/acre

7/19/91 Herbicide applied to all of 1B except a 50' barrier was left untreated near water.
Target species: All broadleaves and cheatgrass.

Herbicide	Rate
Banvel	1.1 pints/acre
Ally	0.1 oz/acre
Oust	0.2 pints/acre

9/13/91 Fertilizer applied.
150# Triple super-phosphate/acre

9/17/91 Deep chiseled.

10/21/91 Light disced.

10/23/91 Harrowed.

10/25/91 Drill seeded. See Appendix D for seed mix and seeding rates.

11/14/91 Mulch applied to 24 acres: then work stopped because of weather and presence of bald eagles in the vicinity.

BEMA SITE 4A MANAGEMENT PRACTICES FOR 1991.
8.5 acres

DATE	MANAGEMENT PRACTICE
5/1/91	Fertilizer applied. 150# ammonium nitrate/acre.
7/30/91	Site was mowed because it contained a dense stand of annual broadleaves.
8/29/91	Site was mowed to reduce regrowth of annual broadleaves.

BEMA SITE 4B MANAGEMENT PRACTICES FOR 1991.
14.5 acres

DATE	MANAGEMENT PRACTICE	
5/2/91	Herbicide applied. Target species: cheatgrass,musk thistle, and annual broadleaves.	
	Herbicide	**Rate**
	Round-up	1.6 pints/acre
	2,4-D (6#)	1.1 pints/acre
	Banvel	0.3 pints/acre
	Surfactant	0.7 pints/acre
5/15/91	Herbicide applied to approx. 0.5 acre on the ditch shoulder and upper bank. Target weeds: cheatgrass	
	Herbicide	**Rate**
	Rodeo	8 pints/acre
	Surfactant	8 pints/acre
5/21/19	Herbicide applied to approx. 1.5 acres on the ditch shoulder and upper bank. Target weeds: cheatgrass and broadleaves.	
	Herbicide	**Rate**
	Round-up	1.3 pints/acre
	2,4-D (6#)	1.3 pints/acre
	Banvel	0.3 pints/acre
	Surfactant	0.7 pints/acre
7/19/91	Herbicide applied to all of 4B. Target weeds: all broadleaves.	
	Herbicide	**Rate**
	Banvel	1.1 pints/acre
	Ally	0.1 oz/acre
	Surfactant	0.2 pints/acre
8/29/91	Site was mowed to remove dense stand of annual broadleaves.	
9/13/91	Fertilizer applied. 150# triple super-phosphate/acre.	
10/12/91	Deep chiseled.	

BEMA SITE 4B MANAGEMENT PRACTICES FOR 1991.
(continued)

10/17/91 Light disced.

10/23/91 Harrowed.

10/22/91 Drill seeded. See Appendix D for seed mix and seeding rates.

10/23/91 Harrowed.

11/12/91 Mulch applied and crimped at a rate of 2 tons/acre.

BEMA SITE 5A MANGEMENT PRACTICES FOR 1991.
11.4 ACRES

DATE	MANAGEMENT PRACTICE
5/1/19	Fertilizer applied. 150# ammonium nitrate/acre 150# triple super-phosphate/acre
5/14/91	Herbicide applied to 9 acres of 5A. Target weeds: cheatgrass(residual), annual and biennial broadleaves.

Herbicide	Rate
Oust	0.6 oz/acre
2,4-D (6#)	1.1 pints/acre
Banvel	0.3 pints/acre
Surfactant	0.1 pints/acre

BEMA SITE 5B MANAGEMENT PRACTICES FOR 1991
22.1 ACRES

DATE	MANAGEMENT PRACTICE
5/3/91	Herbicide applied to 5B west. Target weeds: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.6 pints/acre
2,4-D (6#)	1.3 pints/acre
Banvel	0.4 pints/acre
Surfactant	0.9 pints/acre

5/6/91 Herbicide applied to 5B east.
Target weeds: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.4 pints/acre
2,4-D (6#)	1.1 pints/acre
Banvel	0.3 pints/acre
Surfactant	0.6 pints/acre

5/17/91 Herbicide applied to touch up areas in 5B that need it.
Target species: cheatgrass,annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.5 pints/acre
2,4-D (6#)	1.2 pints/acre
Banvel	0.7 pints/acre
Surfactant	0.7 pints/acre

7/19/91 Herbicide applied.
Target species: all broadleaves.

Herbicide	Rate
Banvel	1.05 pints/acre
Ally	0.42 pints/acre
Surfactant	0.15 pints/acre

9/11/91 Mowed to reduce stand of annual broadleaves.

9/28/91 Fertilizer applied.
150# ammonium nitrate/acre.

BEMA SITE 5C MANAGEMENT PRACTICES FOR 1991
61.7 ACRES

DATE	MANAGEMENT PRACTICE
5/3/91	Herbicide applied to 5C west of 5A (21 acres). Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.00 pints/acre
2,4-D (6#)	0.78 pints/acre
Banvel	0.25 pints/acre
Surfactant	0.53 pints/acre

DATE	MANAGEMENT PRACTICE
5/6/91	Herbicide applied to 5C east of 5A (41 acres). Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.37 pints/acre
2,4-D (6#)	1.14 pints/acre
Banvel	0.34 pints/acre
Surfactant	0.55 pints/acre

DATE	MANAGEMENT PRACTICE
5/17/91	Herbicide applied east of 5C to the chainlink fence (9 acres). Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.56 pints/acre
2,4-D (6#)	0.78 pints/acre
2,4-D (4#)	0.44 pints/acre
Banvel	0.44 pints/acre
Surfactant	0.67 pints/acre

DATE	MANAGEMENT PRACTICE
5/18/91	Herbicide applied to 5C east of 5A. Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.50 pints/acre
2,4-D (6#)	1.15 pints/acre
Banvel	0.25 pints/acre
Surfactant	0.55 pints/acre

BEMA SITE 5C MANAGEMENT PRACTICES FOR 1991
(continued)

5/21/91 Herbicide applied to 4 acres of 5C east for touch-up.
Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Round-up	1.25 pints/acre
2,4-D (6#)	1.25 pints/acre
Banvel	0.37 pints/acre
Surfactant	0.50 pints/acre

7/24/91 Herbicide applied to 5C west of 5A (21 acres).
Target species: all broadleaves.

Herbicide	Rate
Banvel	1.05 pints/acre
Ally	0.42 pints/acre
Surfactant	0.15 pints/acre

9/11/91 Fertilizer applied.
150# triple super-phosphate/acre.

9/16/91 Partial mowing of 5C to prepare site for seed bed preparation.

10/14/91 Deep chiseled.

10/17/91 Light disced.

10/18/91 Harrowed.

10/22/91 Drill seeded. See Appendix D for seed mix and seeding rates.

10/25/91 Harrowed.

11/8/91 Mulch applied at a rate of 2 ton/acre.

BEMA SITE 6 EAST MANAGEMENT PRACTICES FOR 1991
24 acres

5/1/91	Fertilizer applied. 150# ammonium nitrate/acre 150# triple super-phosphate/acre
9/28/91	Fertilizer applied. 150# ammonium nitrate/acre

BEMA SITE 6 WEST MANAGEMENT PRACTICES FOR 1991
46 acres

4/5/91	Light chiseled to open up western wheatgrass clones.
8/1/91	Mowed to a height that would cut off the seed heads but retain as much vegetative growth as possible.
9/28/91	Fertilizer applied. 150# ammonium nitrate/acre

BEMA SITE 7A MANAGEMENT PRACTICES FOR 1991
11 acres

5/1/91 Fertilizer applied.
150# ammonium nitrate/acre
150# triple super-phosphate/acre

9/28/91 Fertilizer applied.
150# ammonium nitrate/acre

BEMA SITE 7B MANAGEMENT PRACTICES FOR 1991
18 acres

5/1/91 Mowed to 4" height.

5/2/91 Herbicide applied.
Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Diquat	2.00 pints/acre
2,4-D (6#)	0.91 pints/acre
Banvel	0.23 pints/acre
Surfactant	0.36 pints/acre

5/17/91 Herbicide applied to approximately 1/2 acre. Spotting of wet areas.
Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Diquat	2.00 pints/acre
2,4-D (6#)	1.00 pints/acre
Banvel	0.25 pints/acre
Surfactant	0.66 pints/acre

7/19/91 Herbicide applied.
Target species: cheatgrass, annual and biennial broadleaves.

Herbicide	Rate
Banvel	1.06 pints/acre
Ally	0.11 oz/acre
Oust	0.51 oz/acre
Surfactant	0.15 pints/acre

9/28/91 Fertilizer applied.
150# ammonium nitrate

NEEDLE AND THREAD GRASS HARVEST AREA MANAGEMENT
PRACTICES FOR 1991
16.5 acres

5/18/91 Herbicide applied.
Target species: broadleaves

Herbicide	Rate
2,4-D (6#)	1.00 pints/acre
2,4-D (4#)	0.50 pints/acre
Banvel	0.13 pints/acre
Telar	0.25 oz/acre
Surfactant	0.48 pints/acre

5/21/91 Herbicide applied to areas of cheatgrass (7 acres).
Target species: cheatgrass

Herbicide	Rate
Diquat	2.29 pints/acre
Surfactant	0.57 pints/acre

7/24/91 Herbicide applied to areas of bindweed and Canada thistle (2 acres).
Target species: broadleaves, especially bindweed and Canada thistle.

Herbicide	Rate
Banvel	1.00 pints/acre
Ally	0.10 oz/acre
Surfactant	0.50 pints/acre

8/14/91 Mowed area to a height that would remove needle and thread grass seed heads but not disturb the other vegetation.

APPENDIX B: COORDINATES FOR TRANSECT LOCATIONS

COORDINATES FOR 50 METER LINE-POINT TRANSECTS IN BEMA SITES

SITE 1A

TRANSECT	NORTHING	EASTING
1	175975.445	2198221.955
	175888.074	2198083.231
2	176071.163	2198502.201
	175919.705	2198440.085
3	175981.710	2198822.549
	175875.188	2198698.086
4	175723.965	2198738.531
	175619.489	2198611.982
5	175757.778	2198332.372
	175615.209	2198251.463
6	175672.905	2198909.924
	175818.635	2198834.983

SITE 1B

TRANSECT	NORTHING	EASTING
1	175226.131	2198713.177
	175104.296	2198822.845
2	174514.139	2198855.291
	174667.107	2198913.911
3	174416.333	2198334.576
	174541.341	2198228.340
4	174824.132	2198389.817
	174974.668	2198324.583
5	175011.946	2198024.139
	175142.813	2197924.834

COORDINATES FOR 50 METER LINE-POINT TRANSECTS IN BEMA SITES

SITE 4A

TRANSECT	NORTHING	EASTING
1	183957.751	2191041.887
	183988.452	2190880.986
2	184152.384	2190773.230
	184294.439	2190692.226
3	184268.128	2190514.427
	184251.113	2190351.737
4	184459.293	2190066.719
	184356.341	2190193.501
5	184450.867	2190253.979
	184443.926	2190417.393

SITE 5A

1	190863.000	2189142.219
	190706.364	2189095.968
2	190178.824	2189227.262
	190019.323	2189191.157
3	189512.760	2189371.165
	189349.675	2189359.056
4	188507.061	2189670.990
	188386.908	2189780.409
5	187029.057	2190237.503
	186869.003	2190204.171

COORDINATES FOR 50 METER LINE-POINT TRANSECTS IN BEMA SITES

SITE 5B

TRANSECT	NORTHING	EASTING
1 EAST	190961.495	2189157.377
	190804.921	2189207.330
2 EAST	190282.158	2189285.393
	190120.977	2189259.664
3 EAST	189584.141	2189425.675
	189420.370	2189427.934
4 EAST	188463.958	2189777.190
	188335.353	2189878.832
5 EAST	187191.970	2190290.183
	187032.738	2190251.409
1 WEST	190991.356	2189036.695
	190829.430	2189061.183
2 WEST	190304.384	2189094.594
	190152.964	2189153.275
3 WEST	189586.256	2189218.477
	189457.205	2189319.305
4 WEST	188455.394	2189678.411
	188297.489	2189720.330
5 WEST	186921.369	2190164.297
	186757.945	2190151.397

COORDINATES FOR 50 METER LINE-POINT TRANSECTS IN BEMA SITES

SITE 6 EAST

TRANSECT	NORTHING	EASTING
1	191121.666	2191930.739
	190974.463	2191858.070
2	190798.226	2191083.175
	190677.154	2191972.531
3	190227.709	2192041.153
	190109.907	2191927.347
4	190521.703	2191780.769
	190384.860	2191690.749
5	190935.739	2191676.087
	190780.026	2191625.244

SITE 6 WEST

TRANSECT	NORTHING	EASTING
1	190939.888	2190705.952
	190812.593	2190602.819
2	190595.429	2190430.494
	190471.170	2190537.907
3	189999.361	2190405.974
	190045.411	2190248.539
4	189525.061	2190600.726
	189572.053	2190757.695
5	189984.627	2190802.757
	190112.844	2190700.549

COORDINATES FOR 50 METER LINE-POINT TRANSECTS IN BEMA SITES

SITE 7A

TRANSECT	NORTHING	EASTING
1	192318.488	2188923.795
	192430.071	2189043.792
2	192520.617	2189238.396
	192681.071	2189205.481
3	192894.156	2189121.081
	192923.687	2189260.729
4	192939.004	2189464.570
	193061.530	2189356.328
5	193338.548	2189400.133
	193450.967	2189518.685

SITE 7B

1	192812.278	2188872.883
	192952.263	2188957.657
2	193028.646	2188877.827
	193141.607	2188995.450
3	193341.239	2189128.410
	193459.103	2189014.992
4	193583.990	2188933.249
	193647.539	2189083.631
5	193497.722	2189320.623
	193656.957	2189283.896

APPENDIX C: PRECIPITATION RECORD

YEAR	MONTH	STAPLETON	AVERAGE	DEPARTURE
			(1951-1980)	
1989	JANUARY	1.14	0.51	0.6
1989	FEBRUARY	0.66	0.69	0.0
1989	MARCH	0.56	1.21	-0.7
1989	APRIL	1	1.81	-0.8
1989	MAY	3.83	2.47	1.4
1989	JUNE	2.04	1.58	0.5
1989	JULY	1.64	1.93	-0.3
1989	AUGUST	1.28	1.53	-0.3
1989	SEPTEMBER	1.55	1.23	0.3
1989	OCTOBER	0.81	0.98	-0.2
1989	NOVEMBER	0.15	0.82	-0.7
1989	DECEMBER	0.81	0.55	0.3
1989	TOTAL	15.47	15.31	0.2
1990	JANUARY	0.74	0.51	0.2
1990	FEBRUARY	0.55	0.69	-0.1
1990	MARCH	3.1	1.21	1.9
1990	APRIL	1.01	1.81	-0.8
1990	MAY	1.51	2.47	-1.0
1990	JUNE	0.21	1.58	-1.4
1990	JULY	3.57	1.93	1.6
1990	AUGUST	1.96	1.53	0.4
1990	SEPTEMBER	1.46	1.23	0.2
1990	OCTOBER	1.03	0.98	0.1
1990	NOVEMBER	1.28	0.82	0.5
1990	DECEMBER	0.27	0.55	-0.3
1990	TOTAL	16.69	15.31	1.4

YEAR	MONTH	STAPLETON	AVERAGE	DEPARTURE
1991	JANUARY	0.76	0.51	0.3
1991	FEBRUARY	0.08	0.69	-0.6
1991	MARCH	0.76	1.21	-0.5
1991	APRIL	1.94	1.81	0.1
1991	MAY	2.43	2.47	0.0
1991	JUNE	2.2	1.58	0.6
1991	JULY	4.11	1.93	2.2
1991	AUGUST	3.69	1.53	2.2
1991	SEPTEMBER	0.79	1.23	-0.4
1991	OCTOBER		0.98	-1.0
1991	NOVEMBER		0.82	-0.8
1991	DECEMBER		0.55	-0.6
1991	TOTAL		15.31	-15.3
YEAR	ANNUAL	AVERAGE	DEPARTURE	
1986	12.09	15.31	-3.22	
1987	20.03	15.31	4.72	
1988	14.96	15.31	-0.35	
1989	15.47	15.31	0.16	
1990	16.69	15.31	1.38	
'86-90	15.85	15.31	0.538	

APPENDIX D: SEED MIXES

SEED MIXES AND RATES FOR BEMA VEGETATION MANAGEMENT
SITES FOR 1991

SITE	SPECIES	COMMON NAME	VARIETY	PLS/AC
1A	Chondrosum gracile	Blue Grama	Hachita	0.75
	Calamovilfa longifolia	Prairie Sandreed	Goshen	1.0
	Andropogon halii	Sand Bluestem	Woodward	5.0
	Panicum virgatum	Switchgrass	Neb 28	0.3
	Oligosporus filifolius	Sand Sagebrush	Native	0.05
	Artemisia frigida	Fringed Sagebrush	Native	0.01
			TOTAL	7.11
1B	Calamovilfa longifolia	Prairie Sandreed	Goshen	1.0
	Andropogon hallii	Sand Bluestem	Woodward	5.0
	Panicum virgatum	Switchgrass	Neb 28	0.3
	Oligosporus filifolius	Sand Sagebrush	Native	0.05
	Artemisia frigida	Fringed Sagebrush	Native	0.01
			TOTAL	6.36
4B	Andropogon gerardii	Big Bluestem	Kaw	3.4
	Schizachryrium scoparium	Little Bluestem	Pastura	1.7
	Panicum virgatum	Switchgrass	Neb 28	1.1
	Sorghastrum avenaceum	Yellow Indiangrass	Holt	3.4
	Bouteloua curtipendula	Side-oats Grama	Vaughn	2.3
			TOTAL	11.9
5C	Pascopyrum smithii	Western Wheatgrass	Arriba	6.9
	Elytrigia dasystachya	Thickspike Wheat	Critana	2.8
	Elymus trachycaulus	Slender Wheatgrass	Revenue	1.4
	Bouteloua curtipendula	Side-oats Grama	Vaughn	2.1
	Chondrosum gracile	Blue Grama	Hachita	0.5
	Artemisia frigida	Fringed Sagebrush	Native	\
	Gaillardia apistata	Blanket Flower	Native	\
	Achillea lanulosa	Yarrow	Native	0.01
	Rudbeckia hirta	Black-eyed Susan	Native	/
	Adenolium lewisii	Blue Flax	Native	/
			TOTAL	13.72

APPENDIX E: VEGETATION SUMMARY TABLES

Table 1 BEMA SITE 1A VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Pascopyrum smithii	0.40	0.87	0 - 2	20.00	2.17	3.04	13
Stipa comata	1.20	2.61	0 - 6	20.00	2.17	4.78	11
Sub-total	1.60	3.48					
WARM SEASON PERENNIAL GRASSES							
Buchloe dactyloides	0.40	0.87	0 - 2	20.00	2.17	3.04	13
Sporobolus cryptandrus	2.40	5.22	0 - 10	40.00	4.35	9.57	6
Sub-total	2.80	6.09					
ANNUAL GRASSES							
Anisantha tectorum	13.20	28.70	4 - 20	100.00	10.87	39.57	1
Eragrostis cilianensis	0.80	1.74	0 - 4	20.00	2.17	3.91	12
Sub-total	14.00	30.43					
PERENNIAL FORBS							
Ambrosia psilostachya	1.60	3.48	0 - 4	60.00	6.52	10.00	5
Convolvulus arvensis	4.80	10.43	0 - 18	40.00	4.35	14.78	3
Lygodesmia juncea	0.40	0.87	0 - 2	20.00	2.17	3.04	13
Medicago sativa	6.00	13.04	0 - 14	80.00	8.70	21.74	2
Nuttallia nuda	1.60	3.48	0 - 6	40.00	4.35	7.83	8
Oenothera villosa	1.20	2.61	0 - 4	40.00	4.35	6.96	9
Physalis virginiana	1.60	3.48	0 - 4	60.00	6.52	10.00	5
Sub-total	17.20	37.39					
ANNUAL AND BIENNIAL FORBS							
Amaranthus retroflexus	2.40	5.22	0 - 6	60.00	6.52	11.74	4
Annual and Biennial Forbs	0.80	1.74	0 - 2	60.00	6.52	8.26	7
Bassia sieversiana	0.80	1.74	0 - 4	20.00	2.17	3.91	12
Chenopodium album	0.40	0.87	0 - 2	20.00	2.17	3.04	13

Table 1(cont'd). BEMA SITE 1A VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Croton texensis	0.40	0.87	0 - 2	20.00	2.17	3.04	13
Lactuca serriola	0.40	0.87	0 - 2	20.00	2.17	3.04	13
Lappula redowskii	0.40	0.87	0 - 2	20.00	2.17	3.04	13
Machaeranthera canescens	0.80	1.74	0 - 2	40.00	4.35	6.09	10
Polygonum aviculare	0.40	0.87	0 - 2	20.00	2.17	3.04	13
Salsola australis	2.40	5.22	0 - 8	40.00	4.35	9.57	6
Ximenesia encelioides	0.80	1.74	0 - 4	20.00	2.17	3.91	12
Sub-total	10.00	21.74					
CACTI AND SUCCULENTS							
Opuntia polyacantha	0.40	0.87	0 - 2	20.00	2.17	3.04	13
Sub-total	0.40	0.87					
SUM OF SPECIES COVER	46.00						
Litter	34.00		0 - 0	100.00			
TOTAL VEGETATION	46.80 +/-	7.56					
LITTER/ROCK	34.00 +/-	10.30					
BARE SOIL	19.20 +/-	5.76					
TOTAL COVER	80.80 +/-	5.76					
Number of Species/sample	9.20						

Table 2 BEMA SITE 1A VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 6 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Critesion jubatum	1.67	2.58	0 - 8	33.33	4.17	6.74	10
Pascopyrum smithii	<0.01	<0.01	0 - <1	0.00	0.00	0.00	16
Stipa comata	0.67	1.03	0 - 4	16.67	2.08	3.11	14
Sub-total	2.34	3.61					
WARM SEASON PERENNIAL GRASSES							
Andropogon hallii	<0.01	<0.01	0 - <1	0.00	0.00	0.00	16
Calamovilfa longifolia	0.67	1.03	0 - 4	16.67	2.08	3.11	14
Chondrosum gracile	4.33	6.70	0 - 8	66.67	8.33	15.03	6
Panicum virgatum	<0.01	<0.01	0 - <1	0.00	0.00	0.00	16
Sporobolus cryptandrus	16.67	25.77	0 - 38	83.33	10.42	36.18	1
Sub-total	21.67	33.50					
ANNUAL GRASSES							
Anisantha tectorum	3.00	4.64	0 - 16	33.33	4.17	8.80	8
Cenchrus longispinus	0.33	0.52	0 - 2	16.67	2.08	2.60	15
Eragrostis cilianensis	2.00	3.09	0 - 12	16.67	2.08	5.18	11
Panicum capillare	2.00	3.09	0 - 8	33.33	4.17	7.26	9
Sub-total	7.33	11.34					
PERENNIAL FORBS							
Ambrosia psilostachya	8.00	12.37	0 - 24	33.33	4.17	16.53	4
Argemone polyanthemos	<0.01	<0.01	0 - <1	0.00	0.00	0.00	16
Asclepias speciosa	<0.01	<0.01	0 - <1	0.00	0.00	0.00	16
Convolvulus arvensis	1.33	2.06	0 - 8	16.67	2.08	4.14	12
Lygodesmia juncea	0.33	0.52	0 - 2	16.67	2.08	2.60	15
Nuttallia nuda	<0.01	<0.01	0 - <1	0.00	0.00	0.00	16
Physalis virginiana	3.00	4.64	0 - 8	83.33	10.42	15.05	5
Sub-total	12.67	19.59					

Table 2(cont'd). BEMA SITE 1A VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 6 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
ANNUAL AND BIENNIAL FORBS							
Amaranthus arenicola	3.00	4.64	0 - 14	33.33	4.17	8.80	8
Amaranthus blitoides	2.00	3.09	0 - 10	33.33	4.17	7.26	9
Chamaesyce glyptosperma	4.00	6.18	0 - 14	33.33	4.17	10.35	7
Chamaesyce serpyllifolia	<0.01	<0.01	0 - <1	0.00	0.00	0.00	16
Chenopodium album	0.33	0.52	0 - 2	16.67	2.08	2.60	15
Croton texensis	0.33	0.52	0 - 2	16.67	2.08	2.60	15
Helianthus annuus	<0.01	<0.01	0 - <1	0.00	0.00	0.00	16
Lactuca serriola	1.00	1.55	0 - 6	16.67	2.08	3.63	13
Melolotis species	1.00	1.55	0 - 0	16.67	2.08	3.63	13
Poinsettia dentata	4.67	7.21	0 - 10	83.33	10.42	17.63	2
Salsola australis	4.33	6.70	0 - 8	83.33	10.42	17.12	3
Sub-total	20.67	31.96					
CACTI AND SUCCULENTS							
Opuntia polyacantha	<0.01	<0.01	0 - <1	0.00	0.00	0.00	16
Sub-total	<0.01	<0.01					
SUM OF SPECIES COVER	64.68						
Litter	25.67		0 - 0	100.00			
TOTAL VEGETATION	64.67 +/-	6.77					
LITTER/ROCK	25.67 +/-	4.80					
BARE SOIL	9.67 +/-	6.86					
TOTAL COVER	90.33 +/-	6.86					
Number of Species/sample	8.00						

Table 3 BEMA SITE 1B VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
WARM SEASON PERENNIAL GRASSES							
Sporobolus cryptandrus	41.20	66.87	22 - 60	100.00	17.24	84.11	1
Sub-total	41.20	66.87					
ANNUAL GRASSES							
Anisantha tectorum	4.80	7.79	0 - 10	80.00	13.79	21.58	2
Eragrostis cilianensis	1.60	2.60	0 - 4	60.00	10.34	12.94	4
Panicum capillare	<0.01	<0.01	0 - <1	0.00	0.00	0.00	9
Setaria viridis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	9
Sub-total	6.40	10.39					
PERENNIAL FORBS							
Ambrosia psilostachya	<0.01	<0.01	0 - <1	0.00	0.00	0.00	9
Asclepias speciosa	0.80	1.30	0 - 4	20.00	3.45	4.75	7
Cirsium arvense	1.20	1.95	0 - 6	20.00	3.45	5.40	6
Cirsium undulatum	<0.01	<0.01	0 - <1	0.00	0.00	0.00	9
Convolvulus arvensis	0.80	1.30	0 - 4	20.00	3.45	4.75	7
Lygodesmia juncea	0.80	1.30	0 - 4	20.00	3.45	4.75	7
Physalis heterophylla	0.80	1.30	0 - 4	20.00	3.45	4.75	7
Physalis virginiana	3.20	5.19	0 - 6	80.00	13.79	18.99	3
Verbascum thapsus	0.40	0.65	0 - 2	20.00	3.45	4.10	8
Sub-total	8.00	12.99					
ANNUAL AND BIENNIAL FORBS							
Amaranthus retroflexus	<0.01	<0.01	0 - <1	0.00	0.00	0.00	9
Chenopodium album	0.40	0.65	0 - 2	20.00	3.45	4.10	8
Portulaca oleracea	0.80	1.30	0 - 2	40.00	6.90	8.19	5
Salsola australis	4.80	7.79	0 - 10	80.00	13.79	21.58	2
Sub-total	6.00	9.74					

Table 3(cont'd). BEMA SITE 1B VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
SHRUBS							
Oligosporus filifolius	<0.01	<0.01	0 - <1	0.00	0.00	0.00	9
Sub-total	<0.01	<0.01					
CACTI AND SUCCULENTS							
Opuntia polyacantha	<0.01	<0.01	0 - <1	0.00	0.00	0.00	9
Sub-total	<0.01	<0.01					
SUM OF SPECIES COVER	61.61						
Litter	26.80		0 - 0	100.00			
TOTAL VEGETATION	62.00 +/-	10.58					
LITTER/ROCK	26.80 +/-	9.01					
BARE SOIL	11.20 +/-	3.63					
TOTAL COVER	88.80 +/-	3.63					
Number of Species/sample	5.80						

Table 4 BEMA SITE 4A VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Aristida purpurea var. longise	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Sub-total	<0.01	<0.01					
WARM SEASON PERENNIAL GRASSES							
Bouteloua curtipendula	10.40	19.99	4 - 18	100.00	12.50	32.49	2
Chondrosum gracile	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Panicum virgatum	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Sub-total	10.80	20.76					
ANNUAL GRASSES							
Anisantha tectorum	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Echinochloa crus-galli	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Eragrostis cilianensis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Panicum capillare	1.60	3.08	0 - 6	40.00	5.00	8.08	6
Setaria viridis	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Sorghum	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Sub-total	3.20	6.16					
PERENNIAL FORBS							
Achillea lanulosa	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Asclepias speciosa	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Cirsium arvense	1.60	3.08	0 - 0	40.00	5.00	8.08	6
Convolvulus arvensis	2.00	3.84	0 - 6	60.00	7.50	11.34	5
Glycyrrhiza lepidota	1.20	2.31	0 - 4	40.00	5.00	7.31	7
Machaeranthera species	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Medicago sativa	0.80	1.54	0 - 2	40.00	5.00	6.54	8
Nepeta cataria	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Oenothera villosa	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Verbascum thapsus	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Sub-total	5.61	10.79					

Table 4(cont'd). BEMA SITE 4A VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
ANNUAL AND BIENNIAL FORBS							
Amaranthus blitoides	5.20	10.00	0 - 10	80.00	10.00	20.00	4
Amaranthus retroflexus	0.80	1.54	0 - 2	40.00	5.00	6.54	8
Bassia sieversiana	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Carduus nutans ssp.macrolepis	6.00	11.53	0 - 12	80.00	10.00	21.53	3
Chenopodium album	0.80	1.54	0 - 4	20.00	2.50	4.04	9
Conyza canadensis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Fallopia convolvulus	17.60	33.83	0 - 38	60.00	7.50	41.33	1
Lactuca serriola	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Rumex triangulivalvis	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Solanum rostratum	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Solanum triflorum	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Verbena bracteata	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Sub-total	32.40	62.29					
SUM OF SPECIES COVER	52.02						
Litter	44.80		0 - 0	100.00			
TOTAL VEGETATION	52.00 +/-	11.75					
LITTER/ROCK	44.80 +/-	14.81					
BARE SOIL	3.20 +/-	4.15					
TOTAL COVER	96.80 +/-	4.15					
Number of Species/sample	8.00						

Table 4(cont'd). **BEMA SITE 4A VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.**

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
ANNUAL AND BIENNIAL FORBS							
Amaranthus blitoides	5.20	10.00	0 - 10	80.00	10.00	20.00	4
Amaranthus retroflexus	0.80	1.54	0 - 2	40.00	5.00	6.54	8
Bassia sieversiana	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Carduus nutans ssp.macrolepis	6.00	11.53	0 - 12	80.00	10.00	21.53	3
Chenopodium album	0.80	1.54	0 - 4	20.00	2.50	4.04	9
Conyza canadensis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Fallopia convolvulus	17.60	33.83	0 - 38	60.00	7.50	41.33	1
Lactuca serriola	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Rumex triangulivalvis	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Solanum rostratum	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Solanum triflorum	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Verbena bracteata	0.40	0.77	0 - 2	20.00	2.50	3.27	10
Sub-total	32.40	62.29					
SUM OF SPECIES COVER	52.02						
Litter	44.80		0 - 0	100.00			
TOTAL VEGETATION	52.00 +/-	11.75					
LITTER/ROCK	44.80 +/-	14.81					
BARE SOIL	3.20 +/-	4.15					
TOTAL COVER	96.80 +/-	4.15					
Number of Species/sample	8.00						

Table 5 BEMA SITE 5A VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Critesion jubatum	0.80	1.03	0 - 4	20.00	2.70	3.73	9
Elymus trachycaulus	50.40	64.62	30 - 66	100.00	13.51	78.13	1
Pascopyrum smithii	3.60	4.62	0 - 8	60.00	8.11	12.72	4
Sub-total	54.80	70.26					
WARM SEASON PERENNIAL GRASSES							
Chondrosum gracile	3.60	4.62	0 - 12	60.00	8.11	12.72	4
Sporobolus cryptandrus	0.80	1.03	0 - 4	20.00	2.70	3.73	9
Sub-total	4.40	5.64					
INTRODUCED PERENNIAL GRASSES							
Lolium perenne	0.40	0.51	0 - 2	20.00	2.70	3.22	10
Sub-total	0.40	0.51					
ANNUAL GRASSES							
Anisantha tectorum	4.00	5.13	0 - 12	60.00	8.11	13.24	3
Sub-total	4.00	5.13					
PERENNIAL FORBS							
Ambrosia psilostachya	0.40	0.51	0 - 2	20.00	2.70	3.22	10
Asclepias speciosa	0.80	1.03	0 - 4	20.00	2.70	3.73	9
Cirsium arvense	1.20	1.54	0 - 2	60.00	8.11	9.65	6
Convolvulus arvensis	5.20	6.67	2 - 8	100.00	13.51	20.18	2
Sub-total	7.60	9.74					
ANNUAL AND BIENNIAL FORBS							
Bassia sieversiana	1.60	2.05	0 - 4	60.00	8.11	10.16	5
Carduus nutans ssp.macrolepis	0.40	0.51	0 - 2	20.00	2.70	3.22	10
Chenopodium album	1.60	2.05	0 - 8	20.00	2.70	4.75	8

Table 5(cont'd). BEMA SITE 5A VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Chenopodium leptophyllum	1.60	2.05	0 - 8	20.00	2.70	4.75	8
Melilotus alba	0.80	1.03	0 - 2	40.00	5.41	6.43	7
Polygonum aviculare	0.40	0.51	0 - 2	20.00	2.70	3.22	10
Salsola australis	0.40	0.51	0 - 2	20.00	2.70	3.22	10
Sub-total	6.80	8.72					
SUM OF SPECIES COVER	78.00						
Litter	10.00		0 - 0	100.00			
TOTAL VEGETATION	78.00 +/-	11.92					
LITTER/ROCK	10.00 +/-	5.66					
BARE SOIL	12.00 +/-	9.70					
TOTAL COVER	88.00 +/-	9.70					
Number of Species/sample	7.40						

Table 6 BEMA SITE 5A VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Critesion jubatum	0.40	0.97	0 - 2	20.00	3.57	4.54	8
Elymus canadensis	0.80	1.94	0 - 4	20.00	3.57	5.51	7
Elymus trachycaulus	4.40	10.68	0 - 10	80.00	14.29	24.96	3
Pascopyrum smithii	7.20	17.47	2 - 12	100.00	17.86	35.33	1
Sub-total	12.80	31.06					
WARM SEASON PERENNIAL GRASSES							
Buchloe dactyloides	<0.01	<0.01	0 - <1	0.00	0.00	0.00	9
Chondrosum gracile	7.20	17.47	4 - 14	100.00	17.86	35.33	1
Sporobolus cryptandrus	5.20	12.62	0 - 22	40.00	7.14	19.76	5
Sub-total	12.40	30.10					
ANNUAL GRASSES							
Eragrostis cilianensis	0.40	0.97	0 - 2	20.00	3.57	4.54	8
Panicum capillare	<0.01	<0.01	0 - <1	0.00	0.00	0.00	9
Sub-total	0.40	0.98					
PERENNIAL FORBS							
Asclepias speciosa	0.40	0.97	0 - 2	20.00	3.57	4.54	8
Cirsium arvense	1.20	2.91	0 - 4	40.00	7.14	10.06	6
Convolvulus arvensis	8.40	20.39	0 - 14	80.00	14.29	34.67	2
Sub-total	10.00	24.27					
ANNUAL AND BIENNIAL FORBS							
Bassia sieversiana	5.60	13.59	0 - 20	40.00	7.14	20.73	4
Sub-total	5.60	13.59					
SUM OF SPECIES COVER	41.20						
Litter	41.20		0 - 0	100.00			
TOTAL VEGETATION	41.20 +/-	5.02					
LITTER/ROCK	41.20 +/-	6.26					
BARE SOIL	17.60 +/-	6.23					
TOTAL COVER	82.40 +/-	6.23					
Number of Species/sample	5.60						

Table 7 BEMA SITE 5B VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 10 50 METER LINER-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Critesion jubatum	1.00	1.47	0 - 6	30.00	3.49	4.95	14
Elymus canadensis	0.20	0.29	0 - 2	10.00	1.16	1.46	18
Elymus trachycaulus	1.20	1.76	0 - 8	30.00	3.49	5.25	13
Sub-total	2.40	3.52					
WARM SEASON PERENNIAL GRASSES							
Chondrosum gracile	0.40	0.59	0 - 4	10.00	1.16	1.75	17
Sporobolus cryptandrus	0.80	1.17	0 - 6	20.00	2.33	3.50	15
Sub-total	1.20	1.76					
ANNUAL GRASSES							
Anisantha tectorum	5.60	8.21	0 - 12	80.00	9.30	17.51	4
Sub-total	5.60	8.21					
PERENNIAL FORBS							
Ambrosia psilostachya	2.00	2.93	0 - 10	40.00	4.65	7.58	10
Cardaria draba	0.20	0.29	0 - 2	10.00	1.16	1.46	18
Cirsium arvense	3.20	4.69	0 - 6	80.00	9.30	13.99	7
Convolvulus arvensis	15.40	22.58	3 - 32	100.00	11.63	34.21	1
Medicago sativa	7.40	10.85	0 - 56	30.00	3.49	14.34	6
Sub-total	28.20	41.35					
ANNUAL AND BIENNIAL FORBS							
Annual and Biennial Forbs	1.80	2.64	0 - 8	40.00	4.65	7.29	11
Bassia sieversiana	8.20	12.02	0 - 36	60.00	6.98	19.00	3
Carduus nutans ssp.macrolepis	5.40	7.92	0 - 28	70.00	8.14	16.06	5
Chenopodium album	2.20	3.23	0 - 12	30.00	3.49	6.71	12
Chenopodium leptophyllum	7.40	10.85	0 - 32	80.00	9.30	20.15	2
Lappula redowskii	0.20	0.29	0 - 2	10.00	1.16	1.46	18

Table 7(cont'd). BEMA SITE 5B VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 10 50 METER LINER-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Melolotis species	3.60	5.28	0 - 16	50.00	5.81	11.09	8
Polygonum ramocissiumum	0.60	0.88	0 - 4	20.00	2.33	3.21	16
Salsola australis	1.40	2.05	0 - 8	60.00	6.98	9.03	9
Sub-total	30.80	45.16					
SUM OF SPECIES COVER	68.20						
Litter	12.00		2 - 22	100.00			
TOTAL VEGETATION	68.20 +/-	12.59					
LITTER/ROCK	12.00 +/-	8.33					
BARE SOIL	12.60 +/-	10.83					
TOTAL COVER	80.40 +/-	11.81					
Number of Species/sample	8.60						

Table 8 BEMA SITE 5B VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 10 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Critesion jubatum	3.20	8.51	0 - 16	30.00	4.29	12.79	4
Distichlis spicata var.stricta	0.40	1.06	0 - 4	10.00	1.43	2.49	17
Elymus canadensis	1.40	3.72	0 - 6	40.00	5.71	9.44	7
Elymus trachycaulus	1.60	4.25	0 - 12	20.00	2.86	7.11	12
Pascopyrum smithii	0.80	2.13	0 - 2	40.00	5.71	7.84	11
Schedonnardus paniculatus	<0.01	<0.01	0 - <1	0.00	0.00	0.00	19
Sub-total	7.40	19.68					
WARM SEASON PERENNIAL GRASSES							
Buchloe dactyloides	9.60	25.53	2 - 22	100.00	14.29	39.81	1
Chondrosum gracile	3.80	10.10	0 - 8	70.00	10.00	20.10	3
Sporobolus cryptandrus	5.20	13.83	0 - 22	50.00	7.14	20.97	2
Sub-total	18.60	49.46					
INTRODUCED PERENNIAL GRASSES							
Chloris verticillata	<0.01	<0.01	0 - <1	0.00	0.00	0.00	19
Poa pratensis	0.20	0.53	0 - 2	10.00	1.43	1.96	18
Sub-total	0.20	0.53					
ANNUAL GRASSES							
Anisantha tectorum	1.60	4.25	0 - 12	30.00	4.29	8.54	9
Bromus japonicus	0.80	2.13	0 - 6	20.00	2.86	4.98	13
Cenchrus longispinus	<0.01	<0.01	0 - <1	0.00	0.00	0.00	19
Eragrostis cilianensis	0.40	1.06	0 - 2	20.00	2.86	3.92	15
Panicum capillare	1.00	2.66	0 - 4	40.00	5.71	8.37	10
Setaria viridis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	19
Sub-total	3.80	10.11					
PERENNIAL FORBS							
Asclepias speciosa	<0.01	<0.01	0 - <1	0.00	0.00	0.00	19

Table 8(cont'd). BEMA SITE 5B VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 10 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Cardaria draba	0.40	1.06	0 - 4	10.00	1.43	2.49	17
Cirsium arvense	<0.01	<0.01	0 - <1	0.00	0.00	0.00	19
Convolvulus arvensis	1.40	3.72	0 - 4	60.00	8.57	12.29	5
Physalis heterophylla	0.20	0.53	0 - 2	10.00	1.43	1.96	18
Physalis virginiana	0.20	0.53	0 - 2	10.00	1.43	1.96	18
Verbascum thapsus	0.60	1.60	0 - 6	10.00	1.43	3.02	16
Sub-total	2.80	7.45					
ANNUAL AND BIENNIAL FORBS							
Amaranthus blitoides	0.20	0.53	0 - 2	10.00	1.43	1.96	18
Bassia sieversiana	1.80	4.79	0 - 6	40.00	5.71	10.50	6
Croton texensis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	19
Fallopia convolvulus	0.60	1.60	0 - 4	20.00	2.86	4.45	14
Portulaca oleracea	<0.01	<0.01	0 - <1	0.00	0.00	0.00	19
Salsola australis	0.40	1.06	0 - 2	20.00	2.86	3.92	15
Solanum triflorum	1.80	4.79	0 - 10	30.00	4.29	9.07	8
Sub-total	4.80	12.77					
CACTI AND SUCCULENTS							
Opuntia polyacantha	<0.01	<0.01	0 - <1	0.00	0.00	0.00	19
Sub-total	<0.01	<0.01					
SUM OF SPECIES COVER	37.61						
Litter	48.80		44 - 58	100.00			
TOTAL VEGETATION	37.40 +/-	3.53					
LITTER/ROCK	48.80 +/-	5.35					
BARE SOIL	13.80 +/-	4.94					
TOTAL COVER	86.40 +/-	4.88					
Number of Species/sample	7.00						

Table 9 BEMA SITE 6 EAST VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
PERENNIAL GRASSES							
Perennial Grasses	0.40	0.66	0 - 2	20.00	4.76	5.42	5
Sub-total	0.40	0.66					
COOL SEASON PERENNIAL GRASSES							
Pascopyrum smithii	17.20	28.47	6 - 34	100.00	23.81	52.28	2
Sub-total	17.20	28.47					
WARM SEASON PERENNIAL GRASSES							
Buchloe dactyloides	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Chondrosum gracile	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Sub-total	<0.01	<0.01					
PERENNIAL FORBS							
Convolvulus arvensis	4.80	7.95	2 - 16	100.00	23.81	31.76	3
Sub-total	4.80	7.95					
ANNUAL AND BIENNIAL FORBS							
Bassia sieversiana	30.00	49.67	14 - 40	100.00	23.81	73.48	1
Lactuca serriola	0.40	0.66	0 - 2	20.00	4.76	5.42	5
Salsola australis	7.60	12.58	0 - 20	80.00	19.05	31.63	4
Sub-total	38.00	62.91					
SUM OF SPECIES COVER	60.40						
Litter	8.80		0 - 0	100.00			
TOTAL VEGETATION	60.40 +/-	11.87					
LITTER/ROCK	11.20 +/-	4.82					
BARE SOIL	29.20 +/-	9.96					
TOTAL COVER	70.80 +/-	9.96					
Number of Species/sample	4.20						

Table 10 BEMA SITE 6 EAST VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Aristida purpurea var. longise	<0.01	<0.01	0 - <1	0.00	0.00	0.00	5
Elymus canadensis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	5
Pascopyrum smithii	40.00	48.30	22 - 56	100.00	29.41	77.71	1
Schedonnardus paniculatus	<0.01	<0.01	0 - <1	0.00	0.00	0.00	5
Sub-total	40.01	48.31					
WARM SEASON PERENNIAL GRASSES							
Chondrosum gracile	<0.01	<0.01	0 - <1	0.00	0.00	0.00	5
Sporobolus cryptandrus	0.40	0.48	0 - 2	20.00	5.88	6.37	4
Sub-total	0.40	0.49					
ANNUAL GRASSES							
Anisantha tectorum	<0.01	<0.01	0 - <1	0.00	0.00	0.00	5
Bromus japonicus	0.40	0.48	0 - 2	20.00	5.88	6.37	4
Sub-total	0.40	0.49					
PERENNIAL FORBS							
Convolvulus arvensis	6.00	7.24	0 - 14	80.00	23.53	30.77	3
Machaeranthera pinnatifida	<0.01	<0.01	0 - <1	0.00	0.00	0.00	5
Sub-total	6.00	7.25					
ANNUAL AND BIENNIAL FORBS							
Bassia sieversiana	35.60	42.99	20 - 48	100.00	29.41	72.40	2
Carduus nutans ssp.macrolepis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	5
Conyza canadensis	0.40	0.48	0 - 2	20.00	5.88	6.37	4
Lactuca serriola	<0.01	<0.01	0 - <1	0.00	0.00	0.00	5
Salsola australis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	5
Sub-total	36.01	43.48					
SUM OF SPECIES COVER	82.82						
Litter	8.80		0 - 0	100.00			
TOTAL VEGETATION	82.80 +/-	3.63					
LITTER/ROCK	8.80 +/-	4.60					
BARE SOIL	8.40 +/-	3.85					
TOTAL COVER	91.60 +/-	3.85					
Number of Species/sample	3.40						

Table 11 BEMA SITE 6 WEST VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Aristida purpurea var. longise	1.20	1.92	0 - 6	20.00	3.33	5.26	8
Pascopyrum smithii	8.00	12.82	2 - 14	100.00	16.67	29.48	3
Schedonnardus paniculatus	0.40	0.64	0 - 2	20.00	3.33	3.97	10
Sub-total	9.60	15.38					
WARM SEASON PERENNIAL GRASSES							
Chondrosum gracile	0.40	0.64	0 - 2	20.00	3.33	3.97	10
Sporobolus cryptandrus	0.80	1.28	0 - 2	40.00	6.67	7.95	6
Sub-total	1.20	1.92					
ANNUAL GRASSES							
Anisantha tectorum	3.20	5.13	0 - 8	60.00	10.00	15.13	4
Eragrostis cilianensis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Panicum capillare	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Sub-total	3.20	5.13					
PERENNIAL FORBS							
Cirsium arvense	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Convolvulus arvensis	0.40	0.64	0 - 2	20.00	3.33	3.97	10
Machaeranthera pinnatifida	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Oenothera caespitosa	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Sphaeralcea coccinea	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Verbascum thapsus	<0.01	<0.01	0 - <1	0.00	0.00	0.00	11
Sub-total	0.41	0.66					
ANNUAL AND BIENNIAL FORBS							
Bassia sieversiana	22.80	36.53	4 - 58	100.00	16.67	53.20	1
Chamaesyce serpyllifolia	1.20	1.92	0 - 4	40.00	6.67	8.59	5
Other Annual/Biennial Forbs	1.20	1.92	0 - 4	40.00	6.67	8.59	5

Table 11(cont'd). BEMA SITE 6 WEST VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Portulaca oleracea	0.80	1.28	0 - 4	20.00	3.33	4.62	9
Salsola australis	20.00	32.04	0 - 32	80.00	13.33	45.38	2
Ximenesia enceloides	0.40	0.64	0 - 2	20.00	3.33	3.97	10
Sub-total	46.40	74.34					
SEMI-SHRUBS OR HALF-SHRUBS							
Gutierrezia sarothrae	1.60	2.56	0 - 8	20.00	3.33	5.90	7
Sub-total	1.60	2.56					
SUM OF SPECIES COVER	62.41						
Litter	25.60		0 - 0	100.00			
TOTAL VEGETATION	66.40 +/-	11.61					
LITTER/ROCK	25.60 +/-	9.42					
BARE SOIL	12.00 +/-	7.75					
TOTAL COVER	88.00 +/-	7.75					

Number of Species/sample 6.00

Table 12 BEMA SITE 7A VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Critesion jubatum	0.40	0.45	0 - 2	20.00	2.50	2.95	10
Elymus canadensis	2.80	3.17	0 - 14	20.00	2.50	5.67	8
Elymus trachycaulus	29.60	33.48	20 - 42	100.00	12.50	45.98	1
Pascopyrum smithii	2.80	3.17	0 - 10	60.00	7.50	10.67	5
Sub-total	35.60	40.27					
WARM SEASON PERENNIAL GRASSES							
Calamovilfa longifolia	0.80	0.90	0 - 2	40.00	5.00	5.90	7
Chondrosum gracile	1.20	1.36	0 - 2	60.00	7.50	8.86	6
Sub-total	2.00	2.26					
ANNUAL GRASSES							
Anisantha tectorum	23.60	26.70	6 - 48	100.00	12.50	39.20	2
Bromus japonicus	0.40	0.45	0 - 2	20.00	2.50	2.95	10
Sub-total	24.00	27.15					
PERENNIAL FORBS							
Asclepias speciosa	0.40	0.45	0 - 2	20.00	2.50	2.95	10
Cirsium arvense	2.80	3.17	0 - 8	60.00	7.50	10.67	5
Convolvulus arvensis	2.80	3.17	0 - 8	80.00	10.00	13.17	4
Lygodesmia juncea	0.40	0.45	0 - 2	20.00	2.50	2.95	10
Sub-total	6.40	7.24					
ANNUAL AND BIENNIAL FORBS							
Amaranthus retroflexus	2.80	3.17	0 - 8	60.00	7.50	10.67	5
Bassia sieversiana	16.40	18.55	8 - 36	100.00	12.50	31.05	3
Polygonum aviculare	0.40	0.45	0 - 2	20.00	2.50	2.95	10
Salsola australis	0.80	0.90	0 - 4	20.00	2.50	3.40	9
Sub-total	20.40	23.08					
SUM OF SPECIES COVER	88.40						
Litter	5.20		0 - 0	100.00			
TOTAL VEGETATION	88.40 +/-	5.55					
LITTER/ROCK	5.20 +/-	3.63					
BARE SOIL	6.40 +/-	4.34					
TOTAL COVER	93.60 +/-	4.34					
Number of Species/sample	8.00						

Table 13 BEMA SITE 7A VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Critesion jubatum	1.20	1.44	0 - 4	40.00	5.26	6.70	8
Elymus canadensis	4.40	5.26	0 - 22	20.00	2.63	7.89	6
Elymus trachycaulus	20.40	24.40	10 - 42	100.00	13.16	37.56·	2
Pascopyrum smithii	16.00	19.14	6 - 32	100.00	13.16	32.29	3
Sub-total	42.00	50.23					
WARM SEASON PERENNIAL GRASSES							
Chondrosum gracile	2.40	2.87	0 - 6	60.00	7.89	10.77	5
Sporobolus cryptandrus	1.20	1.44	0 - 6	20.00	2.63	4.07	10
Sub-total	3.60	4.31					
ANNUAL GRASSES							
Anisantha tectorum	2.00	2.39	0 - 8	40.00	5.26	7.66	7
Bromus japonicus	0.80	0.96	0 - 2	40.00	5.26	6.22	9
Eragrostis cilianensis	0.40	0.48	0 - 2	20.00	2.63	3.11	12
Panicum capillare	0.40	0.48	0 - 2	20.00	2.63	3.11	12
Sub-total	3.60	4.31					
PERENNIAL FORBS							
Asclepias speciosa	0.40	0.48	0 - 2	20.00	2.63	3.11	12
Cirsium arvense	0.80	0.96	0 - 2	40.00	5.26	6.22	9
Convolvulus arvensis	3.20	3.83	0 - 8	80.00	10.53	14.35	4
Lygodesmia juncea	0.40	0.48	0 - 2	20.00	2.63	3.11	12
Physalis virginiana	<0.01	<0.01	0 - <1	0.00	0.00	0.00	13
Sub-total	4.80	5.74					
ANNUAL AND BIENNIAL FORBS							
Bassia sieversiana	28.40	33.97	16 - 44	100.00	13.16	47.13	1
Chenopodium album	<0.01	<0.01	0 - <1	0.00	0.00	0.00	13

Table 13(cont'd). BEMA SITE 7A VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Gaura parviflora	<0.01	<0.01	0 - <1	0.00	0.00	0.00	13
Lactuca serriola	<0.01	<0.01	0 - <1	0.00	0.00	0.00	13
Melilotus alba	<0.01	<0.01	0 - <1	0.00	0.00	0.00	13
Other Annual/Biennial Forbs	0.40	0.48	0 - 2	20.00	2.63	3.11.	12
Salsola australis	0.80	0.96	0 - 4	20.00	2.63	3.59	11
Sub-total	29.61	35.41					
SUM OF SPECIES COVER	83.61						
Litter	14.80		0 - 0	100.00			
TOTAL VEGETATION	83.60 +/-	8.05					
LITTER/ROCK	14.80 +/-	7.01					
BARE SOIL	1.60 +/-	2.61					
TOTAL COVER	98.40 +/-	2.61					
Number of Species/sample	7.60						

Table 14 BEMA SITE 7B VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Critesion jubatum	0.40	0.68	0 - 2	20.00	2.63	3.32	11
Elymus trachycaulus	3.20	5.48	0 - 12	60.00	7.89	13.37	7
Sub-total	3.60	6.16					
WARM SEASON PERENNIAL GRASSES							
Sporobolus cryptandrus	16.40	28.08	2 - 34	100.00	13.16	41.24	1
Sub-total	16.40	28.08					
ANNUAL GRASSES							
Anisantha tectorum	12.00	20.55	0 - 34	80.00	10.53	31.07	2
Eragrostis cilianensis	1.60	2.74	0 - 8	20.00	2.63	5.37	9
Panicum capillare	3.60	6.16	0 - 8	60.00	7.89	14.06	6
Sub-total	17.20	29.45					
PERENNIAL FORBS							
Ambrosia psilostachya	0.40	0.68	0 - 2	20.00	2.63	3.32	11
Asclepias speciosa	0.80	1.37	0 - 4	20.00	2.63	4.00	10
Cirsium arvense	2.00	3.42	0 - 6	40.00	5.26	8.69	8
Convolvulus arvensis	3.60	6.16	0 - 6	80.00	10.53	16.69	5
Lygodesmia juncea	0.40	0.68	0 - 2	20.00	2.63	3.32	11
Psoralidium tenuiflorum	0.40	0.68	0 - 2	20.00	2.63	3.32	11
Sphaeralcea coccinea	0.40	0.68	0 - 2	20.00	2.63	3.32	11
Sub-total	8.00	13.70					
ANNUAL AND BIENNIAL FORBS							
Amaranthus retroflexus	0.40	0.68	0 - 2	20.00	2.63	3.32	11
Bassia sieversiana	8.80	15.07	2 - 18	100.00	13.16	28.23	3
Salsola australis	4.00	6.85	0 - 12	80.00	10.53	17.38	4
Sub-total	13.20	22.60					
SUM OF SPECIES COVER	58.40						
Litter	9.20		0 - 0	100.00			
TOTAL VEGETATION	58.40 +/-	10.62					
LITTER/ROCK	9.20 +/-	3.35					
BARE SOIL	32.40 +/-	12.84					
TOTAL COVER	67.60 +/-	12.84					
Number of Species/sample	7.60						

Table 15 BEMA SITE 7B VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Critesion jubatum	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Elymus canadensis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Elymus trachycaulus	3.60	6.29	0 - 8	60.00	8.57	14.86	5
Pascopyrum smithii	1.20	2.10	0 - 4	40.00	5.71	7.81	9
Sub-total	4.80	8.40					
WARM SEASON PERENNIAL GRASSES							
Chondrosum gracile	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Sporobolus cryptandrus	28.40	49.63	10 - 36	100.00	14.29	63.92	1
Sub-total	28.40	49.63					
ANNUAL GRASSES							
Anisantha tectorum	6.00	10.49	0 - 14	60.00	8.57	19.06	3
Bromus japonicus	4.00	6.99	0 - 8	80.00	11.43	18.42	4
Eragrostis cilianensis	0.80	1.40	0 - 2	40.00	5.71	7.11	10
Panicum capillare	3.20	5.59	0 - 8	40.00	5.71	11.31	7
Setaria viridis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Sub-total	14.00	24.47					
PERENNIAL FORBS							
Ambrosia psilostachya	0.80	1.40	0 - 2	40.00	5.71	7.11	10
Asclepias speciosa	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Cirsium arvense	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Convolvulus arvensis	1.60	2.80	0 - 6	40.00	5.71	8.51	8
Lygodesmia juncea	0.80	1.40	0 - 2	40.00	5.71	7.11	10
Physalis virginiana	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Sub-total	3.21	5.60					
ANNUAL AND BIENNIAL FORBS							
Bassia sieversiana	4.80	8.39	0 - 10	80.00	11.43	19.82	2

Table 15(cont'd). **BEMA SITE 7B VEGETATION SUMMARY FOR 1991. BASED ON DATA FROM 5 50 METER LINE-POINT TRANSECTS.**

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Chenopodium album	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Gaura parviflora	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Lactuca serriola	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Melolotis species	<0.01	<0.01	0 - <1	0.00	0.00	0.00	12
Other Annual/Biennial Forbs	0.40	0.70	0 - 2	20.00	2.86	3.56	11
Salsola australis	1.60	2.80	0 - 4	60.00	8.57	11.37	6
Sub-total	6.81	11.90					
SUM OF SPECIES COVER	57.22						
Litter	24.80		16 - 36	100.00			
TOTAL VEGETATION	57.20 +/-	10.35					
LITTER/ROCK	24.80 +/-	9.12					
BARE SOIL	18.00 +/-	12.33					
TOTAL COVER	82.00 +/-	12.33					
Number of Species/sample	7.00						

Table 16 NEEDLE AND THREAD GRASS HARVEST AREA VEGETATION SUMMARY FOR 1990. BASED ON DATA FROM 8 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Stipa comata	25.50	80.31	38 - 16	100.00	42.11	122.42	1
Sub-total	25.50	80.31					
WARM SEASON PERENNIAL GRASSES							
Sporobolus cryptandrus	3.50	11.02	0 - 8	62.50	26.32	37.34	2
Sub-total	3.50	11.02					
ANNUAL GRASSES							
Anisantha tectorum	1.75	5.51	0 - 6	50.00	21.05	26.56	3
Sub-total	1.75	5.51					
PERENNIAL FORBS							
Ambrosia psilostachya	0.50	1.57	0 - 4	12.50	5.26	6.84	4
Sub-total	0.50	1.57					
SHRUBS							
Oligosporus filifolius	0.50	1.57	0 - 4	12.50	5.26	6.84	4
Sub-total	0.50	1.57					
SUM OF SPECIES COVER	31.75						
Litter	63.00		50 - 74	100.00			
TOTAL VEGETATION	31.75 +/-	8.38					
LITTER/ROCK	62.75 +/-	7.92					
BARE SOIL	5.50 +/-	3.16					
TOTAL COVER	94.50 +/-	3.16					
Number of Species/sample	2.38						

Table 17 NEEDLE AND THREAD GRASS HARVEST AREA VEGETATION SUMMARY FOR 1991. BASED ON 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
COOL SEASON PERENNIAL GRASSES							
Aristida purpurea var. longise	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Elymus canadensis	0.40	0.69	0 - 2	20.00	4.35	5.04	5
Pascopyrum smithii	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Stipa comata	26.80	46.31	14 - 36	100.00	21.74	68.05	2
Sub-total	27.20	47.00					
WARM SEASON PERENNIAL GRASSES							
Sporobolus cryptandrus	29.60	51.14	20 - 42	100.00	21.74	72.88	1
Sub-total	29.60	51.14					
ANNUAL GRASSES							
Eragrostis cilianensis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Panicum capillare	0.08	0.14	0 - 2	100.00	21.74	21.88	4
Sub-total	0.08	0.14					
PERENNIAL FORBS							
Ambrosia psilostachya	0.40	0.69	0 - 2	20.00	4.35	5.04	5
Ambrosia tomentosa	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Argemone polyanthemos	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Convolvulus arvensis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Lygodesmia juncea	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Physalis hederifolia	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Physalis virginiana	0.16	0.28	0 - 4	100.00	21.74	22.02	3
Sphaeralcea coccinea	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Taraxacum officinale	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Tradescantia occidentalis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Sub-total	0.58	1.00					
ANNUAL AND BIENNIAL FORBS							
Chamaesyce glyptosperma	0.40	0.69	0 - 2	20.00	4.35	5.04	5

Table 17(cont'd). NEEDLE AND THREAD GRASS HARVEST AREA VEGETATION SUMMARY FOR 1991. BASED ON 5 50 METER LINE-POINT TRANSECTS.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	Importance Value	Rank
Helianthus annuus	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Poinsettia dentata	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Salsola australis	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Verbena bracteata	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Ximenesia encelioides	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Sub-total	0.41	0.71					
CACTI AND SUCCULENTS							
Opuntia polyacantha	<0.01	<0.01	0 - <1	0.00	0.00	0.00	6
Sub-total	<0.01	<0.01					
SUM OF SPECIES COVER	57.87						
Litter	36.40		0 - 0	100.00			
TOTAL VEGETATION	58.80 +/-	9.12					
LITTER/ROCK	36.40 +/-	9.42					
BARE SOIL	4.80 +/-	2.28					
TOTAL COVER	95.20 +/-	2.28					
Number of Species/sample	3.00						

APPENDIX D

DEPARTMENT OF THE ARMY
PROGRAM MANAGER FOR ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO 80022-2180

REPLY TO ATTENTION OF:

17 July 1991

AMXRM-PM (310-2d)

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Authorized Access to and Allowable Activities at Rocky Mountain Arsenal (RMA)

1. This letter sets forth policy and procedures for access to and allowable activities at Rocky Mountain Arsenal that will be enforced by PMRMA. This policy applies to all parties at RMA, including but not limited to those parties involved in the Arsenal clean-up, and their contractors, and all visitors participating in RMA-approved programs, activities, and tours. Parties to the clean-up include RMA staff, the Environmental Protection Agency (EPA), the Department of Justice (DOJ), the Department of the Interior (DOI), Shell, and the State of Colorado. All other personnel are considered visitors to RMA.

2. RMA has been divided into three areas based on surficial soils data and other contaminant studies from the Remedial Investigation at the Arsenal. Access and activities will be regulated according to the type of activity being performed, the area involved, individuals or organizations performing the activity, and natural resource conservation needs. All activities are subject to Program Manager, Rocky Mountain Arsenal (PMRMA) approval. U.S. Fish and Wildlife Service (USFWS) approval is required for conservation of fish and wildlife on RMA. Necessary coordination and approval for access by the PMRMA and USFWS are outlined below under paragraph 4 (Visitor Access Guidelines) and paragraph 5 (Notification and Review Requirements).

3. Enclosure 1 is a map of RMA with a brief description of allowable activities and access procedures. The areas are color and otherwise coded, and an explanation of the codes and activities are located in the map legend. Activities and access to each color-coded area listed below are grouped by area, general description of access and allowable activities, and specific requirements.

This policy supersedes all previous policies concerning authorized access and allowable activities at RMA.
This policy does not restrict the Environmental Protection Agency (EPA) or other federal regulatory agencies' access to the Arsenal to perform statutory oversight and inspection functions.

(b) Intrusive activities in blue areas must be coordinated with and approved by the PMRMA Compliance Office prior to starting work. A PMRMA approved health and safety plan is required for intrusive activities in blue and pink areas. Use of personal protective equipment may be required for intrusive activities in blue areas based on the type and extent of contamination and the activity being performed. Requirements for personal protective equipment and monitoring devices will be addressed in the Health and Safety Plan used for the particular operation and reviewed by the Compliance Office prior to starting operations.

c. PINK areas. Restricted access and activities. Entry is subject to approval of a PMRMA-approved Health and Safety Plan. Visitor-access guidelines and notification requirements are described below.

(1) Visitors. Visitors are not permitted in pink areas with the exception of guided bus tours on hard-surfaced roads and fishing in lakes on the Arsenal (specifically, Lakes Mary, Ladora, and Lower Derby). A further description of the allowed exceptions for visitor access is listed below.

(a) Tours utilizing hard-surfaced roads. Public tours will be coordinated between the USFWS and PMRMA Public Affairs Office; and the tour routes will be approved by the PMRMA Compliance Office.

(b) Fishing in lakes located in pink areas. Contamination in the lakes is located in some lake-bottom sediments, and those sediments should not be disturbed by fishing. Personnel should consult the USFWS for additional guidance and policy concerning use of Arsenal lakes for fishing.

(c) No other activities are authorized for visitors in pink areas.

(2) Parties to the clean-up and their contractors. Entry and work authorization for pink areas, by any group, will be coordinated with and approved by the PMRMA Compliance Office. The following exceptions apply to the parties to the clean-up and their contractors working in pink areas at the Arsenal.

(a) Activities supporting clean-up efforts (i.e., IRA's, treatability studies, etc.). Parties to the clean-up and their contractors will continue to follow safety and health guidelines letter to requesting parties or contractors. <u>All parties to the clean-up and their contractors shall review this schedule and map to ensure that their activities do not conflict with other proposed activities</u>. Any potential conflict should be reported to the PMRMA Compliance Office at 289-0441 or RMA Security at 289-0369 immediately.

6. ACTIVITY GUIDANCE:

a. Intrusive and other work activities may require the use of personal protective equipment in both blue and pink areas. The level of protection required for work activities in these areas will be outlined in the site-specific Health and Safety Plan and reviewed by the Compliance Office.

b. All activities impacting wildlife habitats must be coordinated and approved by the USFWS for all areas throughout RMA to ensure management requirements.

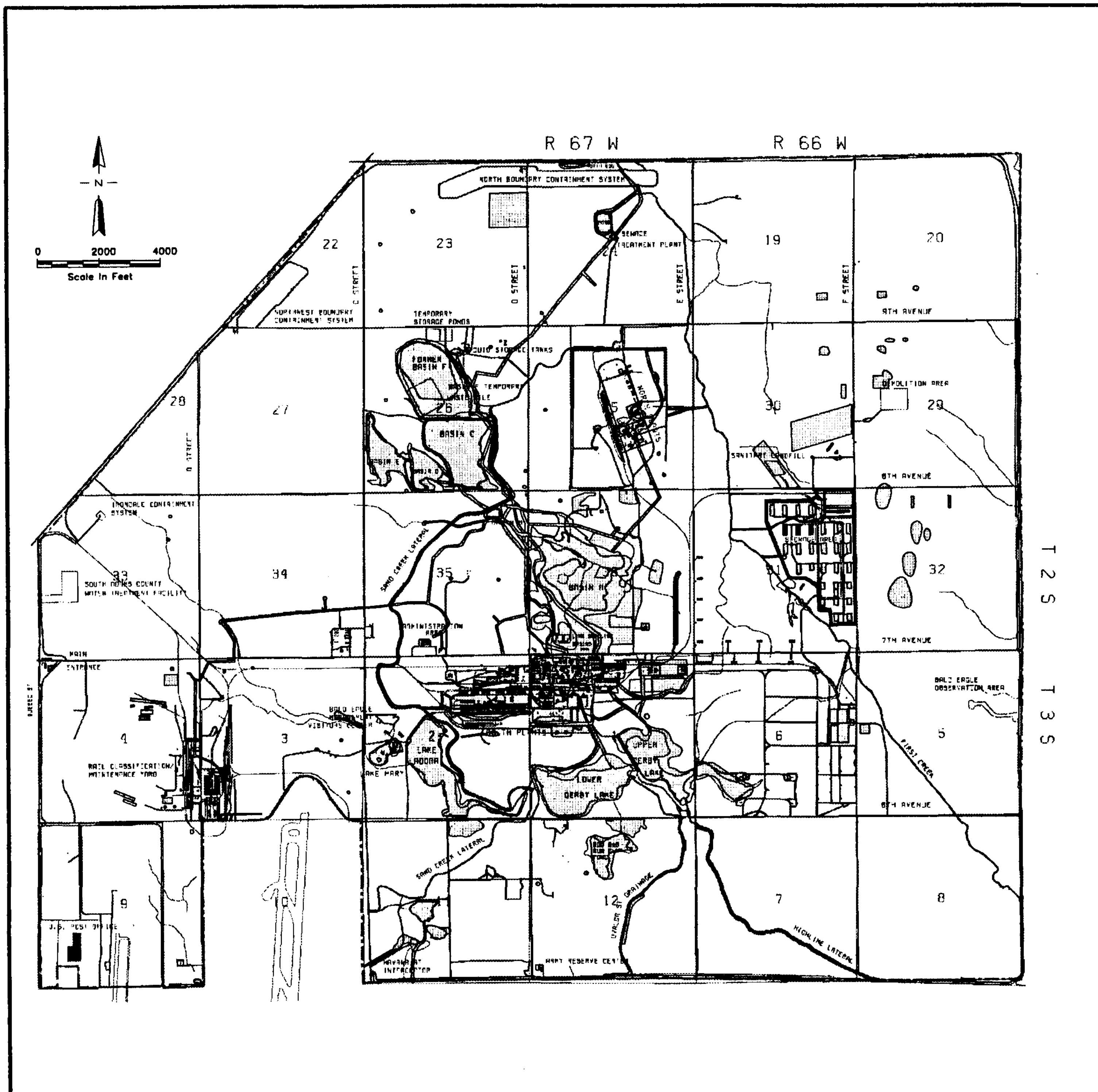
7. Point of contact for these actions is the RMA Compliance Office, telephone 289-0112/289-0338/289-0352.

Eugene H Bishop

Encl

EUGENE H. BISHOP
COLONEL, CM
Program Manager

DISTRIBUTION:
B



EXPLANATION

DEFINITION OF TERMS:

INTRUSIVE ACTIVITIES OR OPERATIONS. Intrusive activities include, but are not limited to, those activities which may result in a displacement of surficial soil, such as excavation, trenching, tilling, and drilling bore holes. Visitors are not allowed to participate in any intrusive activities on RMA with the exception of supervised programs.

NON-INTRUSIVE ACTIVITIES FOR VISITORS. Non-intrusive activities for visitors on RMA include biking, biking, dog trials, jogging, walking, fishing, bird-watching, and supervised volunteer and scout activities. Participation in PMRMA-approved guided bus tours and field trips are also included in non-intrusive activities.

ACCESS. The U.S. Fish and Wildlife Service (USFWS) is responsible for the management and access to all wildlife habitat areas on the Arsenal. USFWS approves all activities which involve the Bald Eagle Management Area (BEMA), and approves all activities within wildlife habitat areas, especially off-road access. This policy does not limit nor restrict the EPA or other federal regulatory agencies access to the Arsenal or to clean up activities at the Arsenal. Activities will be scheduled and coordinated at weekly meetings chaired by the PMRMA Compliance Office and USFWS.

WILDLIFE HABITAT. All lands and buildings at RMA may be considered as potential wildlife habitat and are included in USFWS area of management responsibility. Clean-up activities are exempted from USFWS approval and coordination requirements at the following locations unless actual wildlife/clean-up conflicts are observed: Section line roads; paved roads; South Plant area; North Plant area; Basins A, B, C, D, E, and F; administrative building area; motor pool area; and Visitor Center area and associated trails. If wildlife/clean-up conflicts are observed, USFWS should then be consulted.

AREAS:

1. White Areas. No restrictions on access except by general regulations and by USFWS. Entrance to BEMA during eagle-roosting period is coordinated and approved through the USFWS.

VISITORS. Visitors are allowed controlled access to participate in PMRMA-approved tours, activities, and programs in this area. Non-intrusive activities are authorized in white areas. Visitors are allowed to participate in approved intrusive activities in this area.

PARTIES TO THE CLEAN-UP AND THEIR CONTRACTORS. Personnel working on the Arsenal may perform both routine industrial and intrusive operations in white areas without prior approval from the PMRMA Compliance Office. Activities in white areas require prior approval from the USFWS when the activities are within wildlife habitats, especially off-road-access requirements.

2. Blue Areas. Limited-use access.

VISITORS. Visitor access to blue areas is not restricted if the visitor is participating in PMRMA-approved activities. Visitors are not allowed to participate or engage in intrusive activities in these areas. Access to wildlife habitats within the blue areas requires coordination and approval of the USFWS.

PARTIES TO THE CLEAN-UP AND THEIR CONTRACTORS. Non-intrusive activities are permitted without prior approval of the PMRMA Compliance Office in blue areas by clean-up and contractor personnel. Access to wildlife habitats within blue areas require coordination and approval of the USFWS. Intrusive activities require prior coordination and approval by the PMRMA Compliance Office before starting work.

3. Pink Areas. Restricted access and activities.

VISITORS. Visitors are not permitted in pink areas with the exception of guided bus tours on hard-surfaced roads and fishing in lakes on the Arsenal. Tours will be coordinated through the USFWS and PMRMA Public Affairs Office. No other activities are authorized for visitors in pink areas on the Arsenal.

PARTIES TO THE CLEAN-UP AND THEIR CONTRACTORS. Access to and activities in pink areas are restricted to the parties to the clean-up and their contractor personnel. Entry and work authorization will be coordinated through and approved by the PMRMA Compliance Office with the following exceptions:

a. Activities supporting cleanup efforts (i.e. IRA's, treatability studies, etc.) Health and Safety practices outlined in the parties' health and safety plans will be followed for determining the appropriate level of personal protection. Coordination of activities in pink areas within wildlife habitats, particularly off-road-access requirements, require USFWS coordination and approval.

b. Travel on hard-surfaced roads and work activities by parties to the clean-up and their contractor personnel within buildings located in pink areas will be allowed without PMRMA approval, subject to notification and review requirements.

NOTE:

a. Intrusive and other work activities may require the use of personal protective equipment in both blue and pink areas. The level of protection required for work activities in these areas will be outlined in the site-specific health and safety plan.

b. All activities impacting wildlife habitat must be coordinated and approved by USFWS for all areas throughout RMA.

Prepared For:

U.S. Army Program Manager
for Rocky Mountain Arsenal

Prepared: 17 July 1991 REVISION 1

MAP 1

AUTHORIZED ACCESS AND ALLOWABLE ACTIVITIES AT ROCKY MOUNTAIN ARSENAL (RMA)

* This policy applies to all parties at RMA, including but not limited to those parties involved in the Arsenal clean-up, and their contractors, and all visitors participating in RMA-approved programs, activities, and tours. Parties to the clean-up include RMA staff, the Environmental Protection Agency (EPA), the Department of Justice (DOJ), the Department of the Interior (DOI), Shell, and the State of Colorado. All other personnel are considered visitors to RMA.

Prepared by: Greystone Environmental Services, Inc.

RMA ACTIVITIES COORDINATION

WEEK OF: ______________________ COMPANY/AGENCY: ______________________

POINT OF CONTACT: ______________________ FAX: ____________ PHONE: ____________

1. ACTIVITY: ______________________

LOCATION: (1/4 Section) ______________________

DURATION (DATES & TIMES) ______________________

2. ACTIVITY: ______________________

LOCATION: (1/4 Section) ______________________

DURATION (DATES & TIMES) ______________________

3. ACTIVITY: ______________________

LOCATION: (1/4 Section) ______________________

DURATION (DATES & TIMES) ______________________

4. ACTIVITY: ______________________

LOCATION: (1/4 Section) ______________________

DURATION (DATES & TIMES) ______________________

5. ACTIVITY: ______________________

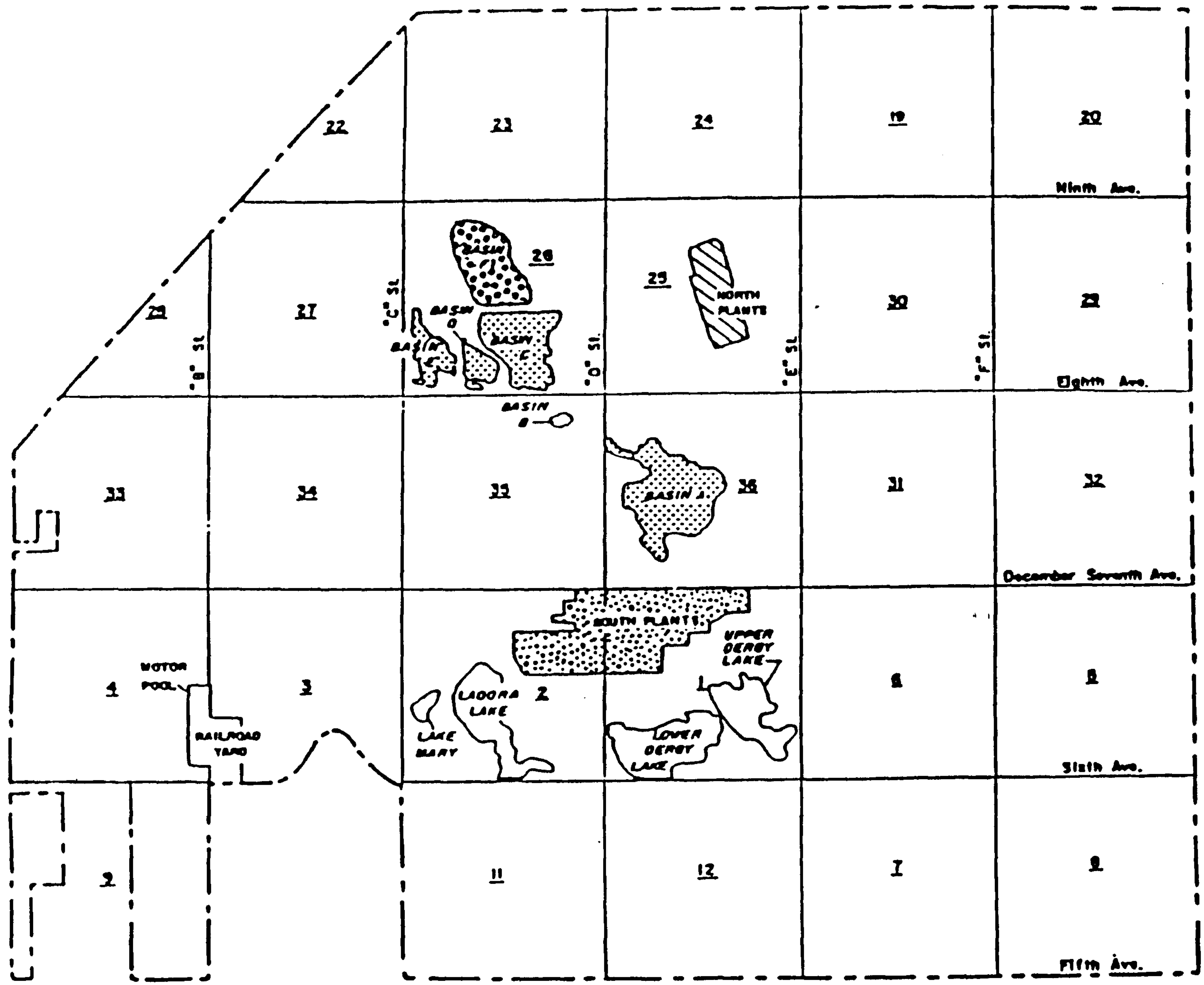
LOCATION: (1/4 Section) ______________________

DURATION (DATES & TIMES) ______________________

Return completed by Tuesday each week to:

Greg Langer
U.S. Fish and Wildlife Service
Rocky Mountain Arsenal Building 111
Commerce City, CO 80022-2180
303-289-0232

Indicate activity locations (using the activity number) on map. (See reverse side).



Ninth Ave.
Eighth Ave.
December Seventh Ave.
Sixth Ave.
Fifth Ave.
"B" St.
"C" St.
"D" St.
"E" St.
"F" St.
NORTH PLANTS
SOUTH PLANTS
BASIN A
BASIN B
BASIN C
BASIN D
BASIN E
BASIN F
UPPER DERBY LAKE
LOWER DERBY LAKE
LADORA LAKE
LAKE MARY
MOTOR POOL
RAILROAD YARD

DIRECTIONS FOR FILLING OUT
RMA ACTIVITIES COORDINATION FORM

1. WEEK OF: Monday through Sunday of the following week.

   (Example: April 29 - May 5, 1991)

2. COMPANY/AGENCY: List company/agency name.

   (Example: Ebasco, Inc.)

3. POINT OF CONTACT: Provide a point of contact person, phone number, and FAX number.

   (Example: Joe Smith ph. 287-4839 FAX 287-4893)

4. ACTIVITY: List a) Type of Activity,
   b) Highest level of protective clothing worn, and
   c) Is soil excavation required?

   (Example: Waterline Ditch dug with backhoe, Level D protection, 6 ft. trench excavated)

5. LOCATION: Including land Section and 1/4 Section, buildings, or other landmarks.

   (Example: Northwest quarter of Section 36)

6. DURATION: Dates and times activities will take place.

   (Example: April 30 - May 1, 1991 8 am to 10 am)

7. Indicate activity locations on attached map.

1991 BALD EAGLE MANAGEMENT AREA
(BEMA)

FACT SHEET

Effective Date: October 15, 1991 - April 15, 1992

Affected Area: All areas in "green" areas on BEMA map are restricted by U.S. Fish and Wildlife Service (Service) (see attached map).

Access to Roost Exclusion Area (dark green) requires prior written permission from the Service.

Restricted Activities:
All activities must be coordinated daily with the Service.

PROCEDURES FOR BEMA ACCESS

1. Contact Greg Langer, Chris Cole or Scott Peltier at 289-0232 or 324-9653.

2. Report date, time, duration and type of activity being performed.

3. Activities will be approved verbally or in writing.

4. Magnetic cones are required on all vehicles while in the BEMA. Any vehicle seen without a cone will be stopped and escorted out.

NOTES:

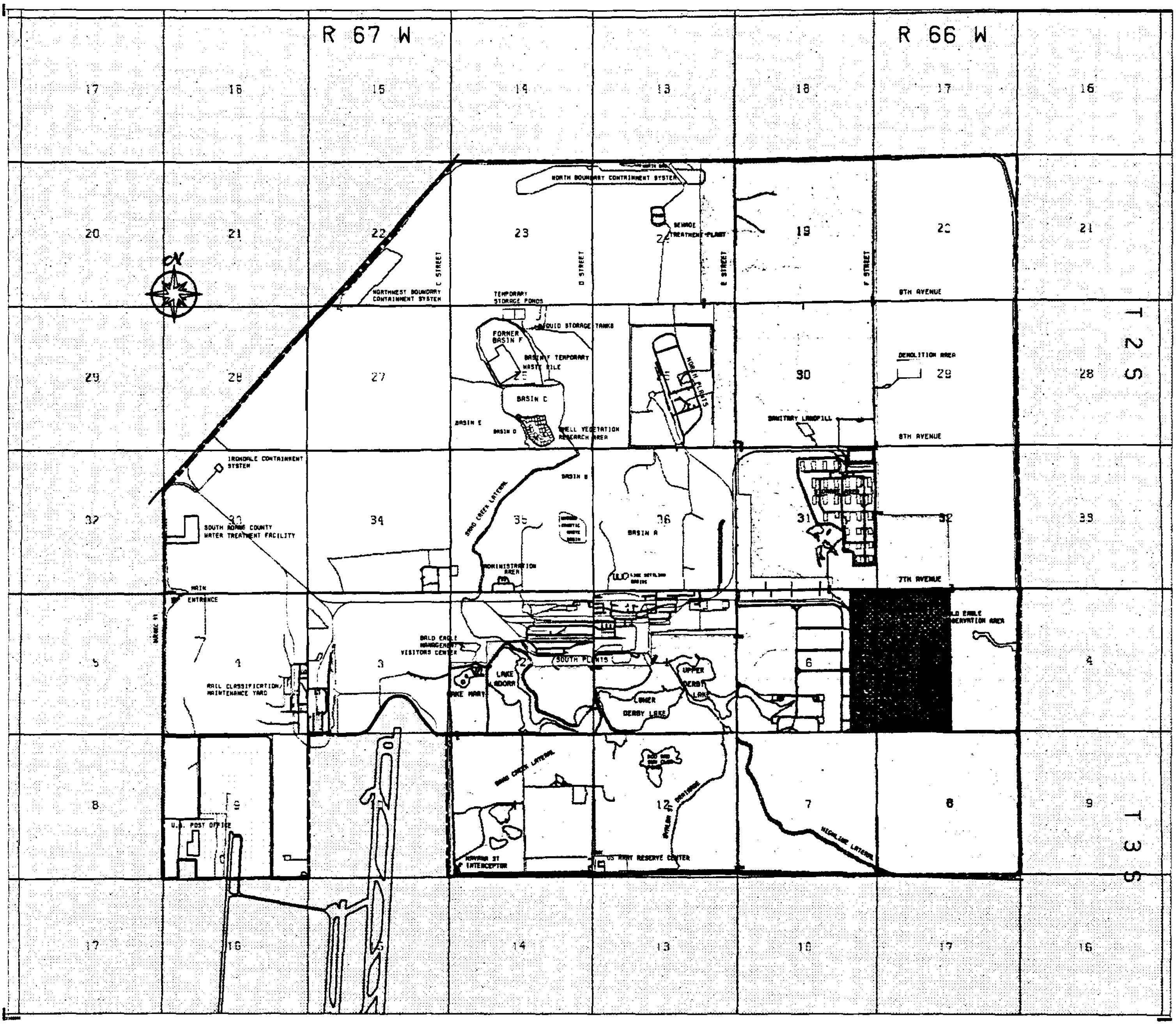
BEMA gates are to remained closed at all times.

Driving around gates is prohibited.

Exceptions are Fire Department and Security personnel.

The Eagle Watch will be open to the public beginning December 7, 1991. Eagle Watch access is gained from Buckley Road only from 3:00 p.m. to dusk daily.

ROCKY MOUNTAIN ARSENAL BALD EAGLE MANAGEMENT AREA (BEMA)



The information presented on this basemap has been captured from various sources and all locations exist within 'X–Y' data files. These files are available for access.

Data captured from the 1988 General Site Maps (revised from the U.S. Army Corps of Engineers 1984 Basic Information Maps) include the following:

Data captured from 1988 or 1989 Aerial Photographs include the following:

Additional updates have been made on the roads and airport runways in Section 9.

- Drainage/Streams
- Basins A,C
- Basins/Ponds
- Sites
- Railroads
- Unpaved Roads
- Paved Roads
- Key Structures
- Lakes
- Airport Runways
- Basin F Outline
- Basin F temporary waste pile
- Basin C vegetation area

The section coordinates, RMA boundary, and lease boundaries are also available.

Current BEMA

Roost Exclusion Area

BEMA Gates

ROCKY MOUNTAIN ARSENAL BALD EAGLE MANAGEMENT AREA (BEMA)
Digitized and Plotted at TENTIME Data Processing Center, Denver, CO.
Original Source Documentation provided by DP ASSOCIATES, INC. from Archival Documents housed at RIC, Rocky Mountain Arsenal.
Plotted with 44 inch, 400 DPI Versatec Color Electrostatic Plotter.
May, 1991 Version 0.052991

DP Associates, Inc.

Tentime Computer Services

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DEPARTMENT OF THE ARMY
ROCKY MOUNTAIN ARSENAL - DENVER. COLO.

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APPENDIX E

PROGRESS REPORT

FOR

ASPECTS OF NEST SITE SELECTION AND HABITAT USE
BY BURROWING OWLS AT THE ROCKY MOUNTAIN ARSENAL, COLORADO

submitted by:
David L. Plumpton
December 10, 1991

REPORT SUMMARY

Fieldwork began in March, 1991, on the second of 2 years of research into burrowing owl ecology at the Rocky Mountain Arsenal (RMA). Specific objectives of this research were:

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

OBJECTIVE 1:

Burrowing owl abundance was determined by vehicular and foot surveys throughout RMA.

OBJECTIVE 2:

Physical and vegetative attributes were measured at all nesting burrows from 1990 and 1991, and statistically contrasted to an equal number of control burrows, selected at random from within prairie dog towns unused by owls. Fidelity to breeding and natal burrows was determined from 1990 band returns in 1991.

OBJECTIVE 3:

Behavior data were collected from mated pairs, as in 1990. Productivity was monitored by chick observations during behavioral data collection periods, from captures, and from incidental observations. Morphology of adult burrowing owls, and its effect on breeding success and productivity, and the effect of individual size on mate selection were analyzed. Food habits were studied by analysis of collected castings, prey remains, observed prey deliveries, and fortuitous stomach contents.

OBJECTIVE 4:

Data collection was aimed at providing baseline habitat use information for burrowing owls at RMA. This data will be of use in determining the effect of ongoing cleanup operations on burrowing owls, as well as providing an indication of post-cleanup burrowing owl use of the area.

Introduction

This study was designed to examine the effects of contamination and cleanup on owl behavior, nesting, and habitat use, and to collect data that will aid in the future management of this species at the RMA and elsewhere. Fieldwork was conducted from April through August of 1990, and from March through August of 1991. The primary objectives of this study were:

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

Results of fieldwork and data analysis to date will be summarized by research objective.

OBJECTIVE 1

Repeated searches conducted throughout the summer of 1991 provided locations of 47 occupied burrowing owl burrows. During 1991, 38 nesting pairs were discovered (1990:N=23).

OBJECTIVE 2

Burrowing owls at the RMA used only those burrows made by black-tailed prairie dogs (*Cynomys ludovicianus*). During 1990 and 1991, 19 and 28 nesting burrows were studied, respectively, for a total of 47 nesting burrows. Forty-seven unused burrows were used as controls. In both years, 1 nest was located in contaminated areas; no measurements were taken at these sites. In both years, 2 burrows were in areas that were mowed; no vegetation data were collected. In 1991, 1 burrow was filled in before measurements of convolution or orientation were taken. For nesting burrows, mean angle ($\bar{a}$)=95°, dispersion (r)=0.061, and angular deviation (s)=78.53. The orientations of both nesting and available (control) burrows were no different from expected in direction categories (nesting: X^2=7.45, $P > 0.05$, df=7; available: X^2=2.47, $P > 0.05$, df=7). No difference existed in orientation between used and available burrows (X^2=10.06, $P > 0.05$, df=5, U^2=0.069, $P > 0.05$, df=45).

Data for burrow density differed between 1990 and 1991 ($P < 0.05$). Separate-year analyses were done using paired T-tests. In 1990, selected burrows were in areas of greater ($P = 0.009$) burrow density ($\bar{x}$=29/0.2 ha) than control burrows ($\bar{x}$ = 21/0.2 ha) (Table 2.1). In 1991, burrow density at selected burrows was no different ($P > 0.05$) than at control burrows (Table 2.1).

Tunnel convolution data were not different ($P > 0.05$) between years, so data were pooled and analyzed with a T-test. Selected burrows had tunnels no different ($P > 0.05$) in convolution than controls (Table 2.2).

Separate-year, Wilcoxon and Kruskal/Wallis tests were used for the analyses of road distance data. In 1990, selected burrows were closer to roads ($\bar{x}$=105 m) than controls ($\bar{x}$=210 m) ($P = 0.0029$) (Table 2.1). In 1991, selected burrows were no different ($P > 0.05$) than controls in distance to roads (Table 2.1). Perch distance data were pooled for analysis using paired T-tests. Burrowing owls selected burrows with greater nearest-perch distances than control burrows ($P = 0.004$) (Table 2.2).

Separate-year, Wilcoxon and Kruskal/Wallis tests were used for the analysis of town size. In both years, selected burrows were in towns no different ($P > 0.05$) in size than controls (Table 2.1).

Pooled, Wilcoxon ranked-sum and Kruskal/Wallis tests were used in the analysis of mean percent grass cover. Burrowing owls selected burrows in areas no different ($P > 0.05$) than controls based on percent grass cover (Table 2.2).

Separate-year, Wilcoxon and Kruskal/Wallis tests were used for the analyses of mean percent forb cover and mean percent bare ground. Mean percent forb cover was no different at selected and control burrows ($P > 0.05$) (Table 2.1). In 1991, mean percent bare ground was significantly greater ($P = 0.0002$) at selected than control burrows (Table 2.1). Pooled, Wilcoxon ranked-sum and Kruskal/Wallis tests were used in the analysis of mean grass height. For both years combined, burrowing owls selected burrows with shorter mean grass height than controls ($P = 0.02$) (Table 2.2). Separate-year, Wilcoxon and Kruskal/Wallis tests were used for the analyses of mean forb height data. In 1990, mean forb height was no different ($P > 0.05$) at selected and control burrows (Table 2.1). In 1991, mean forb height was significantly shorter ($P = 0.0005$) at selected than control burrows (Table 2.1).

Vertical density data showed significant ($P < 0.05$) among-years differences. For each year separately, the vertical density at nesting burrows was no different ($P > 0.05$) than at controls ($X^2 = 0.184$ and 1.614 for 1990 and 1991, respectively) (Table 2.1).

In 1990, 34 adult burrowing owls were captured. Nineteen male and 15 female adults from 22 mated pairs received Visual Identification legbands. Before migration from the area, 3 adults were found dead or seen killed. In 1991, 12 of the known remaining 31 (39%) returned to the RMA; 8 (66%) selected a burrow within the same town used in 1990. The mean inter-nest distance for those owls that selected the same town in 1990 and 1991 was 100.9 m (range=34.4-251.1 m). Of the 19 dog towns used in 1990, 17 (90%) were reused in 1991. Of the 20 burrows used by mated pairs in 1990, 4 (20%) were reused in 1991. Of the 8 1991 adults choosing burrows used in 1990, 3 (37%) were birds banded in 1990. At least 2 other burrows that were used for nesting in 1990 had unbanded mated pairs occupying them in 1991; these pairs later relocated and nested within the same town.

OBJECTIVE 3

Behavior:

Seventy adult burrowing owls were legbanded during 1990 (n=35) and 1991 (n=35). Due to inaccessibility for observation of some burrows, not all legbanded adults were included in time-budget analysis. Also, not all time-budgeted owls were legbanded.

During 1990 and 1991, 781 time-budgeting sessions were conducted, totaling over 195 h of data collection (1990: 200 sessions = 50 h; 1991: 581 sessions = 145.25 h). For both years combined, burrowing owl males and females differed in 3 of 8 recorded behaviors ($P < 0.05$). These behaviors differed during 1 to 3 observation quarters (Table 3.1). Females were recorded feeding more ($P < 0.05$) during the first quarter than males. Males rested more frequently than females during first and second quarters ($P < 0.05$) and third quarters ($P < 0.005$). Females were out of sight of the burrow (away or within) more often than males during the third and fourth quarters ($P < 0.05$).

The use of radio telemetry was discontinued shortly after monitoring began in 1990, as the short effective range of transmitters, combined with a large amount of local interference on the RMA made location estimates highly inaccurate. In addition, the telemetry packages had a significant effect on the behavior of the bird (Table 3.2). Radio-instrumented birds spent less time resting ($P < 0.05$) and alert ($P < 0.005$), and more time out of sight of the burrow ($P < 0.005$).

Productivity:

In 1990, all nesting burrows were included in behavioral observations. For this reason, number of young fledged and mean young/brood represent total counts (Table 3.3). In 1991, not all nesting burrows were included in time-budget analysis. Brood size estimates for the remaining burrows were based only on incidental observation and captures of chicks. For this reason, the number of chicks fledged represents the total known to have fledged, but does not represent a complete count. For both years combined, mean productivity was 4.38 chicks/nesting territory (range=2-10).

No correlations ($P > 0.05$) existed between size and productivity for male ($r < 0.20$) and female ($r < 0.40$) adults, except for female wing chord ($P = 0.03$) (Table 3.4). Female size showed a higher correlation to productivity than did male size in all other measurements. Parent size is a weak predictor of productivity for this population of burrowing owls. Similarly, burrow attributes showed weak linear relationships to productivity in 1990 ($r <= 0.50$) and 1991 ($r < 0.40$) (Table 3.5).

Morphology:

In 1990 and 1991, 33 adult males were captured a total of 41 times, and 37 adult females were captured 49 times. Using dimensions from only the first capture of an individual/year gave a total of 38 male and 39 female adults in analyses. Female body weight fluctuated greatly before and after egg laying. For this reason, weights of females known to be carrying eggs (N=8, range=197-238 g) were excluded from the analysis. Male and female burrowing owls were significantly ($P < 0.05$) dimorphic (Table 3.6). Females were heavier, while males were significantly bigger for all linear dimensions.

Mate choice in 27 pairs studied did not appear to be influenced by size, as little linear relationship ($P > 0.05$) existed in body measurements between mated birds. As with measurements of the entire adult population captured at the RMA, males were larger ($P < 0.05$) than their mates, except for weight (Table 3.7). Female size is a poor predictor of mate size in this population.

Food Habits:

Food habits data were analyzed from a variety of sources. Regurgitated castings and prey remains were collected biweekly at all nesting burrows. Castings were dissected for identification and enumeration of prey species. Food habits data analysis was incomplete at this writing (Tables 3.8, 3.9).

OBJECTIVE 4

This objective was included to address the unforeseeable cleanup related activities that may affect nesting burrowing owls. No such data analyses were completed regarding data from 1991 at the time of this writing.

Table 2.1. Characteristics of nesting burrowing owl burrows and unoccupied control burrows at the Rocky Mountain Arsenal, Colorado, during 1990 and 1991.

	Year											
	1990						1991					
	Nest Burrows			Control Burrows			Nest Burrows			Control Burrows		
Variable	$\bar{x}$	SE	(n)	$\bar{x}$	SE	(n)	$\bar{x}$	SE	(n)	$\bar{x}$	SE	(n)
Density (no./0.2 ha)	28.7	2.49	(19)	21.0	1.38	(19)[a]	21.28	1.50	(28)	22.25	2.04	(28)
Road Distance (m)	105.26	28.89	(19)	209.76	39.63	(19)[b]	114.55	21.96	(28)	108.3	26.67	(28)
Town Size (ha)	16.10	7.86	(19)	20.48	5.94	(16)	29.18	8.77	(21)	5.16	0.75	(21)
Forb Cover (%)	25.8	2.5	(17)	21.6	2.2	(17)	34.67	3.17	(26)	42.9	3.33	(26)
Bare Ground (%)	63.3	3.1	(17)	64.9	2.9	(17)	53.15	2.83	(26)	37.5	2.34	(26)[d]
Forb Height (cm)	6.66	0.56	(17)	6.95	0.30	(17)	6.86	0.54	(26)	9.73	0.54	(26)[c]
Vertical Density:												
0-10 cm	1.82	0.19	(17)	1.81	0.20	(17)	1.93	0.12	(26)	2.94	0.17	(26)
10-20 cm	0.35	0.09	(17)	0.37	0.10	(17)	0.40	0.08	(26)	0.91	0.09	(26)
20-30 cm	0.09	0.04	(17)	0.04	0.00	(17)	0.06	0.02	(26)	0.19	0.05	(26)
30-40 cm	0.04	0.03	(17)	0.03	0.00	(17)	0.01	0.00	(26)	0.03	0.01	(26)
40-50 cm	0.03	0.02	(17)	0.00	0.00	(17)	0.00	0.00	(26)	0.01	0.01	(26)
50-60 cm	0.01	0.01	(17)	0.00	0.00	(17)	0.00	0.00	(26)	0.00	0.00	(26)
60-70 cm	0.00	0.00	(17)	0.00	0.00	(17)	0.00	0.00	(26)	0.00	0.00	(26)
70-80 cm	0.00	0.00	(17)	0.00	0.00	(17)	0.00	0.00	(26)	0.00	0.00	(26)

[a] Significant at $P < 0.01$
[b] Significant at $P < 0.005$
[c] Significant at $P < 0.0005$
[d] Significant at $P < 0.0001$

Table 2.2. Characteristics of nesting burrowing owl burrows and unoccupied control burrows at the Rocky Mountain Arsenal, Colorado, 1990-1991.

	Nest Burrows			Control Burrows		
Variable	$\bar{x}$	SE	(n)	$\bar{x}$	SE	(n)
Convolution (cm)	86.9	3.93	(46)	77.6	4.60	(47)
Perch Distance (m)[b]	11.0	1.35	(29)	6.8	0.64	(40)
Grass Cover (%)	11.7	2.4	(43)	17.1	2.9	(43)
Grass Height (cm)[a]	7.34	0.97	(43)	11.24	1.22	(43)

[a] Significant at $P < 0.05$
[b] Significant at $P < 0.005$

Table 3.1. Mean percentage (± SE) of instantaneous behavior events recorded for burrowing owls in all observation periods at the Rocky Mountain Arsenal, Colorado, 1990-1991.

Behavior	Observation Period	Sex	
		Male	Female
Feeding	1/4	0.4 (0.1)	0.5 (0.3)[a]
	2/4	0.1 (0.0)	0.1 (0.0)
	3/4	0.1 (0.0)	0.2 (0.2)
	4/4	0.1 (0.0)	0.2 (0.0)
Locomotion	1/4	1.0 (0.2)	0.7 (0.2)
	2/4	0.8 (0.2)	0.8 (0.2)
	3/4	0.5 (0.1)	0.4 (0.1)
	4/4	0.6 (0.1)	1.0 (0.3)
Resting	1/4	6.0 (1.3)	2.4 (0.8)[a]
	2/4	4.8 (1.2)	1.9 (0.6)[a]
	3/4	4.4 (1.1)	1.3 (0.5)[b]
	4/4	7.8 (1.8)	6.0 (1.8)
Comfort	1/4	2.1 (0.5)	1.8 (0.4)
	2/4	0.9 (0.2)	1.7 (0.4)
	3/4	0.8 (0.2)	1.1 (0.3)
	4/4	2.1 (0.6)	2.0 (0.5)
Courtship	1/4	0.1 (0.1)	0.0 (0)
	2/4	0.0 (0.0)	0.0 (0)
	3/4	0.1 (0.1)	0.0 (0)
	4/4	0.1 (0.1)	0.0 (0)
Alert	1/4	40.0 (3.6)	35.1 (3.7)
	2/4	47.2 (4.0)	37.8 (4.0)
	3/4	34.5 (3.7)	27.8 (3.6)
	4/4	42.3 (4.0)	32.2 (3.7)
Agonistic	1/4	tr	tr
	2/4	tr	0.2 (0.1)
	3/4	0.5 (0.5)	tr
	4/4	tr	1.0 (0.9)
Out Of Sight	1/4	50.3 (4.3)	59.3 (4.1)
	2/4	46.1 (4.4)	57.3 (4.4)
	3/4	57.9 (4.2)	69.0 (4.0)[a]
	4/4	46.2 (4.7)	57.5 (4.5)[a]

[a] Significant at $P < 0.05$
[b] Significant at $P < 0.005$
tr = < 0.05%

Table 3.2. Mean percentage (± SE) of instantaneous behavioral events of radio collared and non-radio equipped burrowing owls at the Rocky Mountain Arsenal, Colorado, 1990.

	Radio Instrumentation	
Behavior	Radio equipped	Non-Radio Equipped
Feeding	0.1 (0.05)	0.2 (0.08)
Locomotion	0.5 (0.1)	0.9 (0.2)
Resting	2.3 (0.8)[a]	4.6 (1.0)[a]
Comfort	2.2 (0.7)	1.7 (0.3)
Courtship	0.0 (0.0)	0.0 (0.0)
Alert	26.9 (4.3)[b]	43.4 (3.2)[b]
Agonistic	tr	0.1 (0.04)
Out of Sight	67.9 (5.0)[b]	48.4 (3.6)[b]

[a] Significant at $P < 0.05$
[b] Significant at $P < 0.005$
tr = < 0.05%

Table 3.3. Burrowing owl burrow use and nesting success at the Rocky Mountain Arsenal, Colorado, 1990-1991.

	1990	1991	Total
Occupied burrows	31	44	75
Mated pairs	24	38	62
Nesting attempts	23	33	56
Successful pairs	20	33	53
Young fledged	109	>163	>272
$\bar{x}$ Young fledged/pair	4.54	4.29	4.38

Table 3.4. Correlation coefficient (*r*) and *P* values between morphological characteristics and reproductive success by burrowing owls at the Rocky Mountain Arsenal, 1990-1991.

Adult Variable	Correlation (*r*) to productivity by				
	Males (n=33)		Females		
	r	*P*	*r*	*P*	(n)
Weight	.1508	.4021	-.2612	.1793	(28)
Rectrix	.0492	.5599	.3709	.0507	(36)
Wing chord	-.1052	.7854	.3281	.0259	(36)
Tarsometatarsus	.0867	.6314	.1458	.4031	(35)

Table 3.5. Correlation coefficient (*r*) and *P* values between burrow attributes and reproductive success by burrowing owls at the Rocky Mountain Arsenal, 1990-1991.

Burrow Variable	Correlation (*r*) to productivity					
	1990			1991		
	r	*P*	(n)	*r*	*P*	(n)
Azimuth	.0596	.7820	(24)	.2337	.2716	(24)
Density	-.0237	.9125	(24)	.0553	.7884	(26)
Perch Distance	.2239	.4841	(12)	-.0767	.7549	(19)
Road Distance	-.1459	.4963	(24)	.3235	.1068	(26)
Convolution	.4296	.0361	(24)	.0772	.7135	(25)
Town Size	-.0082	.9757	(24)	-.1492	.5419	(19)

Density = number of available burrows/0.2 ha
Perch = distance to nearest above-ground perch, within 25 m
Convolution = tunnel length to vision-obscuring bend

Table 3.6. Morphological measurements and Dimorphism Indices (D.I.) of adult burrowing owls during the breeding season at the Rocky Mountain Arsenal, Colorado, 1990-1991.

	Male			Female			
Measurement	N	$\overline{x}$	SE	N	$\overline{x}$	SE	D.I.
Weight (g)[a]	38	146.3	1.9	31	156.1	3.6	6.44
Rectrix (mm)[a]	38	80.1	0.7	39	77.4	0.7	-3.41
Wing Chord (mm)[a]	38	163.5	1.1	39	159.4	1.1	-2.53
Tarso. (mm)[b]	38	54.4	0.4	38	51.8	0.3	-4.91

[a] Significant at $P < 0.05$
[b] Significant at $P = 0.0001$
Tarso. = tarsometatarsus length
D.I. = 100(female mean-male mean)/0.5(female mean+male mean) (Storer 1966)

Table 3.7. Mean morphological measurements and correlation coefficients from mated pairs (n=27) of adult burrowing owls at the Rocky Mountain Arsenal, Colorado, 1990-1991.

	Male		Female			
Measurement	$\bar{x}$	SE	$\bar{x}$	SE	*r*	*P*
Weight (g)	147.85	2.08	172.48	6.30	.324	.1214
Rectrix (mm)	80.15	0.73	77.85	0.89	.047	.8137
Wing Chord (mm)	163.81	1.41	160.52	1.28	.147	.4620
Tarsometatarsus (mm)	54.56	0.36	52.22	0.35	-.015	.9406

Table 3.8. Food habits of burrowing owls derived from analysis of castings at the Rocky Mountain Arsenal, Colorado, 1990.

	1990	
Prey Item	N	%N
Vertebrates		
Rodentia		
Cricetidae		
Peromyscus maniculatus	271	39.1
Microtus ochrogaster	38	5.5
Passeriformes	1	0.1
subtotal	310	44.7
Invertebrates		
Coleoptera		
Carabidae	1	0.1
Cicindellidae	52	7.5
Scarabeidae	55	7.9
Silphidae	104	15.0
Tenebrionidae	63	9.1
Orthoptera		
Acrididae	32	4.6
Gryllacrididae	2	0.3
subtotal	309	44.5
Other		
rocks	51	7.4
glass	1	0.1
vegetation	15	2.2
eggshell	7	1.0
subtotal	74	10.7
Total:	693	99.9

Table 3.9. Food habits of burrowing owls based on prey remains found during biweekly searches at the Rocky Mountain Arsenal, Colorado, 14 June-9 August, 1990, and 5 April-26 July, 1991.

Prey Item	1990 N	1990 %N	1991 N	1991 %N	Total N	Total %N
Vertebrates						
Rodentia						
Cricetidae						
Microtus ochrogaster	11	8.5				
Peromyscus maniculatus	40	67.8	10	7.8		
Spermophilus tridecemlineatus	1	1.7	1	0.8		
Sciuridae						
Cynomys ludovicianus	1	1.7				
Heteromyidae						
Dipodomys ordii			1	0.8		
Passeriformes						
Alaudidae						
Eremophila alpestris	4	6.8	5	3.9		
Emberizidae						
Sturnella neglecta	3	5.1	3	2.3		
Icterus galbula			1	0.8		
Muscicapidae						
Catharus spp.			1	0.8		
Unknown spp.	1	1.7	8	6.2		
Squamata						
Viperidae						
Crotalus viridis			1	0.8		
Salientia						
Scaphiopus spp.	1	1.7	2	1.5		
subtotal	51	86.5	44	34.2		
Invertebrates						
Coleoptera						
Carabidae	1	0.8				
Cicindelidae	2	1.5				
Scarabeidae	2	1.5				
Silphidae	2	3.3	8	6.3		
Tenebrionidae	2	3.3	25	19.5		

Table 3.9. (cont'd)

Lepidoptera				
Citheroniidae				
Hyalophora cecropia			1	0.8
Saturniidae				
Antheraea polyphemus	1	1.7		
Sphingidae				
Celerio lineata			8	6.3
Miller moth family	2	3.3	3	2.3
miller moth spp.				
Orthoptera				
Acrididae	1	1.7	34	26.6
subtotal	8	13.3	84	65.6
Total:	59	99.8	128	99.8

16 December 1991
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EFFECT OF GROUP SIZE ON SURVIVAL OF TRANSLOCATED PRAIRIE DOGS

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Abstract: We studied the effects of group size on survival of black-tailed prairie dogs (*Cynomys ludovicianus*) translocated to 12 experimental sites on the United States Army's Rocky Mountain Arsenal, Adams County, Colorado. Group sizes of 10, 30, and 60 prairie dogs were released in 1-, 3- and 6-ha plots located in prairie dog colonies that were extirpated by plague. We found a weak relationship between group size and initial survival rate. No significant differences occurred between survival rates for males and females. No relationship was found between number of animals released and number of immigrants or juveniles trapped.

J. WILDL. MANAGE. 00(0):000-000

Key words: Colorado, *Cynomys ludovicianus*, prairie dog, reintroduction, relocation, survival, translocation.

INTRODUCTION

The black-tailed prairie dog (prairie dog) is a large, social, ground dwelling rodent (King 1955) that occupied 28% of the 17,300 ha RMA (Clippinger 1987). During late fall of 1988, prairie dogs on the RMA were reduced by sylvatic plague to 5.4% of their former range (Ebasco 1989).

Ferruginous hawks (Buteo regalis) and the endangered bald eagle (Haliaeetus leucocephalus) utilized the RMA before prairie dogs were decimated by plague (USFWS 1991, Morrison-Knudsen Environmental Services, Inc. 1989). Ferruginous hawk densities often fluctuate in synchrony with densities of their prey (Woffinden and Murphy 1977, Smith et al. 1981. Ferruginous hawk populations have also been shown to increase with increases sciurid rodent populations (Schmutz and Hungle 1989). After the sylvatic plague outbreak, ferruginous hawk populations on the RMA declined (United States Fish and Wildlife Service 1991). Bald eagle populations showed a slight reduction (United States Fish and Wildlife Service 1991), but the reduction might not have been as dramatic as that of the ferruginous hawks due to a supplemental feeding program. In addition, burrowing owls (Athene cunicularia), which depend on prairie dogs for burrows, breed and rear young at the RMA (Butts and Lewis 1982, Morrison-Knudsen Environmental Services, Inc. 1989).

To re-establish prairie dogs for public viewing and food for predators, the United States Fish and Wildlife Service (USFWS) relocated approximately 1000 prairie dogs to the RMA during the fall and winter of 1989. However, no data were available on the minimum number of prairie dogs that could be released in 1 area to establish a viable colony.

Lewis et al. (1979) suggested that 10 to 20 prairie dogs would be sufficient to start a colony. Clippinger (1989) suggested that prairie dogs would not continue to survive in isolation or thrive in small groups (less than 10 per ha). We evaluated the effect of group size on survival of prairie dogs translocated to abandoned prairie dog burrows on the RMA.

STUDY AREA

The study was conducted on the United States Army's RMA, Adams County, Colorado. The RMA is a 69 km^2 area located just northeast of Denver, Colorado and directly north of Stapleton Airport. The RMA is predominantly rolling prairie lands that is primarily vegetated by non-native species such as crested wheatgrass (Agropyron cristatum). Common mammalian and avian inhabitants include mule deer (Odocoileus hemionus), white-tailed deer (Odocoileus virginianus), Swainson's hawks (Buteo swainsoni), red-tailed hawks (Buteo jamaicensis), and golden eagles (Aquila chrysaetos) (Morrison-Knudsen Environmental Services, Inc. 1989).

Other residents of the RMA including badgers (Taxidea taxis), coyotes (Canis latrans), Eastern cottontails (Sylvilagus floridanus), black-tailed jackrabbits (Lepus californicus), thirteen-lined ground squirrels (Spermophilus tridecemlineatus), Ord's kangaroo rat (Dipodomys ordii), and rattlesnakes (Crotalus spp.) (Morrison-Knudsen Environmental Services, Inc. 1989) are associated with prairie dog colonies (Campbell and Clark 1981, Clark et al. 1982).

METHODS

Twelve sites in prairie dog colonies extirpated by plague were selected as experimental translocation plots. These plots, including 3 6-ha sites, 3 3-ha sites, and 6 1-ha sites, were randomly assigned to the translocation sizes. We demarcated all release sites with steel t-posts and signs. From July to September 1990, RMA's facilities engineers mowed each relocation plot within the t-posts (Carpenter and Martin 1969, Lewis et al. 1979, Player and Urness 1982) to a uniform height (Clippinger 1989) and dusted the prairie dog burrows with a synthetic pyrethrin insecticide, Pyraperm^{tm} (Fairfield American Corporation, Rutherford, N.J.). These precautions were conducted before releasing animals to increase habitat quality (Griffith et al. 1989, Kleiman 1989) and kill any fleas which might carry plague.

Groups of 10, 30, and 60 prairie dogs were introduced to the 1-ha, 3-ha, and 6-ha sites to maintain densities of 10 animals per ha. Lewis et al (1979) recommended an optimum sex and age composition for a release of 20 animals as: 1) 2-3 adult males, each to provide the nucleus of a coterie and 2) the remainder females, principally adults. We felt sex ratios of 2 females to 1 male and age ratios of 3 juveniles per 2 adults would reflect natural ratios better and used these ratios at all sites.

Prairie dogs were translocated to the experimental plots in a series of 3 blocks (replications) from July to October 1990. Each block included 4 plots; 1 6-ha plot, 1 3-ha plot, and 2 1-ha plots. Two blocks were filled with prairie dogs which were flushed from their burrows with soapy water (Carpenter and Martin 1969, Lewis et al. 1979) and transported to the RMA by prairie dog relocators from sites around Denver, Boulder, and Loveland, Colorado. The remaining block was filled with prairie dogs that were live-trapped on other parts of the RMA.

Upon arrival at the release site, we sprayed each prairie dog with Sectrol™ pet spray (3M Animal Care Products, St. Paul, Minn.) to kill any fleas which might carry plague. The animals were then ear-tagged in both ears with Monel no. 1 fingerling fish tags (National Band and Tag Co. Newport, Ky.). Each prairie dog was distinctly marked with Nyanzol-D fur dye (Belmar Inc., North Andover, Mass.) in relation to sex and age to simplify identification during recapture. Prairie dogs then were released into burrows near the center of each plot.

We recaptured prairie dogs in the relocation plots during September-October 1990, February-March 1991, June 1991, and September-October 1991 to estimate survival. One block was trapped per trapping session. Each block was prebaited with a commercial horse sweet mix (Agland, Inc., Eaton, Colo.) for 3 days and then trapped for 4 days. Tomahawk model 202 live traps (Tomahawk Live Trap Company, Tomahawk, Wis.) were placed near active burrow mounds at densities of 1.5 traps per prairie dog released.

During the September-October 1990 recapture session, fur dye was reapplied. Replacement eartags were attached if either of the original tags were not present during recapture sessions. We recorded if recaptured animals were initially translocated at the plot (resident) or had moved in from elsewhere (immigrant). During recaptures in June 1991 and September-October 1991, juvenile prairie dogs with no ear tags were assumed to have been born on sight and were eartagged in the same manner as the adults.

Survival and recapture estimates were generated with programs RELEASE (Burnham et al. 1987) and SURGE (Lebreton et al. 1992). Data from the 10-animal plots was pooled across the 6 releases with survival and recapture rates allowed to vary by time. Recapture data from the 30- and 60-animal plots were analyzed without pooling across plots. Since recaptures occurred over 3 different weeks for each block, and survival generally encompassed the same period, we selected models for the 30- and 60-animal plots in SURGE which allowed recapture rates to vary by time and by plot and allowed survival to vary only by time.

RESULTS

Survival from release to October 1990 between 10- and 60-animal plots was significantly different (Table 1). Survival for the same period between 10- and 30- animal plots, and 30- and 60-animal plots were not significantly different. No significant difference was detected between survival of males and females (Table 2).

The number of juveniles captured per animal released ($\bar{x}$ = 0.3333, SD 0.5502; $\bar{x}$ = 0.7222, SD = 1.71; and $\bar{x}$ = 0.9774, SD = 0.1129) did not vary among the 10-, 30-, and 60-animal plots (Wilcoxon Rank Sum test, Chi-square = 4.0652, df = 2, P = 0.1310). In addition, the number of immigrants captured per animal released ($\bar{x}$ = 0.1500, SD = 0.2811; $\bar{x}$ = 0.1333, SD = 0.0577; and $\bar{x}$ = 0.2316, SD = 0.1036) did not vary among the 10-, 30-, and 60-animal plots (Wilcoxon Rank Sum test, Chi-square = 2.36, df = 2, P = 0.3073).

We had the highest percentage of released animals recaptured in one of the 10-animal plots. In addition, two of the 10-animal plots failed by the first recapture, and another had failed by the third recapture.

DISCUSSION AND MANAGEMENT IMPLICATIONS

In this study, survival rates were used to indicate the number of animals that remained at relocation sites. We were unable to separate mortality from emigration. However, in translocation the number of animals that remain at a site is more important because emigrants may not be able to find mates and reproduce.

O'Bryan and McCullough (1985) indicated that translocated deer initially do not avoid potential hazards resulting in decreased initial survival. We also found that survival for our translocated prairie dogs increased from the first recapture to the second.

The high variability of survival of 10-animal plots, indicates that releases of small groups are unreliable. We recommend releasing 30 or more animals.

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Table 1. Survival estimates by group size for prairie dogs released on the Rocky Mountain Arsenal, Summer 1990.

Group size	Recapture period	Survival	SE	95% Confidence Interval Lower limit	95% Confidence Interval Upper limit
10	October 1990	0.3789	0.0784	0.2253	0.5325
	February 1991	0.5769	0.1287	0.3247	0.8291
	June 1991	0.9900	0.1453	0.7053	1.2747
30	October 1990	0.5203	0.0552	0.4122	0.6284
	February 1991	0.8680	0.0545	0.7611	0.9749
	June 1991	0.7978	0.0760	0.6488	0.9468
60	October 1990	0.7117	0.0519	0.6100	0.8133
	February 1991	0.7880	0.0616	0.6672	0.9089
	June 1991	0.7125	0.0582	0.5984	0.8266

Table 2. Survival estimates by gender for prairie dogs released on the Rocky Mountain Arsenal, Summer 1990.

				95% Confidence Interval	
Gender	Recapture period	Survival	SE	Lower limit	Upper limit
Female	October 1990	0.5512	0.0425	0.4679	0.6346
	February 1991	0.8342	0.0618	0.7131	0.9552
	June 1991	0.7342	0.0558	0.6249	0.8435
Male	October 1990	0.6491	0.0521	0.5469	0.7512
	February 1991	0.7470	0.0650	0.6195	0.8744
	June 1991	0.7977	0.0856	0.6300	0.9654

Rocky Mountain Arsenal Deer Project:

PATTERNS OF COEXISTENCE FOR SYMPATRIC MULE AND WHITE-TAILED DEER ON THE ROCKY MOUNTAIN ARSENAL, COLORADO

ANNUAL REPORT

1 January 1991 to 31 December 1991

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ABSTRACT

Twenty-two months of feild work have been completed on the Rocky Mountain Arsenal (RMA) deer project. The overall deer population was estimated at 337 mule deer and 121 white-tailed deer for the winter of 1990-91. A total of 202 individuals (121 mule deer and 81 white-tailed deer) were handled during 3 trapping periods, and 82 transmitters were placed on individuals. More than 3,200 location estimates have been collected on 32 adult deer. Home range area varied from 11.72 to 537.80 ha for mule deer and 36.85 to 3591.63 ha for white-tailed deer with summer home ranges being smaller than fall, winter and spring home ranges for both mule ($P = 0.0441$) and white-tailed ($P = 0.08$) deer. Unique patterns of habitat use are present with mule and white-tailed deer using different habitats during all 4 seasons of the first year of data collection. The hypothesis of complete habitat niche overlap between mule and white-tailed deer on RMA cannot be accepted for all 4 seasons analyzed during 1990-91. A test of association, however, indicates that mule and white-tailed deer occurred together more than could be expected if there is no interspecific association.

The majority of all field work is expected to be complete by 31 December 1992. All data will continue to be collected until that time. An attempt to capture 50 more fawns (25 of each species) will be made in spring 1992.

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REVIEW OF PROPOSAL AND OBJECTIVES

Five primary objectives were presented in my Ph.D. research proposal dated January 1991. Objectives 1 - 4 address the patterns of coexistence between sympatric mule and white-tailed deer (Odocoilius hemionus, and O. virginianus, respectively), while the last objective is to provide management recommendations to U.S. Fish and Wildlife Service (USFWS) and U.S. Army personnell concerning deer management on Rocky Mountain Arsenal (RMA). Specifically these objectives are:

1. To determine interspecific relationships between sympatric mule and white-tailed deer on RMA.
2. To determine the intraspecific interactions of mule and white deer on RMA.
3. To determine recruitment and adult mortality for sympatric mule and white-tailed deer on Rocky Mountain Arsenal.
4. To compare sympatric mule and white-tailed deer population statistics from RMA with allopatric and sympatric mule and white-tailed deer population statistics not on RMA.
5. To provide management recommendations and protocals to USFWS and U.S. Army personnel concerning mule and white-tailed deer populations and habitats on Rocky Mountain Arsenal.

Data collection revolves primarily around using radio telemtery techniques that quantify the location of telemetered individuals. In particular, the proposal calls for using telemetry to visually locate individual animals. Once located, data including date, time, habitat type, animal activity, group size and composition, and interspecific distances are recorded. In addition, the proposal calls for collection of feces for diet composition analyses, and site specific vegetation sampling of areas used by telemetered individuals. Included in the telemetry objectives of the proposal is the capture of 50 fawns (25 of each species) for purposes of estimating fawn recruitment for both species of deer.

Statistical analyses of these data include inter- and intra-specific comparisons of habitat use, diet composition, and spatial use patterns using a Chi-Square test of homogeneity (Iman and Conover 1989. Specific niche comparisons are to be analyzed utilizing the procedures of Petraitis (1979).

RESULTS

Demographics

Nine ground and aerial population counts were made during winter 1990-91. Population estimates for individual surveys ranged from 279 - 630 and 32 - 140 for mule and white-tailed deer, respectively (Table 1). The overall population is estimated at 337 (302 - 393) mule deer and 121 (101 - 156) white-tailed deer using the estimator proposed Minta and Mengel (19??).

Animal Capture and Telemetry

Three periods of animal capture have been completed at RMA. Seven adult white-tailed does and 13 adult mule deer does were captured and outfitted with radio transmitters (Telonics, Mesa,

Table 1. Results of ground and aerial deer composition surveys for winter 1990-91 on Rocky Mountain Arsenal.

Species/ Date	Bucks	Does	Fawns	Unc.	Collars	Population Estimate[1]
Mule Deer						
90290	35	68	56	9	2	---[2]
90322	73	112	50	17	6	433
90364	60	84	70	5	12	304
91022[3]	--	--	--	268	14	340
91023	43	64	43	25	12	293
91031[3]	--	--	--	133	8	334
91032	45	70	53	7	11	293
91068	22	37	18	16	6	279
91110	22	49	22	57	5	630
$\hat{N}$[4]						337
White-tailed Deer						
90290	15	30	22	--	5	56
90322	11	21	5	2	1	--[2]
90364	17	39	20	3	6	73
91022[3]	--	--	--	80	7	131
91023	12	20	8	1	4	44
91031[3]	--	--	--	64	6	140
91032	13	17	11	--	3	32
91068	5	8	2	7	4	88
91110	1	17	6	7	6	73
$\hat{N}$[4]						121

[1] Closed population, mark-resight estimate (??? 19??).
[2] Too few collars seen for accurate estimate.
[3] Aerial surveys not classified by sex or age.
[4] Minta-Mengel (19??).

Ariz.) between 17 January and 6 April 1990 (Hanna and Lindzey 1990). An additional 19 adult deer (3 white-tailed does, 4 white-tailed bucks, 4 mule deer does, and 8 mule deer bucks) were transmittered between 9 December 1990 and 30 March 1991. Eight white-tailed deer fawns (4 male and 4 female) and 35 mule deer fawns (20 male and 15 female) were outfitted with solar eartag transmitters (Advanced Telemetry Systems, Inc., Isanti, Minn.) between 31 May and 1 July 1991. A total of 201 individuals (121 mule deer and 81 white-tailed deer) were handled during these 3 periods. Eighty-two transmitters have been placed on individuals (Table 2).

Table 2. Composition of telemetered population of deer on Rocky Mountain Arsenal, Colorado.

	Sex / Age			
Species	Bucks	Does	Fawns	Total
Mule Deer	8	17	35	60
White-tailed Deer	4	10	8	22
Total	12	27	43	82

Of the 39 adult deer that have been transmittered, 4 have subsequently left the study area. One of those individuals was killed by a car near Staplton Airport. Two telemetered adults have died on RMA (1 doe from old age, 1 doe killed by a vehicle). One adult transmitter has failed and no longer transmits. This leaves 32 adult deer with working transmitters on RMA. Slightly more than 3,200 location estimates have been collected on these adult deer on RMA.

Ten mule deer and 3 white-tailed deer fawns were killed by coyotes. One mule deer fawn was hit by a car and one mule deer fawn mortality is undetermined. A problem occurred with fawn transmitter attachment and 26 of the remaining 28 fawns lost thier ear tags. Only 2 fawns, both mule deer, remain with transmitters.

Statistical Analyses

Some statistical analyses and summary statistics have been computed using data from the first complete year of field work. Because of an apparent seasonal effect on data, most comparisons have been conducted on a seasonal basis. Seasons are described as spring (1 March to 31 May), summer (1 June to 31 August), fall (1 September to 30 November), and winter (1 December to 28 February).

Metatarsal gland length, weight, total length, hind foot length, and hoof length were measured on all newborn fawns captured for telemetry. These measurements were then used to estimate age and consequently date of parturition (Haugen and Speake 1958, Robinette et al. 1973) for mule and white-tailed deer fawns on RMA. Weights appeared to be similar between species but different between sexes (Table 3). Mean date of parturition was about 1 week earlier for white-tailed deer than for mule deer (Table 3).

Convex polygon home ranges (Mohr 1947) have been calculated seasonally for those individuals that have been tracked for 4 consequtive seasons during 1990 and 1991. Home range area varied

Table 3. Important summary statistics for mule and white-tailed deer fawns captured on Rocky Mountain Arsenal, spring 1991.

Species	Variable	Mean	Minimum	Maximum
Mule deer	Capture Age (Days)	2.34	< 1	17.2
	Date of Parturition	6 June	27 May	21 June
	Weight (lbs)			
	Males	9.7	7.0	18.5
	Females	9.02	7.5	11.5
White-tailed	Capture Age (days)	4.5	< 1	9.9
	Date of Parturition	30 May	21 May	6 June
	Weight (lbs)			
	Males	10.75	8.5	13.0
	Females	9.0	8.5	10.0

from 11.72 to 537.80 ha for mule deer and 36.85 to 3591.63 ha for white-tailed deer (Table 4). Summer home range area was smaller than fall, winter and spring home range areas for both mule (P = 0.0441) and white-tailed (P = 0.08) deer (Table 4). Two-sample t-tests indicated that mule and white-tailed deer home range areas were similar except for winter 1990-91 (t = -2.1991, P = 0.044).

Although not analyzed statistically, visual presentation of location estimates indicates very little overlap in areas used seasonally by mule and white-tailed deer on RMA. White-tailed deer appear to use the southern and eastern portions of RMA (Figures 1, 2, 3, and 4). Whereas mule deer are more readily found on the southwestern and northern portions of the Arsenal.

Analyses of habitat use patterns indicate that mule deer avoided areas planted in crested wheat and other cultivated

Figure 1.
LOCATION ESTIMATES FOR MULE AND WHITE-TAILED DEER
FOR SPRING 1990 ON
ROCKY MOUNTAIN ARSENAL, COLORADO

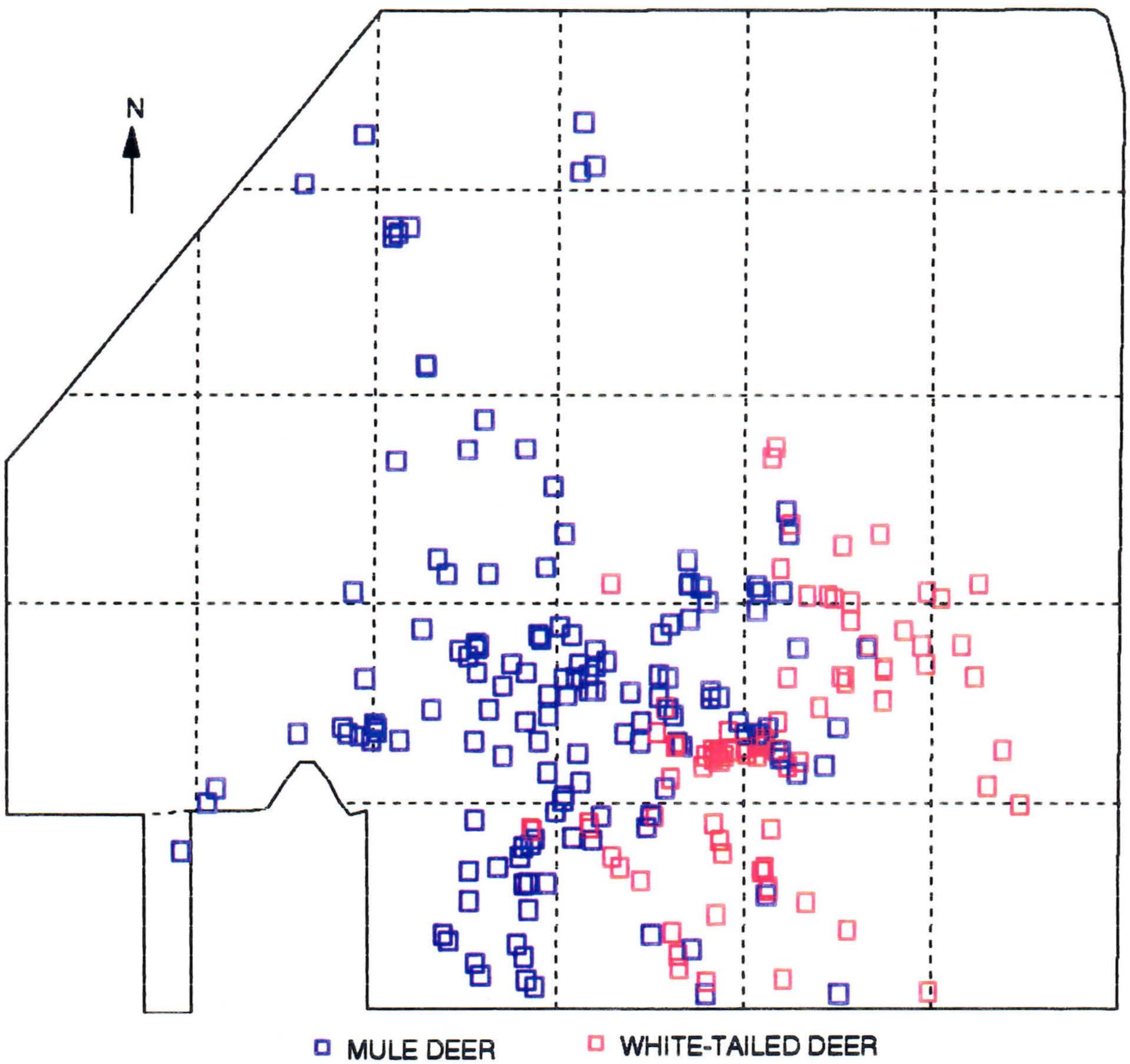

Figure 2.
LOCATION ESTIMATES FOR MULE AND WHITE-TAILED DEER
DURING SUMMER 1990
ON ROCKY MOUNTAIN ARSENAL, COLORADO

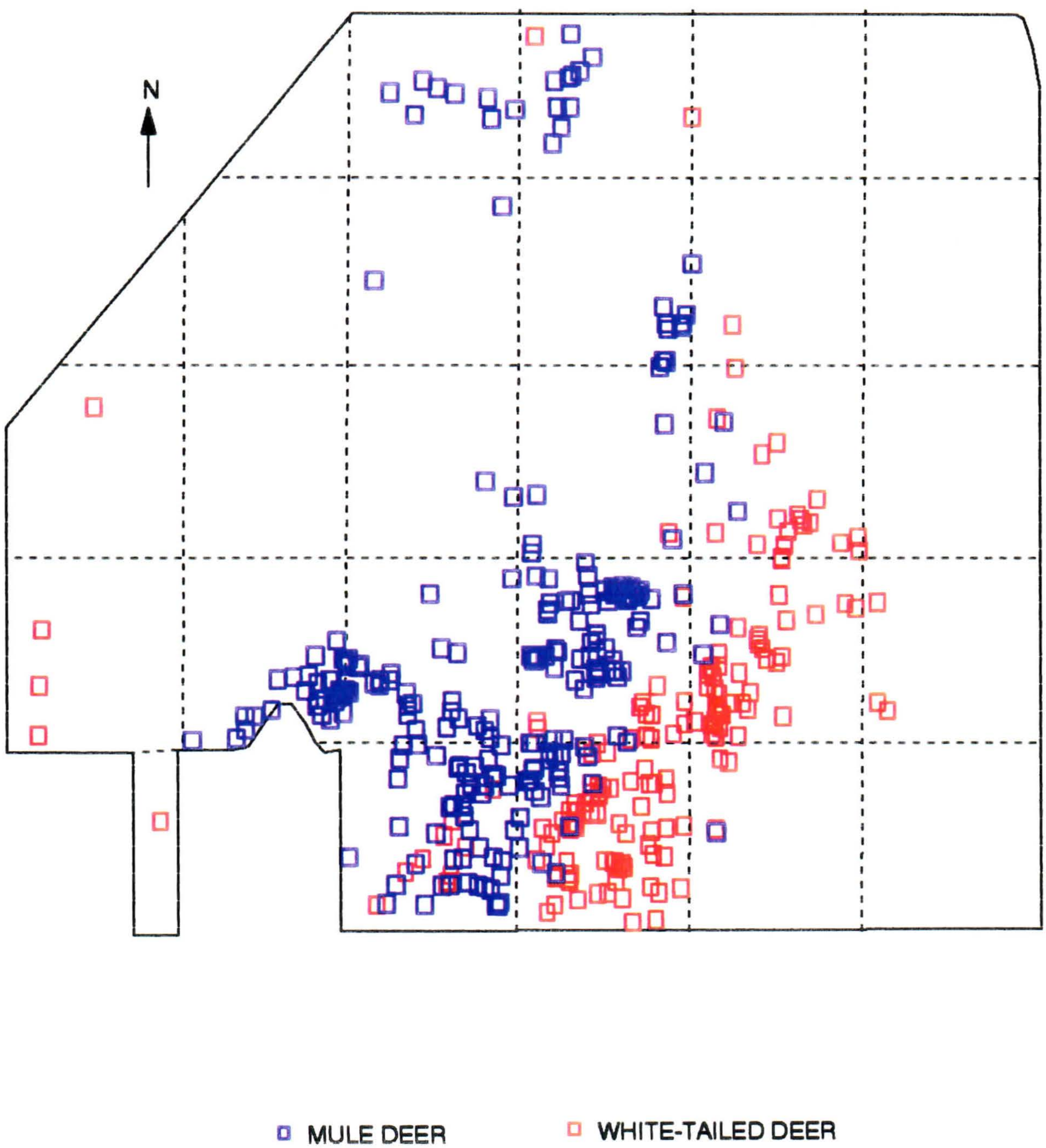

Figure 3.

DISTRIBUTION OF LOCATION ESTIMATES FOR MULE AND WHITE-TAILED DEER DURING FALL 1990

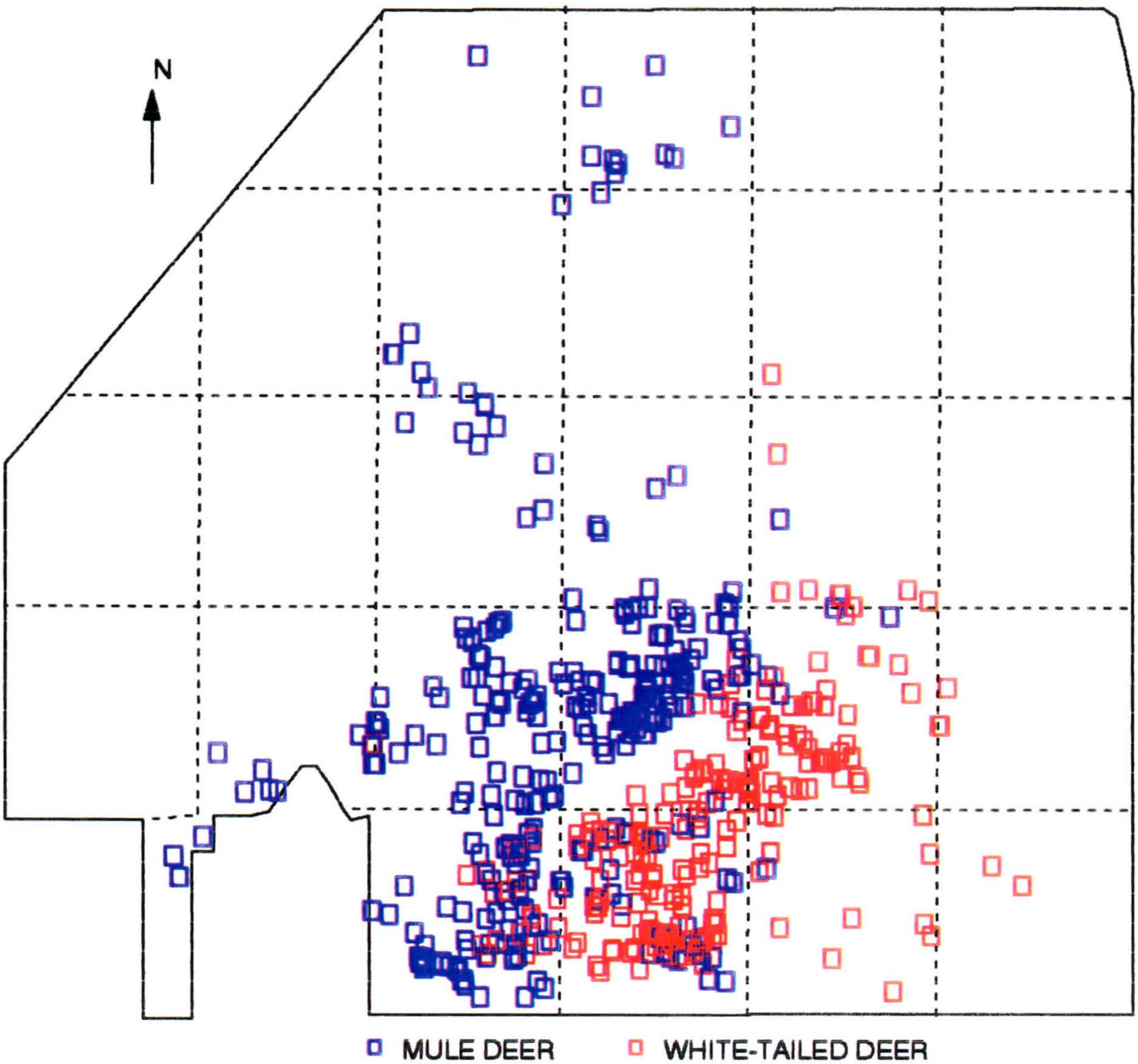

Figure 4.
DISTRIBUTION OF LOCATION ESTIMATES FOR
MULE AND WHITE-TAILED DEER
DURING WINTER 1990-1991

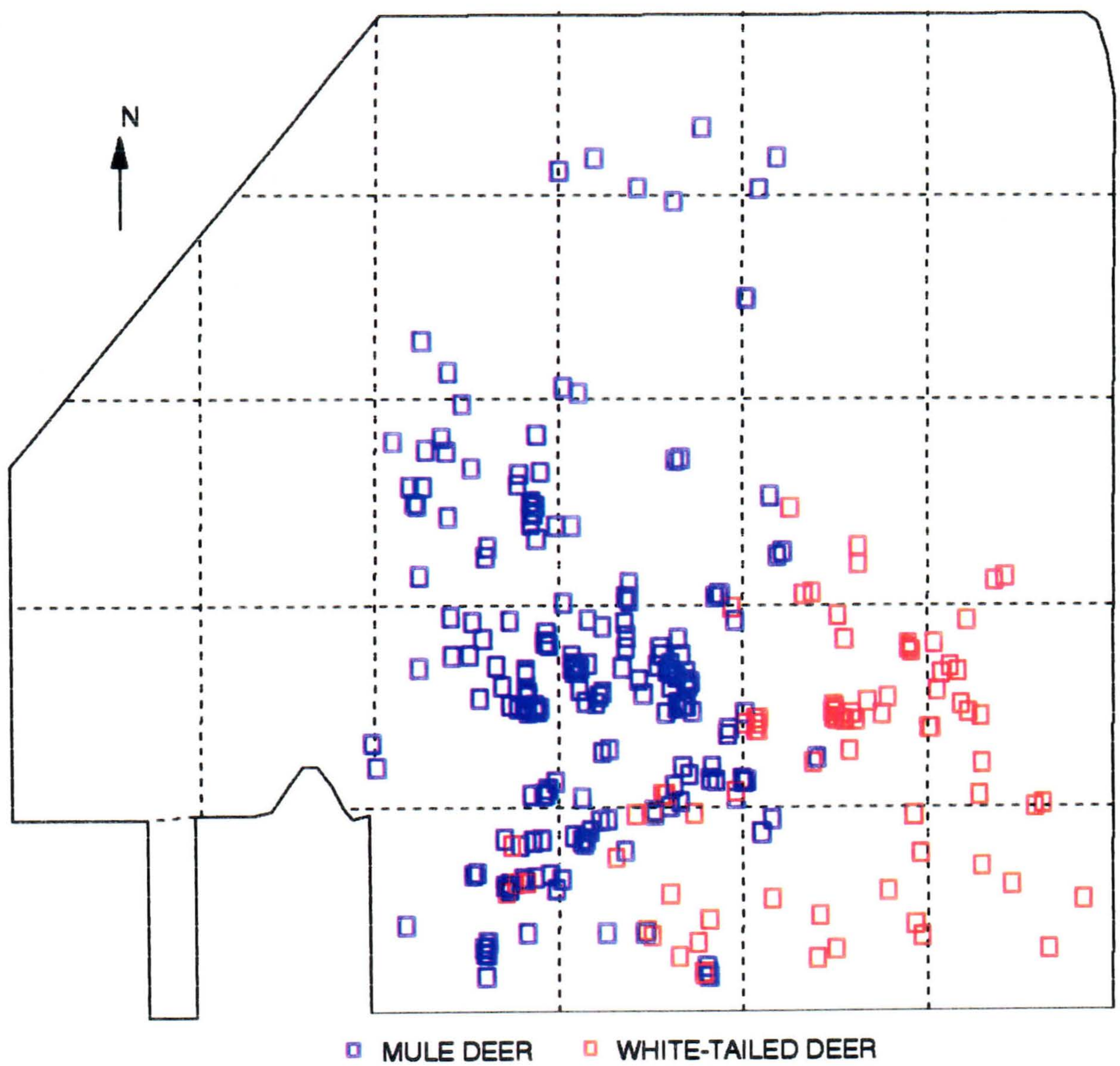

Table 4. Seasonal convex polygon home range (ha) area for 18 mule and white-tailed deer radio-tracked on Rocky Mountain Arsenal during 1990 and 1991.

		Season			
Spp.	ID	Spring '90	Summer '90	Fall '90	Winter '90/'91
MD	2	102.19	96.30	99.13	152.75
	3	362.29	89.15	11.72	139.26
	4	103.17	30.45	124.72	---
	6	208.97	44.23	317.40	184.09
	7	208.41	170.87	153.42	65.12
	9	220.51	163.86	145.12	115.46
	10	231.04	231.35	172.75	265.99
	13	114.63	235.51	362.38	191.67
	14	778.68	236.55	622.69	537.80
	18	125.72	56.74	242.48	207.72
	20	231.65	55.42	330.52	97.30
	$\bar{x}$	244.33A[1]	128.22B	234.76A	195.72AB
WT	1	486.44	321.17	591.24	213.30
	5	442.11	36.85	153.38	688.66
	8	523.05	3591.63[2]	184.96	599.28
	12	165.30	67.29	128.82	265.48
	15	234.74	323.24	325.16	262.25
	16	304.55	96.79	100.99	421.13
	17	205.09	65.22	73.22	167.85
	$\bar{x}$	337.33A[1]	151.76B	225.54AB	373.85A

[1] Means with the same letter in a row are not significantly different (LSD comparison, $P \leq 0.05$).

[2] Home range area for white-tailed deer #8 was not used in statistical comparisons.

species during all 4 seasons, perennial grasslands during spring and summer 1990 and winter 1990-91, and areas dominated by weedy forbs during fall 1990 and winter 1990-91 (Chi-Square, Bonferroni z, Neu et al. (1974), $P \leq 0.05$) (Table 5). Mule deer selected area with locust thickets and dryland trees during all 4 seasons, cheatgrass/weedy forbs during summer, fall, and winter, and wooded and non-wooded wetlands during fall and winter (Table 5).

White-tailed deer avoided areas of crested wheat during spring, fall, and winter, cheatgrass/weedy forbs during spring, summer, and fall, and shrublands during spring and summer (Table 5). Other areas avoided by white-tailed deer were cultivated species during winter and weedy forbs during fall (Table 5). White-tailed deer selected dryland trees, wetlands, and wetland trees during spring summer and fall, as well as locust thickets during summer and fall, and shrublands during fall (Table 5). A Chi-Square test of homogeneity indicates that mule and white-tailed deer used different habitats during spring ($P \leq 0.001$), summer ($P \leq 0.001$), fall ($P \leq 0.001$), and winter ($P = 0.018$).

Table 5. Results of Chi-Square analysis (Neu et al. (1974), $P \leq 0.05$) on seasonal habitat use by mule and white-tailed deer on Rocky Mountain Arsenal, Colorado.

	MULE DEER				MULE DEER			
	SPR	SUM	FAL	WIN	SPR	SUM	FAL	WIN
Cult. Spp.	-	-	-	-	=	=	=	-
Crst. Wht.	-	-	-	-	-	=	-	-
Chtg./Wdy.	=	+	+	+	-	-	-	=
Locust	+	+	+	+	=	+	+	=
Grasslnd.	-	-	=	-	=	=	=	-
Shrublnd.	=	=	=	=	-	-	+	=
Dry Trees	+	+	+	+	+	+	+	=
Wdy. Frb.	=	=	-	-	=	=	-	-
Wetlands	=	=	+	=	+	+	+	=
Wet Trees	=	=	+	+	+	+	+	+

Petraitis (1979) presented 2 measures for niche overlap. Specific overlap is the probability that 1 species' utilization distribution comes from another species' utilization distribution. White-tailed deer seasonal and annual habitat utilization distributions generally had a higher probability of coming from mule deer utilization distributions than did mule deer utilization distributions coming from white-tailed deer utilization distributions (Table 6). Petraitis also presented a measure for general overlap that could be used to test for complete overlap of niches for 2 or more species. Applying the v statistic (Petraitis 1979) to mule and white-tailed deer habitat utilization distributions on RMA indicates that the hypothesis of complete habitat niche overlap between mule and white-tailed deer on RMA cannot be accepted for all 4 seasons analyzed during 1990-91 (Table 7).

Table 6. Specific habitat niche overlap (Petraitis 1979) for mule and white-tailed deer on Rocky Mountain Arsenal.

	Spring		Summer		Fall		Winter		Annual	
Spp.	MD	WT	MD	WT	MD	WT	MD	WT	MD	WT
MD	1.00	0.55	1.00	0.67	1.00	0.60	1.00	0.90	1.00	0.71
WT	0.67	1.00	0.80	1.00	0.72	1.00	0.57	1.00	0.81	1.00

Table 7. Chi-Square test for complete overlap (Petraitis 1979) of habitat niches for mule and white-tailed deer on Rocky Mountain Arsenal.

Variable	Spring	Summer	Fall	Winter	Annual
GO	0.92	0.95	0.92	0.97	0.95
v	51.24^{**1}	43.26**	80.26**	18.88*	150.66**

[1] * = significant at $P \leq 0.01$, ** = significant at $P \leq 0.05$.

The null hypothesis:

H_0: Mule deer and white-tailed deer have no association.

was tested using the procedures of Ludwig and Reynolds (1988). A 1/4 section grid system was applied to RMA. Cells were classified and tallied according to 4 criteria:

a: Cells where both species were found,

b: Cells where only mule deer were found,

c: Cells where only white-tailed deer were found, and

d: Cells where neither species was found.

Presence or absence of a species was determined based on observation from ground trend counts conducted monthly during the year under consideration (Table 8). The calculated Chi-Square value for this information is 7.9915 which is greater than the tabular value of 3.84 (P = 0.05). Thus we fail to accept the null hypothesis and can conclude that there is some degree of interspecific association between mule and white-tailed deer. Since the observed value of 18 where both species occurred together is greater than the expected value of 11, this would indicate that mule and white-tailed deer occurred together more than we could expect if there was no interspecific association.

Table 8. Chi-Square test of homogeneity for interspecific association of mule and white-tailed deer on Rocky Mountain Arsenal.

		Mule Deer			
		Observed		Expected	
		Present	Absent	Present	Absent
WT	Present	18	29	11	37
	Absent	74	294	82	261

ADDITIONAL DATA COLLECTED

Additional data is being collected but has not been analyzed as of yet. Monthly fecal samples are being collected and sent to Colorado State University for diet composition analyses. This data will provide insite into the possibility of diet competition and the amount of dietary overlap between species. Vegetation is being sampled at specific sites being used by telemetered individuals. Measured structural attributes of vegetation used by individuals will enhance those data collected on habitat use by both species.

Several analyses are yet to be conducted with the tracking data. Analyses will be conducted on activity in an attempt to assertain behavioral differences between mule and white-tailed deer. Multi-Response Permutation Procedures will be used to determine distributional differences between mule and white-tailed deer location estimates.

The majority of all field work is expected to be complete by 31 December 1992. All data will continue to be collected until that time. An attempt to capture 50 more fawns (25 of each species) will be made in spring 1992. Method of attachment of eartag transmitters will be modified to increase the probability of fawns retaining transmitters. All deer with active transmitters will be monitored monthly for mortality after December 1992 until completion of the program at University of Wyoming.

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Progress Report

For the period 31 May 1991 to 1 December 1991

on the study of

ECOLOGY OF COYOTES AND BADGERS ON THE ROCKY MOUNTAIN ARSENAL

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1 December 1991

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

EVALUATION OF COYOTE ATTRACTANTS AND AN ORAL BAIT DELIVERY DEVICE.

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Key words: Baiting, biological markers, *Canis latrans*, CLOD, Colorado, coyote, deer carcasses, lures, non-target species, scent stations.

In a cooperative agreement between United States Fish and Wildlife Service and Colorado State University, a field study of coyotes on the RMA began in May 1990. Remediation efforts on the RMA might destroy significant areas of habitat. These clean-up operations might include mitigation efforts for specific species. Therefore, it is important to test procedures to demonstrate their utility in coyote management on the RMA. This report summarizes the field evaluation of a bait delivery device, the Coyote Lure Operative Device (CLOD).

Delivery of oral baits to coyotes (*Canis latrans*) has been studied using a variety of methods such as drop baits (Guthery et al. 1984, Knowlton et al. 1986, Windberg et al. in Review), M-44 devices (Beasom 1974), carrion bait stations (Robinson 1948, Connolly 1983), bait posts

(Teranishi et al. 1981b), toxic collars (Griffiths et al. 1978), and the CLOD (Marsh et al. 1982, Stolzenburg 1986, Ebbert 1988). Coyote control techniques such as strychnine meat and egg baits, toxic drop baits, and bait stations have been criticized as relatively unselective (Beasom 1974, Andelt 1987). The CLOD was developed to selectively deliver oral baits to coyotes (Marsh et al. 1982, McKenna-Kruse and Marsh 1982, Stolzenburg 1986, Ebbert and Fagre 1987, Fagre and Ebbert 1988, Stolzenburg and Howard 1989). Tests on captive coyotes allowed observations of specific behaviors exhibited towards certain lures and scents (Fagre et al. 1981), and to preliminarily test CLODs (Marsh et al. 1982). CLOD lures were designed to attract coyotes and elicit a biting-pulling response (Fagre et al. 1981, Marsh et al. 1982, Fagre and Ebbert 1988).

Prior trap experience reduced coyote responses to scent stations (Andelt et al. 1985), and may affect coyote responses to control techniques, such as delivery of oral baits following non-removal trapping (Knowlton et al. 1986). Martin and Fagre (1988) suggested predator control on 1 of 2 study areas in south Texas may have reduced coyote visits to scent stations. Likewise, Ebbert and Fagre (1988) found coyote visits to CLODs in south Texas was 10 times greater on an area without predator control than an area with predator control. The effectiveness of CLODs needs to be tested on a relatively unexploited population of coyotes such as at the Rocky Mountain Arsenal

(RMA) where only 4 coyotes were previously trapped and released in 3 days during January 1989 by one of us. The affects of this trapping on coyotes was considered negligible.

Carrion has been used to attract coyotes to oral drop-baits (Knowlton et al. 1986, Windberg et al. in review), toxic bait stations (Robinson 1948, Connolly 1983), snares (Nellis 1968), and traps (Beasom 1974), and has been used to enhance behavioral observations (Bowen 1981, Lindzey 1987). However, the attractiveness of carrion to coyotes has not been evaluated.

Coyote lures have been studied with pen tests (Philips et al. 1990), scent stations (Roughton and Bowden 1979, Roughton 1982, Roughton and Sweeney 1982), simulated capture devices (Graves and Boddicker 1988) and a variety of bait devices (Teranishi et al. 1981b, Servheen 1983, Fagre and Ebbert 1988, Stolzenburg and Howard 1989). Several coyote lures should be tested to determine their usefulness as CLOD scents.

Our objectives were to evaluate: 1) the effectiveness of the CLOD system for delivering liquid baits, 2) the attractiveness of deer carrion, and 3) the relative attractiveness of Carman's Distant Canine Lure (CDCL) (Russ Carman, New Milford, Pa.), Fatty Acid Scent (FAS) (Pocatello Supply Depot, Pocatello, Id.), and W-U Lure (WUL) (J-T Eaton & Co. Inc., Twinsburg, Oh.) to free-ranging coyotes on the RMA. We hypothesized that the presence of deer carcasses would increase the number of coyotes attracted to scent stations.

STUDY AREA AND METHODS

The RMA is a 70 km^2 area at the northern boundary of Stapleton International Airport, in Commerce City, Colorado. The average elevation of the RMA is 1600 m (ESE 1989), with maximum topographical relief of approximately 60 m.

A variety of grasses and forbs are found on the RMA including cheatgrass (Bromus tectorum), crested wheatgrass (Agropyron cristatum), blue grama (Bouteloua gracilis), summercypress (Kochia americana), sand sagebrush (Artemisia filifolia), and rubber rabbitbrush (Chrysothamnus nauseosus). Trees, such as plains cottonwood (Populus sargentii), New Mexican locust (Robinia neomexicana), peachleaf willow (Salix amygdaloides) and russian olive (Elaeagnus angustifolia) are found throughout the area in localized, densely stands.

The RMA supports a large variety of birds with lark bunting (Calamospiza melanocorys), western kingbird (Tyrannus verticalis), ferruginous hawk (Buteo regalis), golden eagle (Aquila chrysaetos), and bald eagle (Haliaeetus leucocephalus) abundant during certain seasons. Common mammals include white-tailed deer (Odocoileus virginianus), mule deer (Odocoileus hemionus), black-tailed prairie dog (Cynomys ludovicianus), black-tailed jackrabbit (Lepus californicus), coyote (Canis latrans) and badger (Taxidea taxus).

The climate is characterized by low humidity, abundant sunshine, and a large daily temperature variation with minimum and maximum temperatures averaging -9° C and 6° C in January and 15° C and 31° C in (ESE 1989). Precipitation averages 38 cm annually with the majority falling between April and July (ESE 1989).

CLOD Design

We evaluated the basic CLOD design of Stolzenburg and Howard (1989), but added a silicone bead to attach the vial to the acrylic core to help prevent leakage of the liquid bait. CLODs were assembled by filling a 15 ml low density polyethylene scintillation vial (Cole-Palmer Instrument Company, Chicago, Ill.) with a 12 ml mixture of 95% (by weight), food-grade light corn syrup (Karo, Best Foods, CPC International Inc., Englewood Cliffs, N.J.) to 5% powdered sugar (Fagre and Ebbert 1988) to increase viscosity and enhance ingestion by coyotes (Marsh et al. 1982). The vials were attached to an acrylic core (Acraglas®, Brownell's Inc., Montezuma, Ia.) with a clear silicone sealer (Auto Seal®, General Electric, Waterford, N.Y.). The CLODs were then dipped in Plasti-dip, a flexible industrial-grade plastic coating ("Plasti-dip®", PDI Inc., Circle Pines, Minn.). Vetrap® (Animal Care Products, 3M, Saint Paul, Minn.), an absorbent veterinary bandage, was wrapped around each CLOD head to facilitate lure holding. The CLODs used during the first half of the study were wrapped with 1 strip of yellow and 1 strip of white vetrap, whereas the CLODs used during the second half of the study were wrapped in navy blue.

Placement Strategies and Survey Design

CLODs were placed in a modified survey scent station design. To determine the effect of deer carrion bait stations on coyote visitation and CLOD activation, one-half of our survey sites during each period contained deer carrion, while the remaining one-half did not. Each CLOD was attached to a 1-cm-diameter and 41-cm-long steel stake that was driven 39 cm into the center of a 0.9-m-diameter circle of sifted soil. Scent stations were raked clear of vegetation and soil was sifted through 6.35 mm (1/4 in) mesh wire screen to obtain a tracking substrate of approximately 1 to 1.5 cm depth. Vegetation, rocks, and residual soil left in the soil sifter were deposited > 75 m from each sampling area. Gloves and boots were worn to reduce human odor at CLOD sites.

To estimate the proportion of coyotes activating and ingesting the bait solutions we added 10 mg of iophenoxic acid (alpha-ethyl-3-hydroxy-2,4,6-triiodobenzenepropanoic acid) (Larson et al. 1981, Knowlton et al. 1987) or 100 mg of tetracycline hydrochloride (100 mg/CLOD) (Johnston et al. 1987) to each CLOD. Iophenoxic acid was used near deer carcasses whereas a mixture of iophenoxic acid and tetracycline hydrochloride was used away from carcasses. Iophenoxic acid is detectable by blood serum analysis (Larson et al. 1981, Knowlton et al. 1987), whereas tetracycline hydrochloride should produce a mark detectable in a cross-sectioned lower premolar (D. H. Johnston, Ontario Ministry of Nat. Res., Toronto, pers. commun.).

The experiment was conducted for 2 7-day periods from 11 to 17 and 23 to 29 June 1990. A CLOD night was defined as 1 operable scent station night containing an active CLOD. CLOD stations were distributed uniformly throughout the RMA at a density of approximately 0.4 sampling sites per km^2, to provide coverage of the entire study area. CLOD locations were determined a priori and randomly assigned to one of the 2-week test periods. Survey sites were placed in areas containing coyote sign or where high coyote activity was suspected. Each session had 30 sampling sites with 3 scent stations and 3 CLODs per site. One-third of a road-killed deer was staked at each alternating site following a random assignment for the first site. The scent stations were located approximately 8 m away and at 0°, 120°, and 240° from the center of the carcass or area without a carcass.

Three coyote lures were used on CLODs: Carman's Distant Canine Lure; Fatty Acid Scent; and J-T Eaton's W-U lure with 10% trimethylammonium decanoate. Fagre and Ebbert (1988) found 0.5 cc and 0.1 cc of WUL on CLODs received similar coyote visitations. Therefore, 0.3 cc of each lure was randomly placed on the Vetrap of 1 of the 3 CLODs at each site.

CLODs were placed and carcasses were staked in < 11 daylight hours at the onset of each 7-day test period. CLOD stations were checked each morning to determine visitations by species and behavioral responses before smoothing the tracking surface. A visitation was defined as the presence of tracks or sign by a particular species. Generally, < 5 minutes was spent recording data at each site.

Deer, birds, rodents, mustelids, and lagomorphs were grouped into general categories due to difficulty in accurately separating various species. Small canid tracks that could not be positively identified as coyote were included in 1 category. Visitations to scent stations obscured by wind, rain, poor track impressions, or animal diggings were classified as unknown. Occasionally, CLODs were censored due to human disturbance such as road side mowing or being driven over.

Comparisons of carcass (n = 30) to non-carcass (n = 30) sites and week 1 to week 2 involved summing visitations at the 3 scent stations per site for the 7 nights and dividing by the number of operable scent station nights (maximum = 21). Visitation rates among lures (n = 60 for each lure) were calculated by summing the number of nights each species visited a CLOD station and dividing by the total number of operable scent station nights (maximum of 7). Night analysis for lures involved summing visitations by night to each lure at carcass (n = 15) and non-carcass (n = 15) sites and dividing by the number of operable scent station nights (maximum = 15). All data were arc-sine square-root transformed before analyzing with ANOVA (PROC ANOVA, SAS Inst., Inc. 1988).

RESULTS

Coyotes visited deer carcass sites more frequently than non-carcass sites (F = 6.51, 1,56 df, P = 0.0135). Overall, coyotes visited 29 of the 30 sites containing deer carcasses and 25 of 30 sites without carcasses. Twelve of 30 deer carcasses were completely consumed and an additional 12 were partly consumed by coyotes during the 2 periods.

Birds visited more sites with deer carcasses than without carcasses (F = 38.43, 1,56 df, P = 0.0001). We often flushed magpies (*Pica pica*) from carcasses. In one instance, 17 magpies were noted feeding on or sitting near a carcass. There were no differences in deer (F = 0.28 1,56 df, P = 0.5958) or rodent (F = 0.04, 1,56 df, P = 0.8516) visitations to carcass and non-carcass sites.

There were no differences in coyote visitation rates to CDCL (0.228), FAS (0.167), and WUL (0.156) (F = 2.71, 2,168 df, P = 0.0691) or each lure between each night (F = 1.85, 6,57 df, P = 0.1052).

The experiment consisted of 583 and 588 CLOD station nights for week 1 and week 2, respectively. Visitation rates were higher during week 2 than week 1 for birds (F = 23.68, 1,56 df, P = 0.0001), coyotes (F = 9.26, 1,56 df, P = 0.0036) and deer (*Odocoileus* spp.) (F = 6.37, 1,56 df, P = 0.0145) (Fig. 1). During our experiment, coyotes visited 213 stations, but activated only 3 devices by detaching the vial from the core and pulled the Vetrap or bit 8 CLODs, slightly puncturing one.

The number of activations was not sufficient to determine the proportion of the coyote population that ingested CLOD solutions.

A variety of sign indicated that carrion was attractive to coyotes. Coyotes urinated at 5 stations and scratched or dug at 29 stations. Coyotes rolled on carcasses, pulled hair and viscera out of carcasses, tugged on carcasses hard enough to loosen 46-cm-long stakes securing the deer, dug under and around carcasses, defecated, and flipped or dragged the carcasses from the site.

While nontarget species visited the CLOD stations 331 times during period 1 and 553 times during period 2, no nontarget CLOD activations or punctures were recorded. Vetrap, however, was chewed by various insects, rodents, and lagomorphs, and pecked and unwound by some birds, most notably magpies.

CDCL accounted for 34% (33/96), FAS 29% (28/96), and WUL 36% (35/96) of the lagomorph visits. Additionally, birds regularly visited survey sites, with 20% (223/1097) of all visitations. We found scent stations quite attractive and somewhat attractive to rodents and deer with an overall visitation rate of 40% (437/1097) and 9% (103/1097) respectively. Rodents visited the scent stations more frequently than any other taxa, with 50% of the total visits during week 1 and 34% during week 2. Kangaroo rats (Dipodomys ordii), frequently dug or wallowed small depressions in the finely sifted soil.

DISCUSSION

The moderate number of visitations but low number of CLOD activations by coyotes on the RMA suggests this device was not an effective method for delivering oral baits during the period tested. Stolzenburg (1986) found coyotes activated 64.1% of 237 CLODs visited, whereas Ebbert (1988) reported 55.9% of 202 CLODs visited were activated. Although coyotes activated few CLODs on the RMA, the coyote visitation rates were comparable to previous studies using scent stations (Linhart and Knowlton 1975, Roughton and Bowden 1979, Roughton 1982, Roughton and Sweeney 1982, Stolzenburg 1986).

Fagre and Ebbert (1988) suggest the attractant ability of a CLOD scent determines its effectiveness. FAS and WUL elicited high responses for lick-chew-bite and pull behaviors (Philips et al. 1990) and were chosen along with CDCL for their superior coyote attracting abilities (Fagre et al. 1981, Roughton 1982, Roughton and Sweeney 1982, Martin and Fagre 1983, Turkowski et al. 1983, Ebbert and Fagre 1988, Phillips et al. 1990). However, we found no difference between CDCL, FAS, and WUL for attracting coyotes to CLODs.

Lowered coyote visitations to scent stations due to negative conditioning from leghold traps has been reported (Andelt et al. 1985), and differences in coyote visitations to CLOD stations due to control efforts has been suggested (Ebbert 1988). Our evaluations of the CLOD during June 1990, were conducted on an area off limits to the general public, and unexploited since the mid-1940's. The coyote density on the RMA in December 1990 and January 1991 was estimated at 0.84 km^2 (Hein unpublished data). The high density and unexploited nature of the coyote population on the RMA likely might account for the relatively high visitation rates to scent stations.

Differences in visitations to CLOD stations during the 2 test periods may have been related to the white and yellow Vetrap used during week 1 and navy blue during week 2. However, Roughton and Sweeney (1982) found no differences in coyote visitation rates to a dyed scent disk, a standard disk, a disk covered with 0.5 cm of soil, and no disk. It is believed that coyotes do not see colors (Eisfeld 1966), but dogs (Canis familiaris) may see colors as tones of gray (Smythe 1961, 1975). Birds can distinguish colors (Smythe 1961) and may exhibit differing behaviors while investigating novel objects (Balph and Balph 1981). Brightly-colored novel stimuli such as the yellow and white-colored CLODs may appear in sharp contrast to surrounding features and may frighten some species. The blue Vetrap may have been more neutral and cryptic colored, which may have lessened wariness.

The scent stations received a variety of nontarget species visitations, including deer, birds, rodents, and lagomorphs. Servheen (1983) suggested CDCL repels lagomorphs, Drew et al. (1988) found WUL attractive to lagomorphs. In contrast, we found lagomorph visits to CLODs scented with CDCL, FAS, and WUL nearly identical. Rodents and deer have been reported as frequent (Linhart et al. 1968, Ebbert 1988), or uncommon and not visiting scent stations (Servheen 1983, Stolzenburg 1986). Roadside scent stations may provide an index of relative white-tailed deer abundance, especially in high density areas (Franklin 1986). Therefore, deer (Odocoileus spp.) visitations were probably related to the high density estimated at 4.3 deer per km^2 on the RMA (D. W. Whittaker, Univ. of Wyoming, pers. commun.) CLOD stations appeared to attract rodents, lagomorphs and some birds which may have used the sifted soil for dust baths, similar to Drew et al. (1988) and Teranishi et al. (1981b).

Management Implications

Deer carcasses enhanced coyote visitations to specific sites, but also resulted in 4.5-fold increase in bird visitations. Because carrion increased coyote visits to scent stations in our study, it could be used to likely increase the number of coyotes attracted to control devices. However, because carrion also attracted birds, precautions such as pan tension devices for leghold traps (Linhart et al. 1981), attaching a stop to prevent snares from closing beyond approximately 5 cm (Andelt 1987), placing baits in dense vegetation, on clear full moon nights, or during December and January to help achieve high coyote consumption rates (Guthery et al. 1984) or placing devices > 8 m from carrion should be considered to help exclude non-target species.

SUMMARY

The effectiveness of deer carrion and 3 coyote lures (Carman's Distant Canine Call, Fatty Acid Scent, and W-U Lure) were evaluated for attracting coyotes to and activating the Coyote Lure Operative Device on the Rocky Mountain Arsenal during 2 7-day periods in June 1990. More coyotes and birds visited scent stations with deer carrion than stations without carrion. Caution should be exercised when using control devices near carrion to avoid responding birds. We found no difference in coyote visitation rates among CDCL, FAS, and WUL. Three CLODs were activated during 1,171 CLOD exposure nights, indicating that CLODs were not an effective bait delivery device in our study.

OTHER ACTIVITIES THIS PERIOD

1. Began writing thesis.
2. Enrolled in classes.
3. Prepared for and passed oral examination.
4. Analyzed CLOD data.
5. Analyzed coyote density data.
6. Began analyzing deer carcass experiment data.

PLANS FOR NEXT PERIOD

1. Finish writing thesis.
2. Present deer carcass chapter at Colorado Chapter of Wildlife Society meeting.
3. Continue class work.
4. Graduate.

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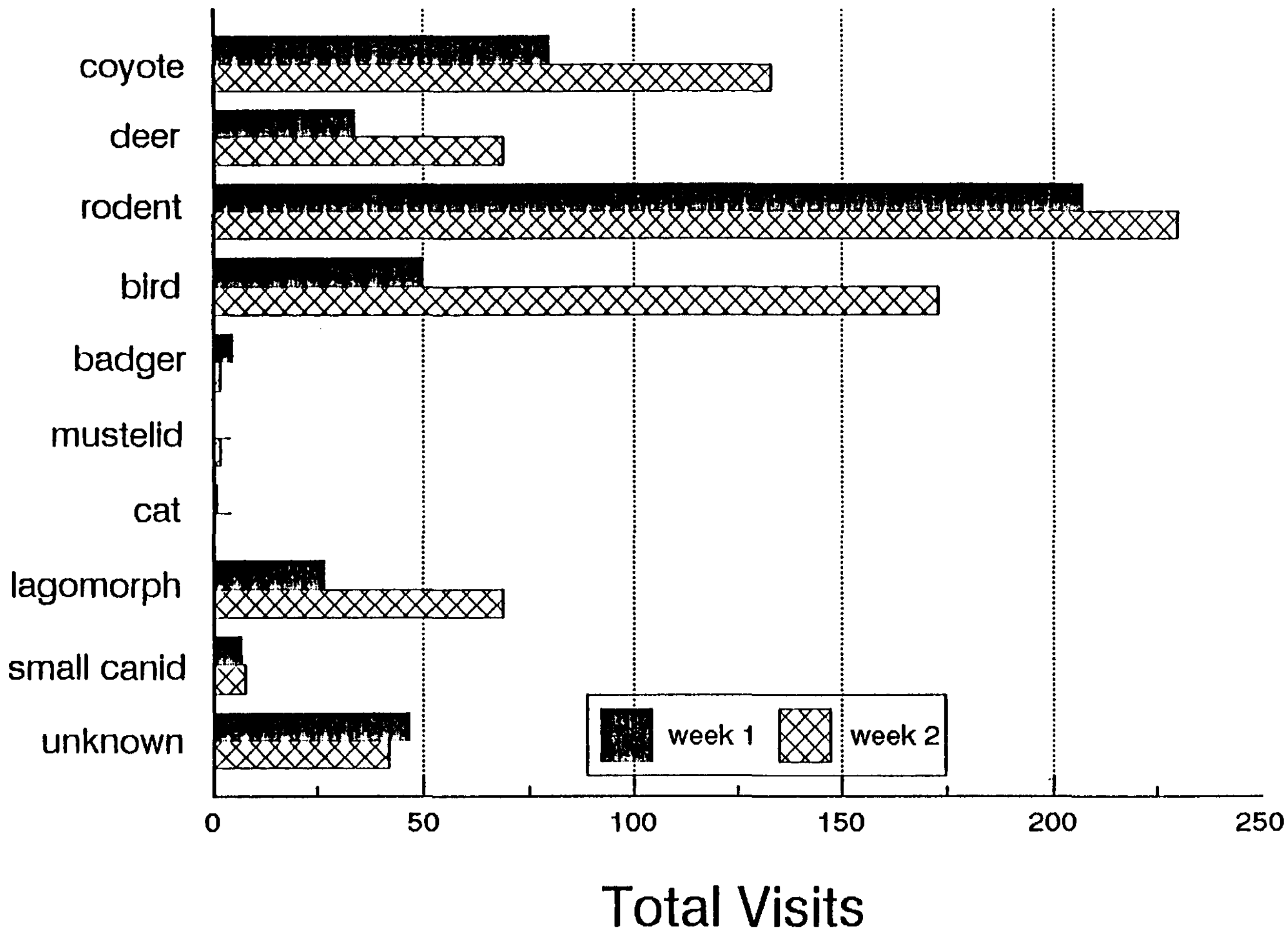
Fig. 1. Total taxa visitations to CLOD stations during 11 to 17 and 23 to 29 June 1990 on the Rocky Mountain Arsenal, Commerce City, Colorado.



30 November 1991
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COYOTE DENSITY ON THE ROCKY MOUNTAIN ARSENAL

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WILLIAM F. ANDELT, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523

Abstract: Coyote (*Canis latrans*) density on the Rocky Mountain Arsenal (RMA) was estimated from surveys of collared and uncollared coyotes (Lincoln-Petersen Index/Mark-Resight). Some coyotes frequently moved on and off of the RMA. Coyote density during December 1990 and January 1991 was estimated at 0.84 coyotes per km^2 using program NOREMARK with the Joint Hypergeometric Maximum Likelihood (JHE) emigration/immigration estimator (Neal et al. in review).

J. Wildl. Manage. 00(0):000-000

Key words: coyote, *Canis latrans*, density, emigration, estimate, immigration, NOREMARK, radio telemetry, Rocky Mountain Arsenal, survey.

Coyotes have been widely studied, but few have examined population density (Babb and Kennedy 1989). Management decisions involving coyote control could utilize suitable methods to obtain more reliable information

20 October 1991
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RH: Coyotes and Carrion · Hein and Andelt

COYOTE ATTRACTANCY TO EXPERIMENTALLY-PLACED DEER CARRION.

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WILLIAM F. ANDELT, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523

Abstract: Radio collared coyotes (*Canis latrans*) were monitored on the Rocky Mountain Arsenal (RMA) to estimate home range boundaries and to determine the effect of experimentally-placed road-killed deer on coyote visitations to preselected areas within home ranges. We monitored 3 carcass locations using a vehicle-mounted antenna system (VMA) and 2 locations using a remote radiotelemetry receiver and attached data logger computer (DL) from 27 January to 6 April 1991. Each site was monitored for collared coyote visitations during 5 pretreatment, treatment and post treatment nights. Eight telemetered coyotes were followed throughout the experiment. A greater number of coyote location estimates were within 150 m of carcass sites during treatment sessions than pre or post treatment sessions (F =

FIRST QUARTERLY REPORT FOR 1991-1992

THE CREATION OF WETLANDS AT THE ROCKY MOUNTAIN ARSENAL: MONITORING THE PATTERNS AND PROCESSES OF VEGETATION ESTABLISHMENT ON SHORT AND LONG TIME SCALES AND WATER TABLE GRADIENTS

Submitted by:
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This is the first quarterly report for 1991-1992 on wetland construction research being conducted at the Rocky Mountain Arsenal near Denver, Colorado. The purpose of this report is to describe work completed as of November 1991 and to describe my current thoughts and plans for continuing wetland research at the Rocky Mountain Arsenal. As you know the first summer (1991) was not one in which scientific research was completed. Due to contract complications we did not have a budget until the end of the summer and at that time it was not possible to move quickly. In many ways I am very glad that we did not move quickly because it has been very productive to watch the five wetland areas through the fall. Research conducted during the fall and early winter and which is ongoing at present is to install a complete set of plots each with shallow ground water monitoring wells to determine the hydrologic regime of each plot. At present approximately 50 wells have been installed in wetlands 3, 4 and 5. Wetland number 1 is just completed and wetland number 2 has much yet to be done. Hence, our work must wait until the wetland is built. We will have the entire plot and well network established by April of 1992 and will commence our monitoring at that time.

You may remember from my funding proposal that I had proposed to set up experiments using different wetlands as treatments. We had proposed to introduce plant propagules into certain treatment wetlands, use untreated wetlands as controls and determine the effects of treatment on the rate and direction of plant succession. As it turns out, the three wetlands (numbers 3, 4 and 5) that had water run into them appear to be very different hydrologically. The amount of water placed into each wetland was different, but the length of time that each has held water since being filled is very different.

Wetland number 4 received water before, or at the same time, as wetland number 2. Wetland 4 did receive quite a bit of water, but unfortunately the volume of water was not recorded. This wetland continues to hold water today. It clearly has lost some water to percolation and evaporation, but retains a large pool of open water and saturated soils around its edges. Wetland number 3 also received a lot of water during the late summer. It has lost quite bit of water due to percolation and also retains a pool today, but a much smaller pool than wetland number 4. Wetland number 5 received water for a shorter time than either wetland 3 or 4. This wetland lost all of its water to percolation very quickly and has been dry for most of the fall.

The different response of these three basins to input of water leads me to believe that these three wetland basins have quite different subsurface soil structure. While augering holes to install monitoring wells in these three wetland areas we did notice clayey horizons under wetland 4 and under wetland 3, but not under wetland 5. In addition, even if there were identical clayey soil horizons under the three basins, the shape and character of the horizon could determine the ability of a basin to perch and hold surface water. For example, if one basin had a clay layer that was horizontal, another concave, while another tilted to the west, they would hold water or drain differently.

Presently I am not sure why the three basins appear to have different water holding capabilities. It could be due to the amount of water each received, the presence-absense or character of subsoil clay layers, or the shape and orientation of the clay layer. It is clear that the three basins are different, and in the final call, all five wetland basins will most likely be different. It is essential to understand the hydrologic regime of these basin to allow us to develop a plan for future management of the water, vegetation and potential wildlife. The hydrologic regime in this instance will consist of the interaction of the input surface water with each basins subsoils.

To do this research will involve some research that we had not written into our proposal and therefore is not in our present scope of work. I am proposing to perform this research under the present scope of work and the cost structure already described in our current contract.

A study of the depth and shape of clay subsoil horizons will be performed by probing down into the soil with a steel rod until the more dense horizon is met. The depth to the horizon will be written on a wooded stake placed at that exact point. We will do this probing throughout the basins of interest. These stakes can then be surveyed in and we can develop elevation profiles and topographic maps of this subsoil layer. This will greatly help us understand the differences in the hydrologic regime of each basin. We will also collect samples from the subsoils for particle size analysis. We will also want to have the ground water montoring wells carefully surveyed in with a full station. Perhaps MK Environmental can provide these surveying services to us.

In addition, these basins are structurally too different from each other to follow the original study plan (whole basins as treatments or controls). Therefore, I need to modify my original study plan to reflect these internal complications. I feel that to get replicable data we must study each wetland basin separately. Within each basin we must establish a control and develop replicates of the treatments that we wish to study.

The study plan should reflect these ideas. Each wetland basin will be divided into four quarters. One half of the basin will be treated to receive plant propagules or plantings, while the other half will act as a control. One half of the control and one half of the treatment area will have cattail seedlings removed as they are found. Cattails are a very aggressive and rapid invader of disturbed wetland soils. They quickly form monocultures and exclude plant species which are more desirable from a wildlife perspective. From this study design we can establish four scenarios for plant succession in each basin: (1) completely natural invasion of any plants (control); (2) natural invasion from which cattails have been removed as a competitor (treatment #1); (3) natural invasion plus the introduction of plant propagules (treatment #2); and (4) natural invasion plus the introduction of plant propagules from which cattails are removed (treatment #4).

The plant introductions I would like to try are as follows:

1. seeds of the following species will be introduced to 1/2 of each wetland, soft-stem bulrush, alkali bulrush, torrey rush, arctic rush.
2. unrooted, dormant stem cuttings of sandbar willow will be planted on the wetland margins. These plants will be cut on post if possible.
3. plugs of wetland plants will be taken from the Shell property just north of the Arsenal boundary and planted in the wetlands. We will most likely try to plant species that do not reproduce well from seeds, eg. nebraska sedge, hairy sedge, arctic rush, prairie cordgrass.

The study of wetland basin hydrology will provide another important benefit. It will help us make decisions regarding the necessity of using bentonite in the wetlands. We believe that our research will determine which basins, if any, will require bentonite.

I am also proposing to conduct an additional study on the Arsenal in conjunction with this ongoing research at no cost to the project. This research will involve the collection of surface soil samples from basins throughout the Arsenal that have been in the past or could potentially be wetland basins. We will put these soil samples into small fish tanks fill them with water and determine what plant species grow from the dormant soil seed bank. I am proposing this because I believe that many basins on the Arsenal have been wetlands in the past, but have been drained or are wetlands during only very wet climatic periods.

This letter proposes some changes in the methodology of the original study plan but it does not change the focus, scope or hypotheses that we will be testing. I hope that you will agree that these changes are essential to develop a realistic data base on the wetlands being created at the Rocky Mountain Arsenal. You might consider talking with Eric Bergersen at the Coop Unit here at CSU to determine how to facilitate the necessary modifications to our study plan.

SUCCESSIONAL CHANGES AND WATER QUALITY IN ARTIFICIAL WETLANDS AT THE ROCKY MOUNTAIN ARSENAL

PROGRESS REPORT

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INTRODUCTION

Wetland habitats are among the most diverse and productive ecosystems known. Loss of wetlands due to agriculture and other practices intensifies the need to justify their existence. This justification can only come through increased understanding and documentation of the overall benefits of these diverse systems. In addition to providing important habitat for fish and wildlife (Cooper and Lee 1987), recent studies have demonstrated that wetlands are highly effective at removing contaminants and may function as natural biological filters. Wetlands have been utilized for removal of heavy metals from acid mine drainage (Howard et al. 1989), tertiary treatment of sewage water (Pride et al. 1990), and in abatement of urban nonpoint source pollution (Daukas et al. 1989).

The treatment of nonpoint source pollution by artificial wetlands is of special significance in the current study. Nonpoint source pollution, the diffuse input of chemicals and particulate materials from urban and agricultural runoff, is a ubiquitous source of surface water contamination and is widely recognized as the major water quality problem in the United States. According to a survey conducted by the U.S. EPA in 1977, 70% of the drainage basins in the United States are impacted by pesticides, nutrients, and suspended solids originating from agricultural practices. Many more U.S. streams are impacted by heavy metals and petroleum hydrocarbons from urban runoff. A recent survey of water quality trends in the United States suggested that nonpoint source pollution will prevent achievement of national water quality goals, even after implementation of point source controls (Smith et al. 1987).

Nonpoint-source pollution may contribute heavy metals, pesticides, petroleum hydrocarbons, and other contaminants to surface waters at the Rocky Mountain Arsenal (RMA), located immediately northeast of Denver, Colorado. High levels of heavy metals, nutrients, petroleum hydrocarbons, and suspended solids have been measured in metropolitan Denver's surface waters (DRCOG 1983). Construction of a new international airport east of RMA has begun and it is likely that the volume of urban runoff entering RMA surface waters will increase significantly following completion of this facility.

During the spring and summer of 1991, five wetland basins were constructed at the Rocky Mountain Arsenal. These wetlands were established primarily to increase habitat diversity and to provide control of potential nonpoint source pollution entering the area. Highline Canal, the principal water source for these wetlands, originates southwest of Denver, meanders through the city, and enters the southeast corner of RMA.

The purpose of this study was to evaluate the suitability of artificial wetlands for providing fish and wildlife habitat at RMA. This report summarizes field and laboratory data collected at RMA from August, 1991 through November, 1991. Data on changes in routine water quality and invertebrate community structure over time in four of the five wetlands are presented. Temporal changes in water quality were examined and differences among wetlands were described. To examine successional changes in these systems, invertebrate communities established in artificial wetlands were compared to those present in an existing wetland. Reproduction of Ceriodaphnia dubia exposed to water collected from two of the artificial wetlands, Highline Canal, and Ladora Lake are compared.

The specific objectives of this research were 1) to monitor changes in water quality in artificial wetlands and other surface waters as increased development occurs in areas adjacent to RMA; 2) to examine colonization of artificial wetlands by benthic organisms and compare structural and functional characteristics of these systems to existing wetlands; 3) to test the ability of artificial wetlands to assimilate nonpoint source contaminants entering RMA surface waters.

MATERIALS AND METHODS

Site Descriptions

The five wetland basins were constructed in the southeast corner of RMA (Fig. 1a and 1b). Wetlands RMA3, RMA4, and RMA5 were natural basins which required little alterations. Wetland RMA2 was excavated slightly. Wetland RMA1 is the largest of the five wetlands, requiring work through the summer and mid-fall on contouring and layering of the bottom with bentonite.

The primary source of water for these wetlands was Highline Canal. Filling the wetlands with water was dependent on water rights appropriations, natural precipitation conditions, and construction schedules. Thus, the sequence of filling the wetlands with water was staggered from mid-June to late October. Due to differences in porosity and composition of the soils, the holding capacity of the wetlands varied. For example, water was diverted to RMA2 from Highline Canal in mid-July, but this wetland was completely dry by late September. RMA3 and RMA4, which were filled in mid-July and mid-August, respectively, will probably retain water through the winter. RMA4 is holding the most water at this time, although it is not the largest basin. RMA4 either received more water than the other basins, or its soils are less porous. Filling of RMA5 occurred in late-August or early-September. This wetland received little water and was dry by mid-October.

Ladora Lake (RMAL), a previously existing wetland at RMA, served as a reference site for this project. As with the artificial wetlands, Highline Canal is the primary water source for RMAL.

Although above-background levels of contaminants have been measured in RMAL sediments (Rosenlund et al. 1986), it currently supports high diversity of fish and invertebrates and should serve as an appropriate reference site for this study.

Field Sampling

Routine water quality data were collected from each wetland immediately following the addition of water. Samples were collected weekly until late September, and bi-weekly through November. Field measurements included temperature, dissolved oxygen (Y.S.I. model 51B), total depth, and secci depth. One-liter water samples were collected from each location and transferred to the laboratory for measurement of pH, alkalinity, hardness, and conductivity.

Benthic invertebrate sampling consisted of net sweeps, artificial substrates, and core sampling. Qualitative sweep samples (1-mm mesh) were collected from several microhabitats (open water, submerged plants, and bottom substrate). Samples were placed in a 7-L cooler and transported to the laboratory. In the laboratory invertebrates were sorted by taxa and placed in 60% ethanol.

Artificial substrates (Hester-Dendy "multiplate samplers") were collected from wetlands RMA2, RMA3, RMA4, and RMAL. Five replicate samples were suspended 30 cm below the surface using a circular float. Two PVC posts were driven into the substrate, and the ring of samplers placed around these to keep the unit stationary. This design allowed vertical movement of the samplers with varying water depths. Samplers were placed on 29 August, 1991 and retrieved after 36 d colonization. Samples from RMA2 were removed earlier due to reduction in water depth. All samples were rinsed through a 500-um mesh sieve in the field and preserved in 60% ethanol.

Five quantitative core samples (47 cm^2) were collected from wetlands RMA3, RMA4, and RMAL on 3 October, 1991. The top 10 cm of each sample was washed through a 500-um mesh sieve and the organisms retained were preserved in 60% ethanol.

Ceriodaphnia Reproduction

Experiments measuring reproduction of *Ceriodaphnia dubia* were conducted using waters collected from RMA3, RMA4, RMAL, and Highline Canal. Tests were carried out in accordance with EPA's 3-brood chronic toxicity testing procedures (U.S. EPA 1985). On 24 October, 1991 4 L of water was collected from each wetland, immediately placed on ice, and returned to the laboratory. After 24 h, water samples were filtered using Wathman #2 papers to remove particulate materials and indigenous organisms. The experimental design included five test concentrations (6.25, 12.5, 25, 50, and 100% of wetland water) and a control. Moderately hard (hardness=95, alkalinity=65) reconstituted water served as diluent water in these experiments. Individual *Ceriodaphnia dubia* were placed into 30 mL containers. Differences in mean number of offspring produced per female were analyzed using one-way and two-way ANOVA.

RESULTS

Water Quality

Changes in water quality at RMA wetlands are shown in Fig. 2. In general, routine water quality parameters among wetlands were similar within 3-4 weeks. Water temperature decreased during the course of the study but was similar among wetlands (Fig. 2a). Water temperature in wetlands RMA2 and RMA5 increased due to decreased depth and reduced volume of these wetlands. Depth in each of the artificial wetlands decreased over time, and RMA2 and RMA5 were dry by early October (Fig. 2b). Dissolved oxygen concentrations in the artificial wetlands were highly variable during the first four weeks, but stabilized in RMA3 and RMA4 after week 5 (Fig. 2c). Increased pH over time was observed at RMA2 and RMA3 during the first four weeks of sampling (Fig. 2d). At RMA3 pH values decreased after week four and followed patterns observed in other wetlands. Samples were not collected from RMA2 because of greatly reduced water levels in this wetland.

Water hardness and alkalinity (measured as mg/L $CaCO_3$) increased in the artificial wetlands over time and approached values measured in RMAL after 4-5 weeks (Figs. 2e and 2f). Hardness and alkalinity values at RMA3 continued to increase during the 11 week period. Conductivity values in the artificial wetlands also increased over time, but were generally lower than values measured in RMAL (Fig. 2g). Conductivity in RMA3 approached values measured in RMAL after 9 weeks.

Colonization by Macroinvertebrates

Qualitative sampling (sweep nets) indicated that artificial wetlands were rapidly colonized by aquatic macroinvertebrates (Table 1; Fig. 3). Representative taxa from most aquatic insect groups were collected from the wetlands within 2-3 weeks after water was introduced. The mayfly *Callibaetis* sp, Corixidae, and Chironomidae (*Chironomus riparius*) were among the first taxa to colonize each artificial wetland. Gastropods were also collected from RMA2 and RMA4 during the early stages of colonization.

These data suggest that within 2-3 weeks invertebrate communities present in artificial wetlands were qualitatively similar to those found in the reference wetland, RMAL. Examination of colonization of artificial wetlands over time revealed that the number of taxa collected quickly approached values measured in RMAL (Fig. 3).

Artificial substrate samples and quantitative core samples collected on 3 October, 1991 from RMA3, RMA4, and RMAL are currently being analyzed.

Ceriodaphnia Reproduction

Reproduction of *Ceriodaphnia dubia* in water collected from Highline Canal, RMAL, RMA3, and RMA4 is shown in Figure 4. In general, reproduction (number of neonates per female) of *C. dubia* increased as a function of percent site water. Reproduction was lowest in controls (=100% reconstituted water and 0% site water), averaging 20.5 ($\pm$ 2.5) neonates per female. Results of ANOVA indicated that reproduction in the controls and 6.25% treatments was significantly less than in the 25%, 50%, or 100% treatments. The highest reproduction was observed in organisms exposed to 25% site water from RMA3 and RMA4 (mean = 33.0 and 31.0 neonates per female, respectively). In all treatments where organisms were exposed to site water, reproduction was greater in the artificial wetlands treatments (RMA3 and RMA4) than in either Highline or RMAL. Results of two-way ANOVA and multiple range tests indicated that these differences were highly significant.

DISCUSSION

Water quality analysis, benthic invertebrate collections, and reproductive tests with Ceriodaphnia dubia suggest that artificial wetlands constructed at RMA were similar to natural wetlands. Water quality in these wetlands, appears to be quite good, as evidenced by the high reproductive rate of C. dubia in water collected from RMA3 and RMA4. Based on the rapid rate at which benthic invertebrates colonized and became established in these wetlands, it is likely that these systems will support a diverse community of plants and animals. Colonization of wetlands by the mayfly Callibaetis spp. (Ephemeroptera: Baetidae) is also indicative of good water quality, as mayflies are generally quite sensitive to a wide variety of contaminants (Clements et al. 1988; Clements 1991).

Increased reproduction of Ceriodaphnia dubia observed in site water compared to controls (=100% reconstituted water) strongly suggests that water in RMA wetlands is of good quality (Fig. 4). Furthermore, these experiments suggest that water quality in artificial wetlands (RMA3 and RMA4) was actually better than in either Highline Canal or RMAL.

FUTURE RESEARCH

During the next several months researchers at Colorado State University will continue to examine water quality in RMA wetlands. Artificial substrate samples and quantitative core samples collected during the summer will be analyzed to obtain better information on colonization dynamics of these wetlands. We are currently conducting acute and chronic toxicity tests with Ceriodaphnia dubia exposed to reference toxicants (zinc) in water collected from RMA3, RMA4, and RMAL. The purpose of these experiments is to compare the ability of wetlands to assimilate, degrade and/or detoxify potential contaminants entering wetlands from Highline Canal. Results of benthic invertebrate studies and these toxicity tests will be discussed in the next progress report.

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Table 1. Summary of qualitative invertebrate collections from RMA2, RMA3, RMA4, and RMAL from 8/16/91 to 9/26/91.

Wetland RMA2

	8/16	8/29	9/12	9/19	9/26
Callibaetis	X		X		
Corixidae	X	X	X		
Notonectidae			X	X	
Dytiscidae	X	X	X	X	
Hydrophilidae	X	X	X	X	
Pantala			X	X	
Enallagma			X		
Oecitis		X	X		
Chironomidae	X	X			
Hydracarina		X			
Conchostraca		X			
Gastropoda		X	X		
Total Taxa	5	8	9	4	

Wetland RMA3

	8/16	8/29	9/12	9/19	9/26
Callibaetis			X	X	X
Corixidae	X		X	X	X
Dytiscidae			X		X
Hydrophilidae			X	X	X
Chironomidae			X	X	
Culicidae			X		X
Cladocera			X	X	
Hydracarina					X
Total Taxa	1	0	7	5	6

Table 1. (cont.)

	Wetland RMA4				
	8/16	8/29	9/12	9/19	9/26
Callibaetis	X	X	X	X	X
Corixidae	X	X	X	X	X
Notonectidae		X	X	X	
Dytiscidae		X		X	X
Hydrophilidae		X	X	X	X
Pantala				X	X
Enallagma			X	X	X
Chironomidae	X	X	X	X	X
Culicidae	X	X			
Cladocera			X	X	X
Misc. Diptera		X			
Hydracarina		X		X	
Gastropoda	X	X	X		
Total Taxa	5	10	8	10	8

	Wetland RMAL				
	8/16	8/29	9/12	9/19	9/26
Callibaetis		X		X	
Caenis		X		X	
Pantala		X			
Enallagma		X		X	
Oecetis				X	
Chironomidae		X		X	
Culicidae		X			
Cladocera		X		X	
Hydracarina		X			
Gastropoda		X			
Total Taxa		9		6	

FIGURE LEGENDS

Fig. 1.a. Rocky Mountain Arsenal, Commerce City, CO. -Indicates wetlands described in this study (modified from ESE, 1988).

Fig. 1.b. Sections 7 and 8 on southeast corner of Rocky Mountain Arsenal, Commerce City, CO. -Indicates wetlands described in this study.

Fig. 2. Water quality and abiotic trends in artificial wetlands and Ladora Lake at Rocky Mountain Arsenal, Commerce City, CO. Data were collected from 16 August 1991 through 21 November 1991. a. Water temperature; b. Water depth; c. Dissolved oxygen; d. pH; e. Alkalinity; f. Hardness; g. Conductivity.

Fig. 3. Invertebrate colonization in artificial wetlands at Rocky Mountain Arsenal, 16 August to 26 September, 1991. Open circles represent number of taxa found in Ladora Lake.

Fig 4. Reproduction of <u>Ceriodaphnia dubia</u> (number of neonates per female in three-brood test) using water from RMA3, RMA4, RMAL, and Highline Canal. Highline Canal water was collected approximately 3 kilometers upstream from the RMA.

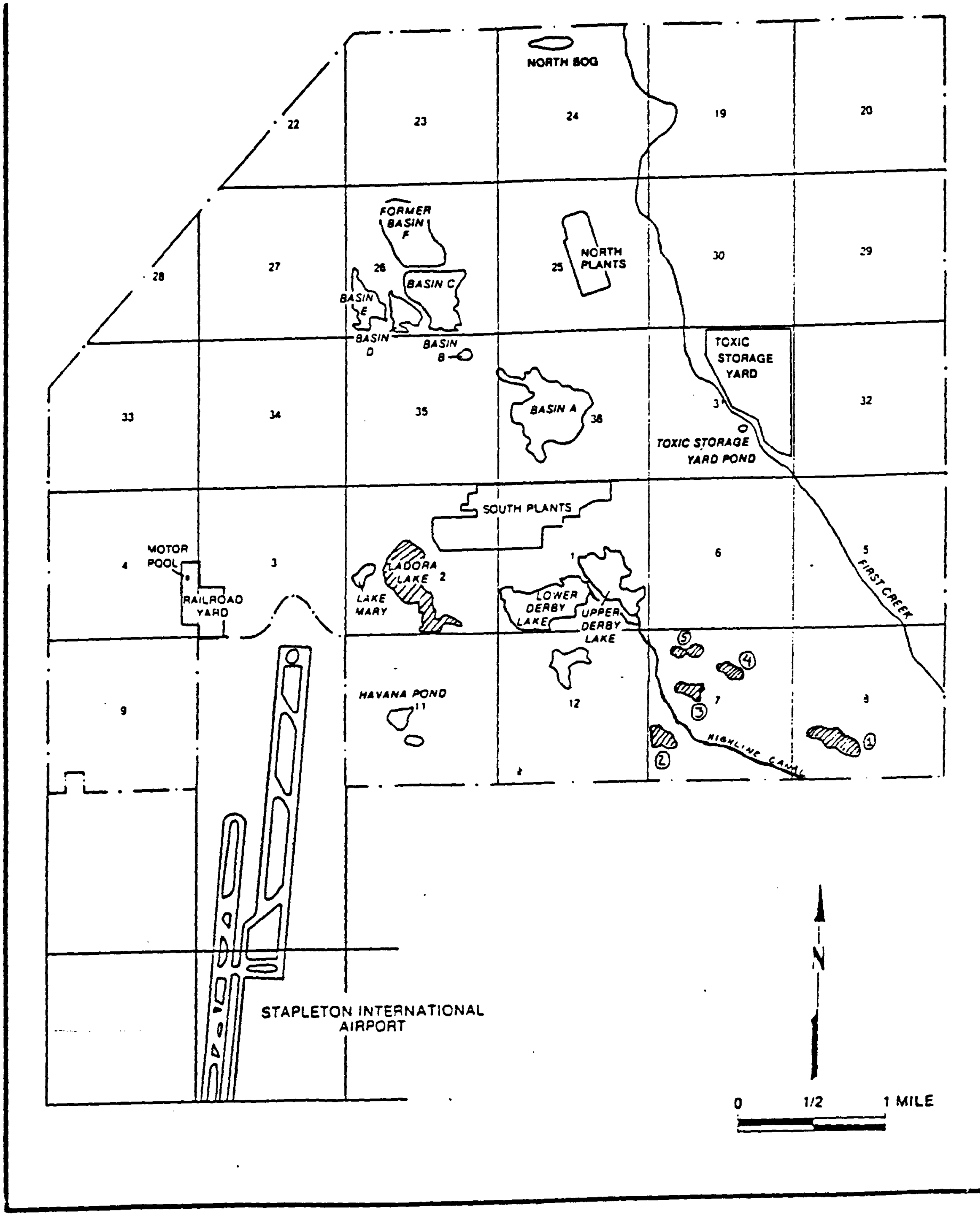


Fig 1.a. Rocky Mountain Arsenal, Commerce City, CO. -Indicates wetlands involved with this study (modified from ESE, 1988).

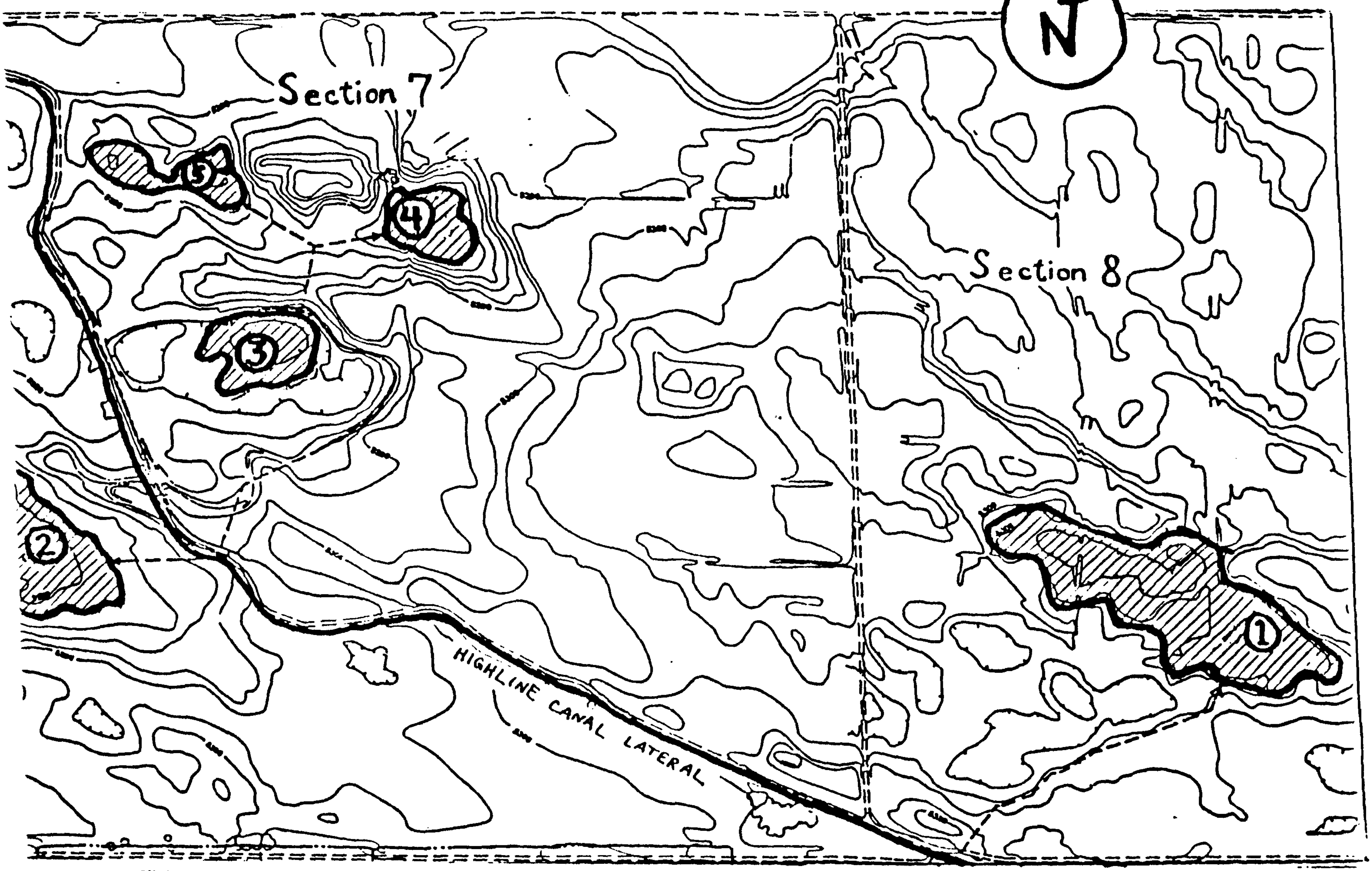
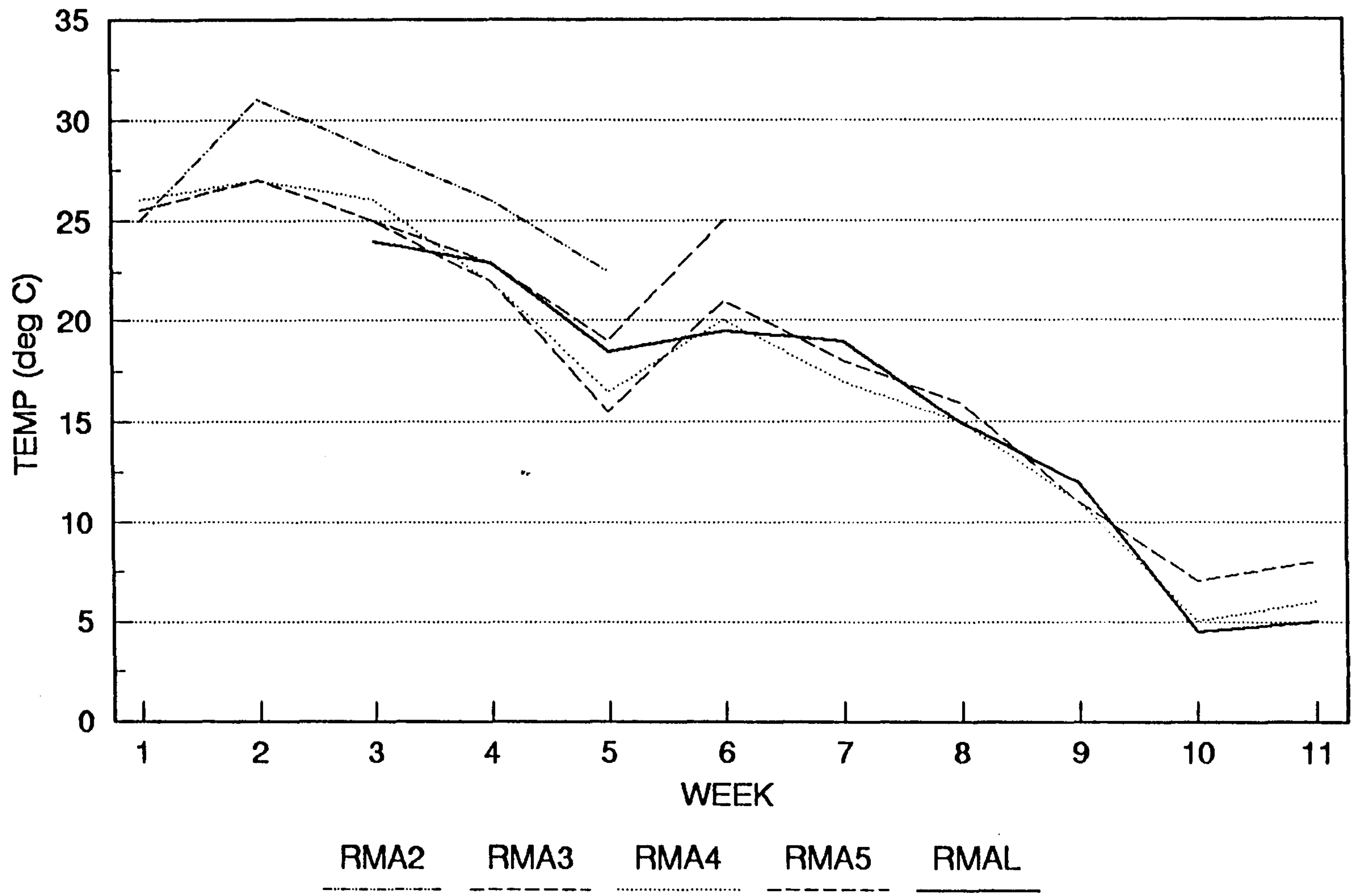


Fig 1.b. Sections 7 and part of 8 on southeast corner of Rocky Mountain Arsenal, Commerce City, CO. -Indicates wetlands involved with this study.

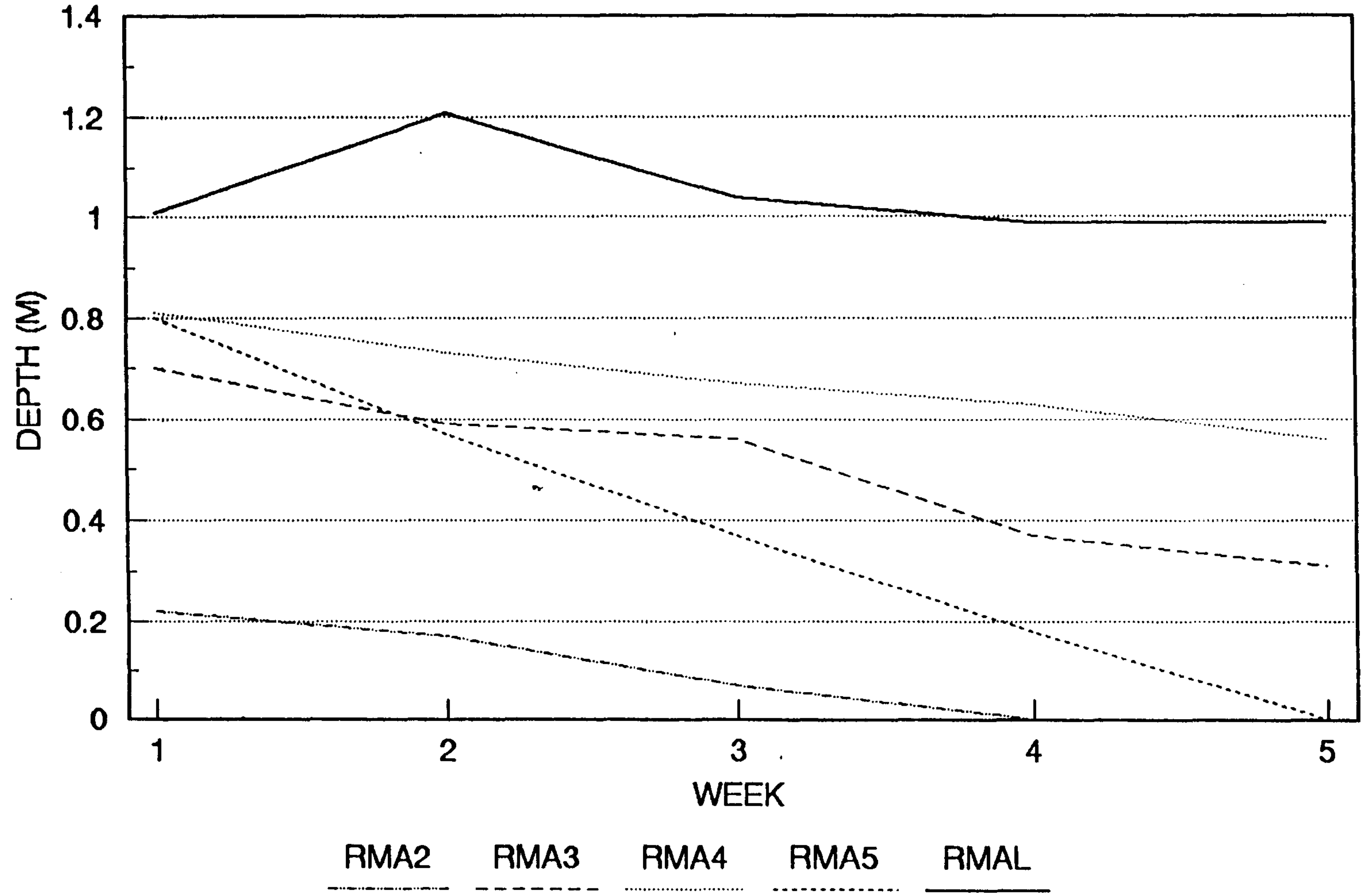
ROCKY MOUNTAIN ARSENAL-WETLANDS

Water Temperature 8-16-91 through 11-21-91



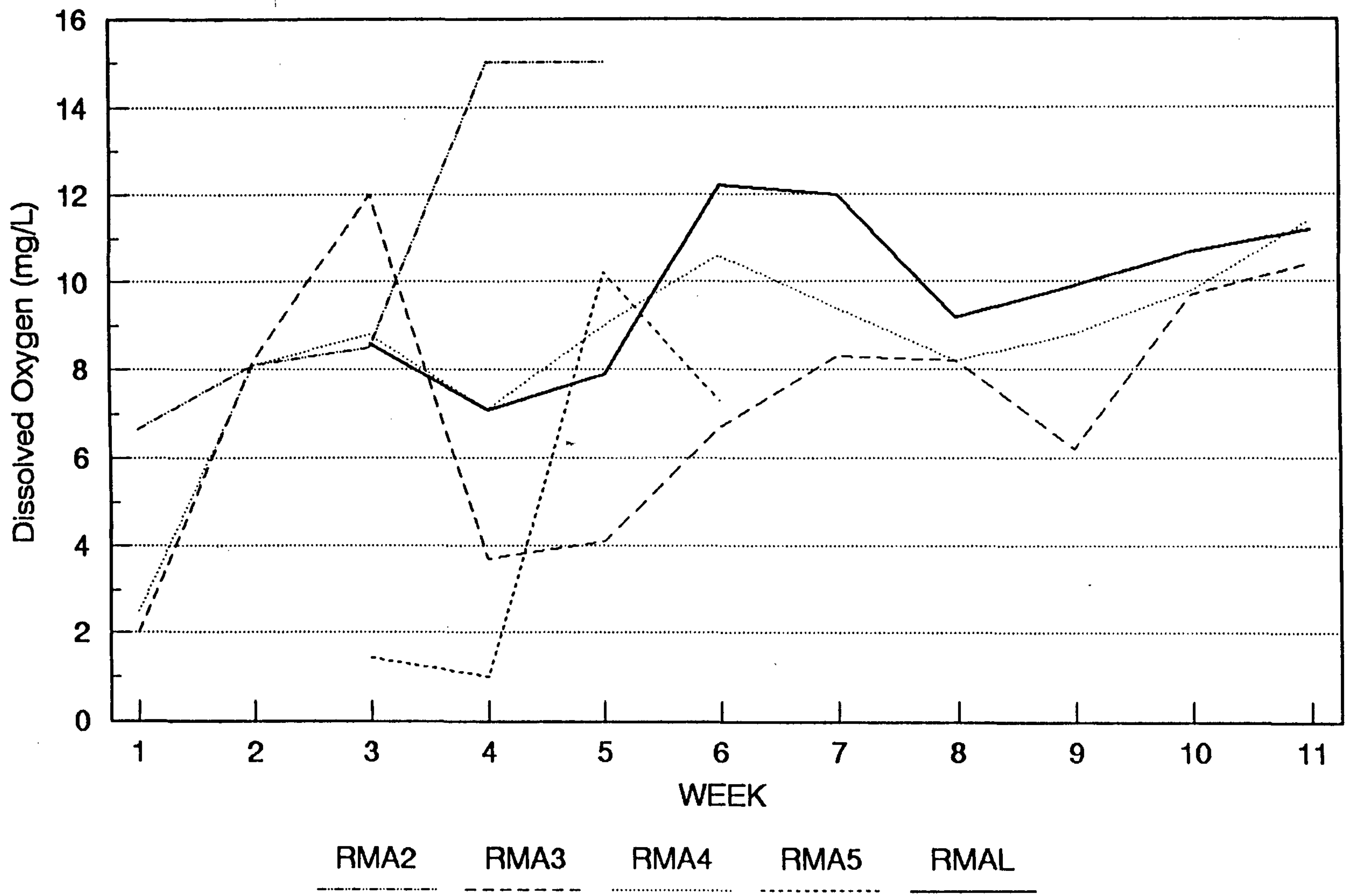
ROCKY MOUNTAIN ARSENAL-WETLANDS

Total Depth (M) 9-5-91 through 10-3-91



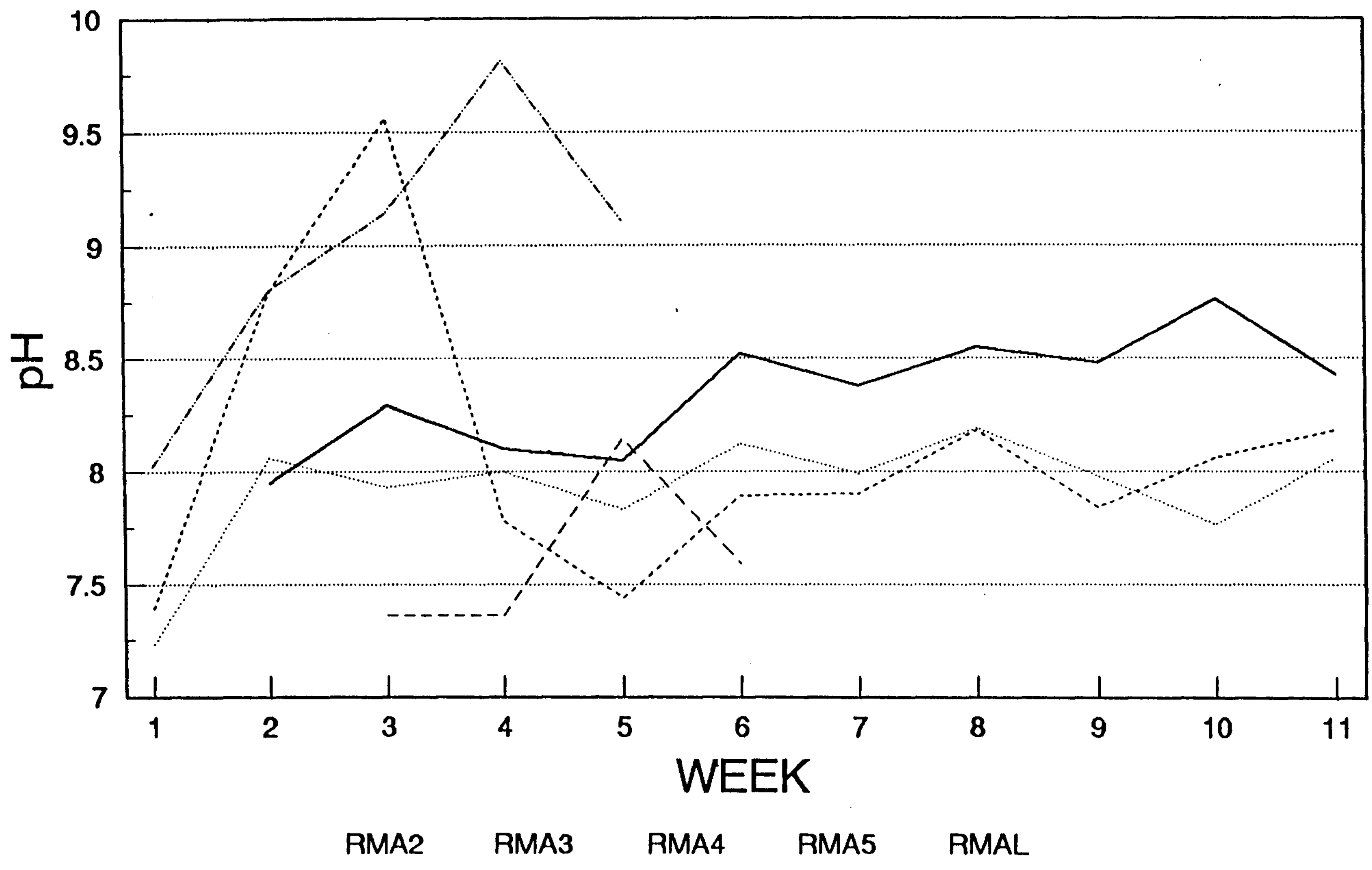
ROCKY MOUNTAIN ARSENAL-WETLANDS

Dissolved Oxygen 8-16-91 through 11-21-91



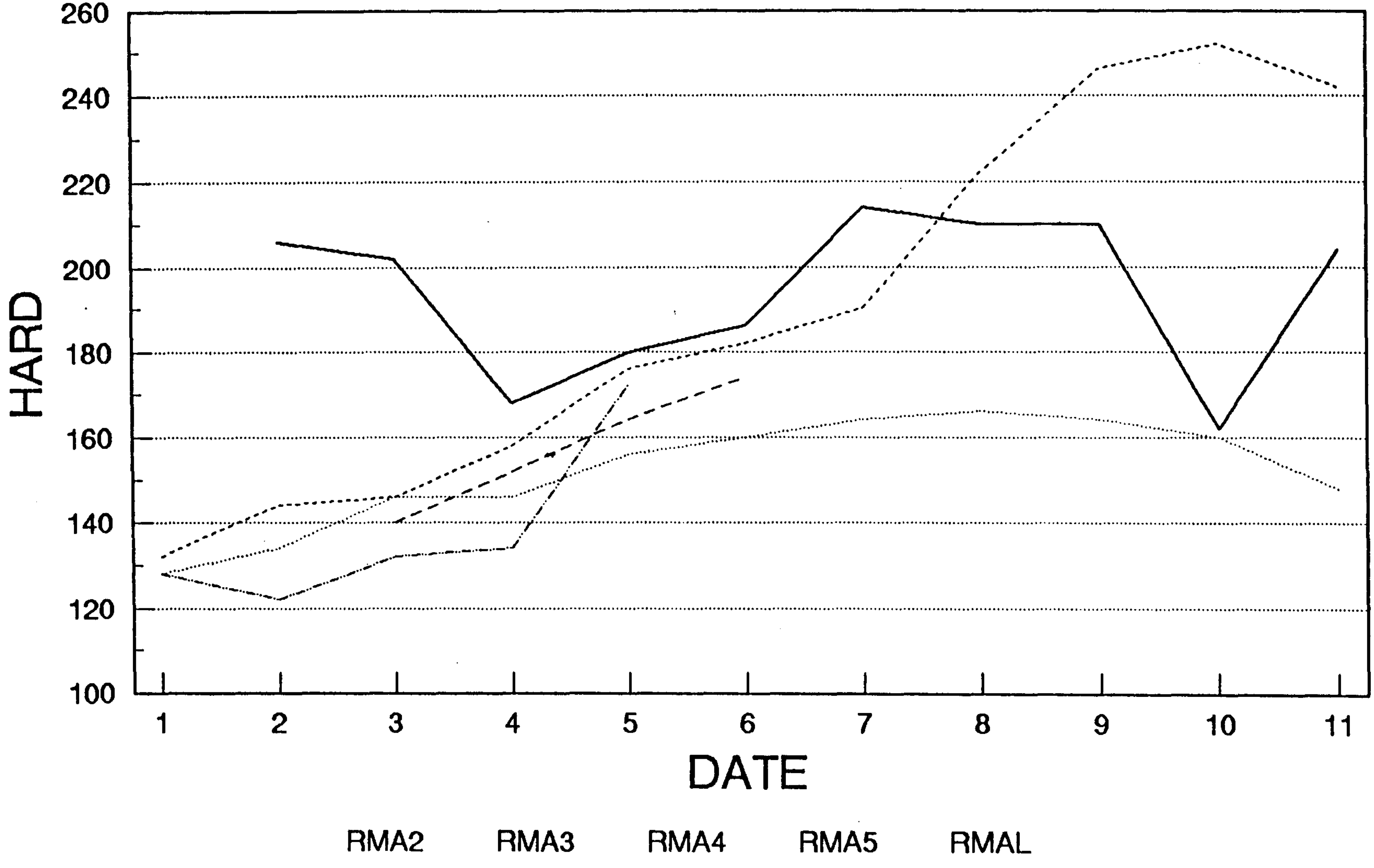
Rocky Mountain Arsenal-Wetlands

pH for 8-16-91 through 11-21-91



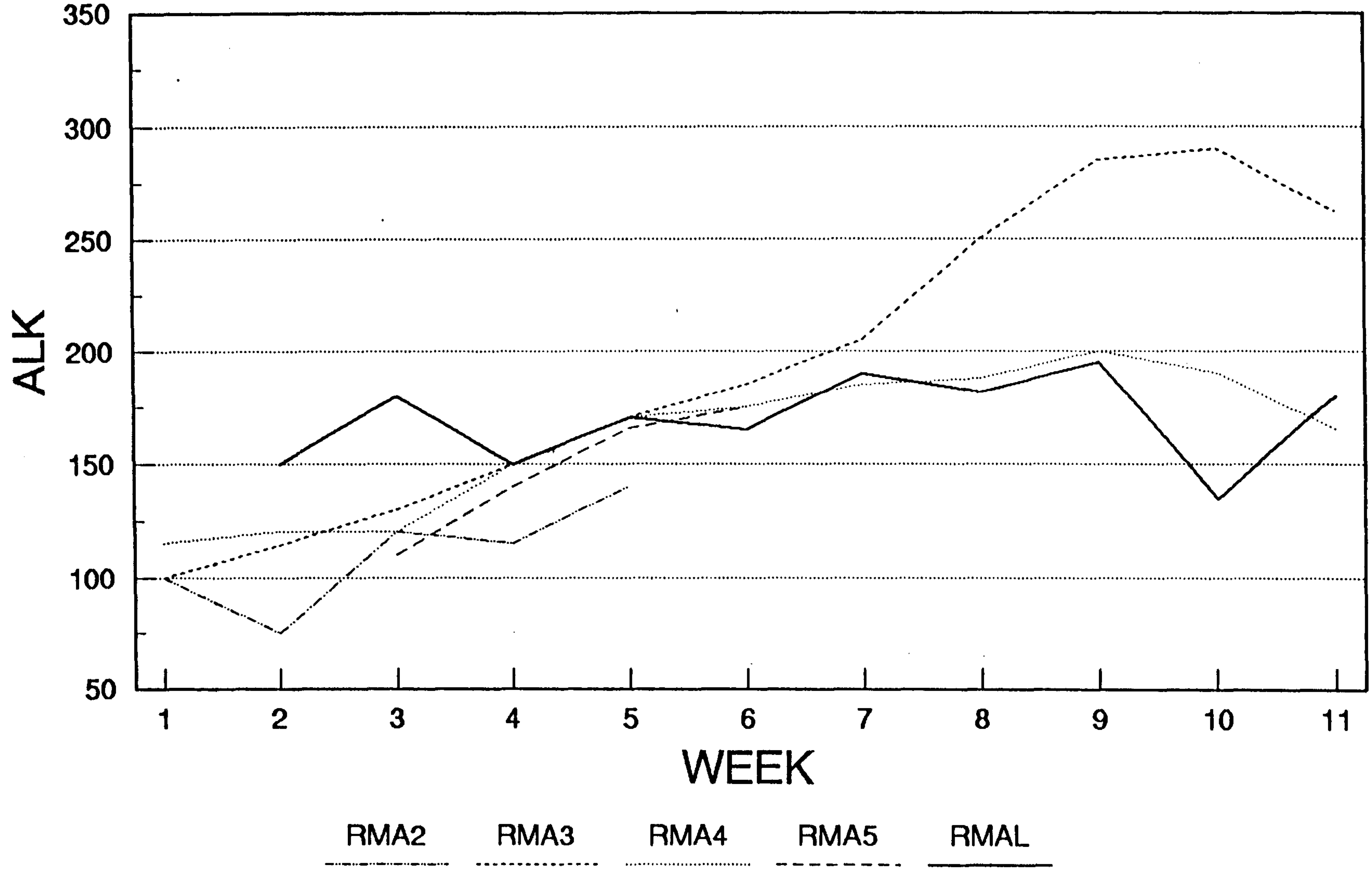
Rocky Mountain Arsenal-Wetlands

Hardness 8-16-91 through 11-21-91



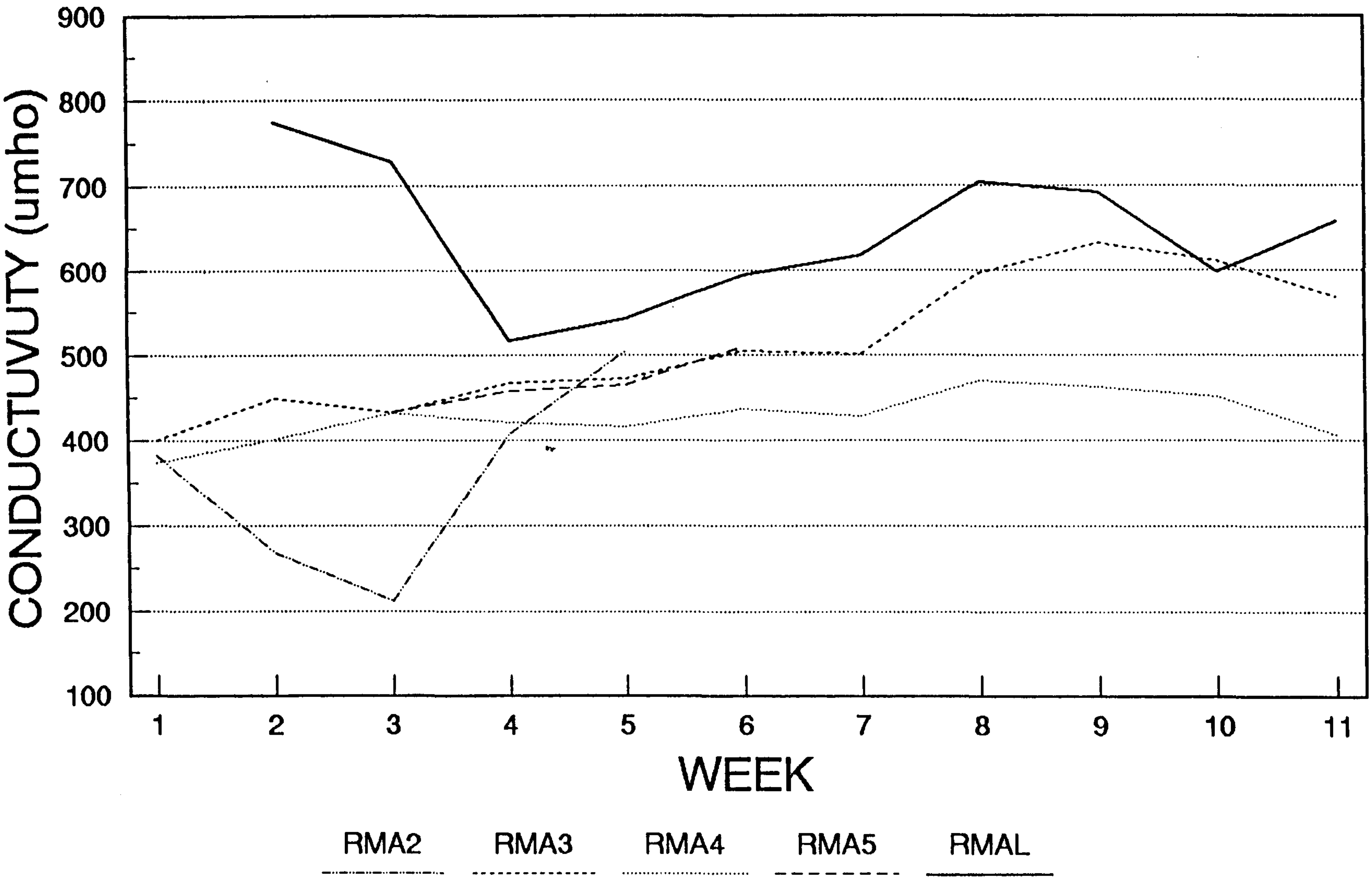
Rocky Mountain Arsenal-Wetlands

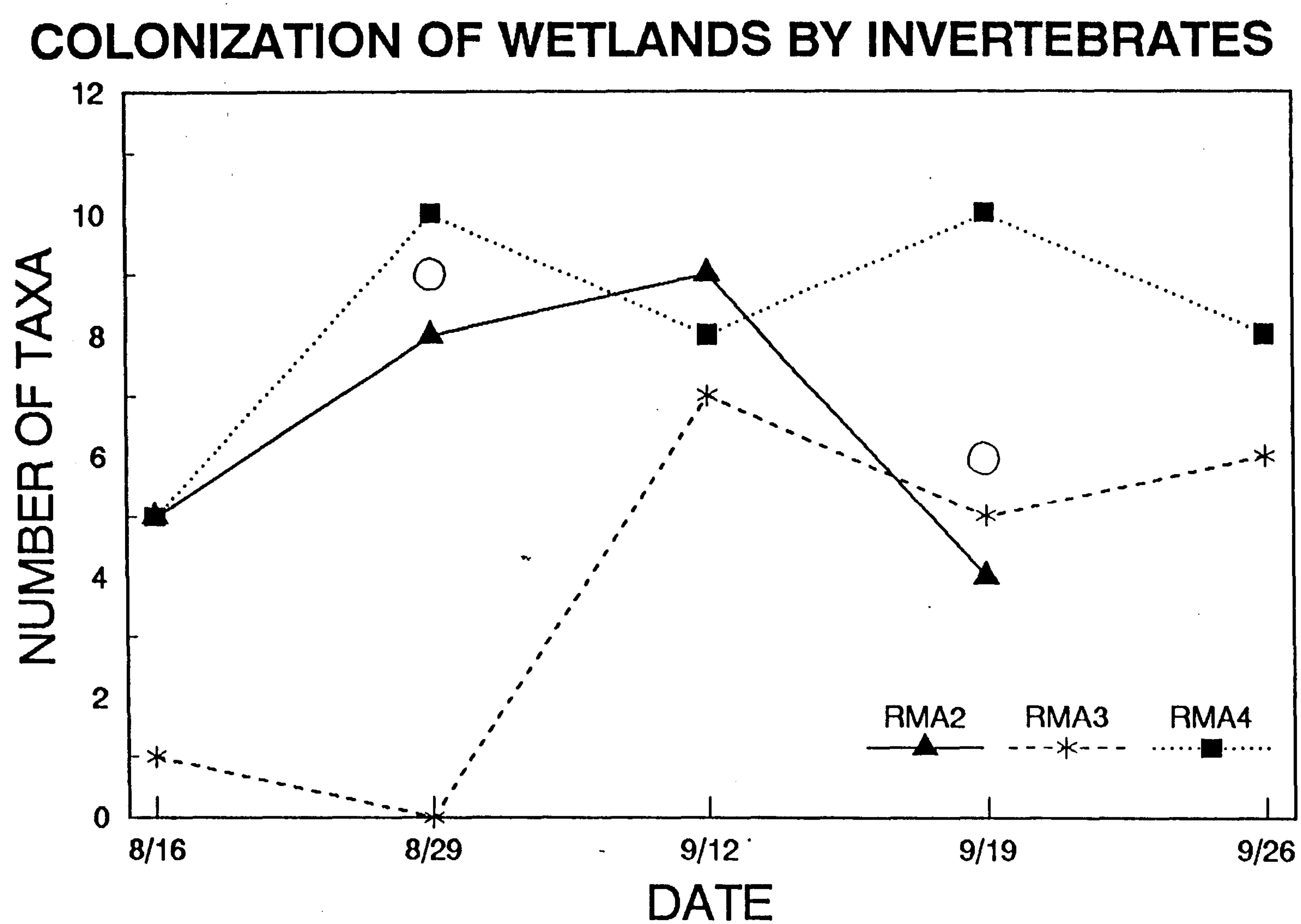
Alkalinity 8-16-91 through 11-21-91

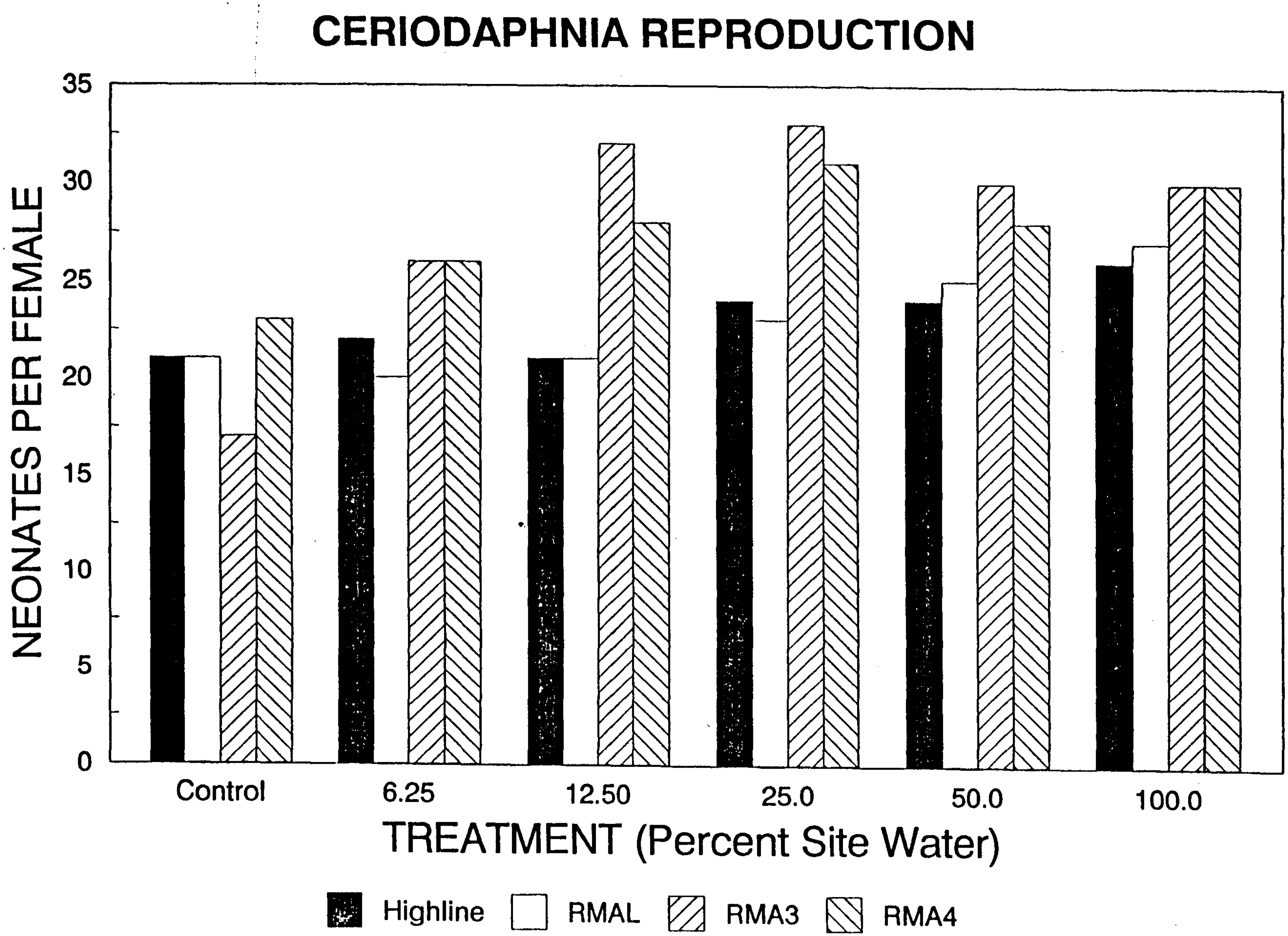


Rocky Mountain Arsenal-Wetlands

Conductivity 8-16-91 through 11-21-91




COLONIZATION OF WETLANDS BY INVERTEBRATES
NUMBER OF TAXA
0
2
4
6
8
10
12
DATE
8/16
8/29
9/12
9/19
9/26
RMA2
RMA3
RMA4



CERIODAPHNIA REPRODUCTION
NEONATES PER FEMALE
35
30
25
20
15
10
5
0
Control
6.25
12.50
25.0
50.0
100.0
TREATMENT (Percent Site Water)
Highline
RMAL
RMA3
RMA4

Assessing Fish Use of Structural Diversity at the Rocky Mountain Arsenal

ANNUAL REPORT

January 1991

Submitted by

Kevin B. Rogers
Eric P. Bergersen
Colorado Cooperative Fish and Wildlife Research Unit
Rm 201 Wagar Building
Colorado State University
Fort Collins, Colorado
80523

YEAR IN REVIEW:

Our two primary objectives for our research project at the Rocky Mountain Arsenal have been to develop instrumentation to measure structural diversity of the lake basins (echo integrator) and to determine how northern pike and largemouth bass associate with bottom complexity. Both arms of the study were actively pursued in 1991.

Measuring structural diversity quantitatively has proved to be more difficult than we initially anticipated, yet we continue to make progress. National Instruments' (Austin, TX) acquisition system LabVIEW was selected as the foundation for our echo integrator because of its relative user friendliness and extreme flexibility. We have successfully wired temperature, velocity and compass bearing sensors into this system, but continue to have problems incorporating our depth finder. Once we succeed in integrating all components of this mobile unit, the resulting maps of bottom contours will be subjected to seven structural diversity indices (Appendix A) that will allow for real time assessment of bottom complexity.

Although we have yet to quantitatively describe the habitat, we have monitored fish use of it since May. Twenty coded sonic transmitters were purchased from Sonotronics (Tucson, AZ) and implanted in ten northern pike and ten largemouth bass after the methods described by Hart and Summerfelt (1975). Descriptions of individual fish receiving tags are given in Table 1. Half of the pike and bass were released in Ladora, an impoundment with lush macrophytic growth and strong predator populations (Figure 1). The remainder were released in Lower Derby Lake, an extremely turbid reservoir with a large carp population and little structural diversity. Despite the invasiveness of the tagging procedure, we lost only one fish to surgical malpractice. Two additional fish have been lost due to transmitter failure or angler harvest over the course of the field season. Hooking mortality became a real concern among northern pike in Ladora during July and August when water temperatures exceeded 80 F but our tagged fish have survived the intense fishing pressure received by that lake.

ECHO INTEGRATOR:

This Macintosh based unit represents the foundation of our research project. It will ultimately be able to sense direction, velocity, and depth, synthesizing that information to develop maps of the lake topography with isopleths of structural diversity. Distance and bearing measurements will define any position on the lakes, with a corresponding depth being recorded at the same instant. Once complete, the system will not require trained personnel to run, and is fully mobile. The precision afforded by the electronic compass will allow the user to survey any body of water without the aid of aerial photographs or quality maps.

TRACKING:

Tagged fish were followed since May, with their locations being recorded in universal trans mercatur (UTM) coordinates for future analysis. Precise fixes were obtained from an aerial photograph with a UTM grid overlay. Although the bulk of the literature analyzes data recorded weekly we felt that a true assessment of time budget allocation could not be make without knowing the whereabouts of an individual fish over a 24 hour period. In addition to the traditional weekly tracks, we set out initially to monitor our fish bimonthly (within 60 hours of a full or new moon). Since variable light conditions do seem to effect fish behavior however, new moon tracks were discontinued. Each fish in both lakes was located six times (once every four hours) over the course of each intensive tracking session. Our preliminary data suggests some inconsistencies with the published literature. Largemouth bass in Lower Derby had rather large home ranges, and would frequently traverse the lake in a period of four hours (Figure 2,3). Some northern pike on the other hand, were extremely sedentary, with three individuals spending the entire summer in the arm of Ladora.

QUARTER HIGHLIGHTS:

Delays in completing the echo integrator have stemmed from our depth finders (Lowrance x-16) inherent incompatibility with computer acquisition. The analogs used to generate a graphic interface on the x-16 are not easily interpretable. Liquid crystal models might be better suited for our work and are being investigated. Some LCG models come with NMEA (National Marine Electronic Association) outputs designed specifically for data transfer. Although this is not compatible with the computer industries standard output (RS232), we should be able to integrate the two. An additional drawback of the NMEA output, is that it can only relay a signal every two seconds. If employed, this would necessitate traversing the lake at very slow speeds if submerged logs, pipes etc. are to be detected. Accuracy from our speedometer may also be jeopardized at these low velocities. On the brighter side, our electronic compass has arrived, and is already incorporated into the system. This KVH unit boasts half a degree accuracy and should therefore not be a limiting factor in the performance of our echo integrator.

We continued our 24 hour tracks through the fall quarter, but have had two restrictions placed on them. Both Ladora and Lower Derby are inside the Bald Eagle Management Area (BEMA) on the Arsenal, making them off limits to all activities over the winter months. Special permission has been granted, allowing us to resume tracking after dark. Our intensive tracks will therefore continue to bracket a 24 hour period but two out of the six fixes will be omitted. These restrictions will last until March when we can resume our normal operations. The second limitation on our tracking ability is more transient in nature. Ice cover on the lakes during our December track was too thick to break up with a boat, yet too thin to walk on. Fish locations had to be triangulated from shore.

Errors associated with triangulation make these fixes less accurate than those obtained from the boats.

FUTURE PLANS:

In the coming winter quarter, we intend to explore different avenues for incorporating bottom contours into our acquisition system. Investigation of other sources of sonar units other than the commercially available "fish finders" might prove fruitful. Tracking will continue through the ice, with thicker ice cover enabling us to enjoy the same precision that was realized by tracking from the boats. We will analyze the past years data to determine home range sizes, activity periods, and any other parameters that might prove to be relevant. Upon ice out, we will replace all tagged fish that have perished or otherwise been lost over the course of the study.

LADORA BASS:

Length (mm)	Weight (Kg)	PIT tag number	Captured	Method	tag ID
470	1.73	7F7D172D38	4/10/91	NET	284
476	1.59	7F7D172842	4/10/91	NET	626
415	1.25	7F7D13023D	5/01/91	LINE	365
380	0.94	7F7D1A2D33	5/01/91	LINE	374
450	1.25	7F7D1A4D2A	5/16/91	LINE	347

LOWER DERBY BASS:

Length (mm)	Weight (Kg)	PIT tag number	Captured	Method	tag ID
466	2.07	7F7D140C4A	4/24/91	NET	275
486	2.39	7F7D1A333A	5/16/91	SHOCK	96
456	1.82	7F7D1A4A1E	5/16/91	SHOCK	87
485	2.36	7F7D0D092F	5/16/91	SHOCK	2227
402	1.00	7F7D13345E	5/16/91	SHOCK	2236

LADORA PIKE:

Length (mm)	Weight (Kg)	PIT tag number	Captured	Method	tag ID
650	1.88	7F7D165D25	4/10/91	NET	338
800	2.96	7F7D141D34	4/10/91	NET	725
887	4.28	7F7D1A3358	4/10/91	NET	464
735	2.50	7F7D1A370A	4/10/91	NET	545
552	1.20	7F7D141D36	5/01/91	LINE	446

LOWER DERBY PIKE:

Length (mm)	Weight (Kg)	PIT tag number	Captured	Method	tag ID
660	1.54	7F7D143048	4/24/91	NET	356
630	1.56	7F7D161E79	4/24/91	NET	248
656	1.59	7F7D1A494F	4/24/91	NET	455
710	2.27	7F7D134B01	4/24/91	NET	383
800	3.38	7F7D1H4772	5/10/91	NET	293

Table 1: A variety of relevant parameters for northern pike and largemouth bass receiving coded sonic tags are given here. Fish still living at the end of the study will be recaptured to evaluate growth and other effects our initial capture and surgery might have had.

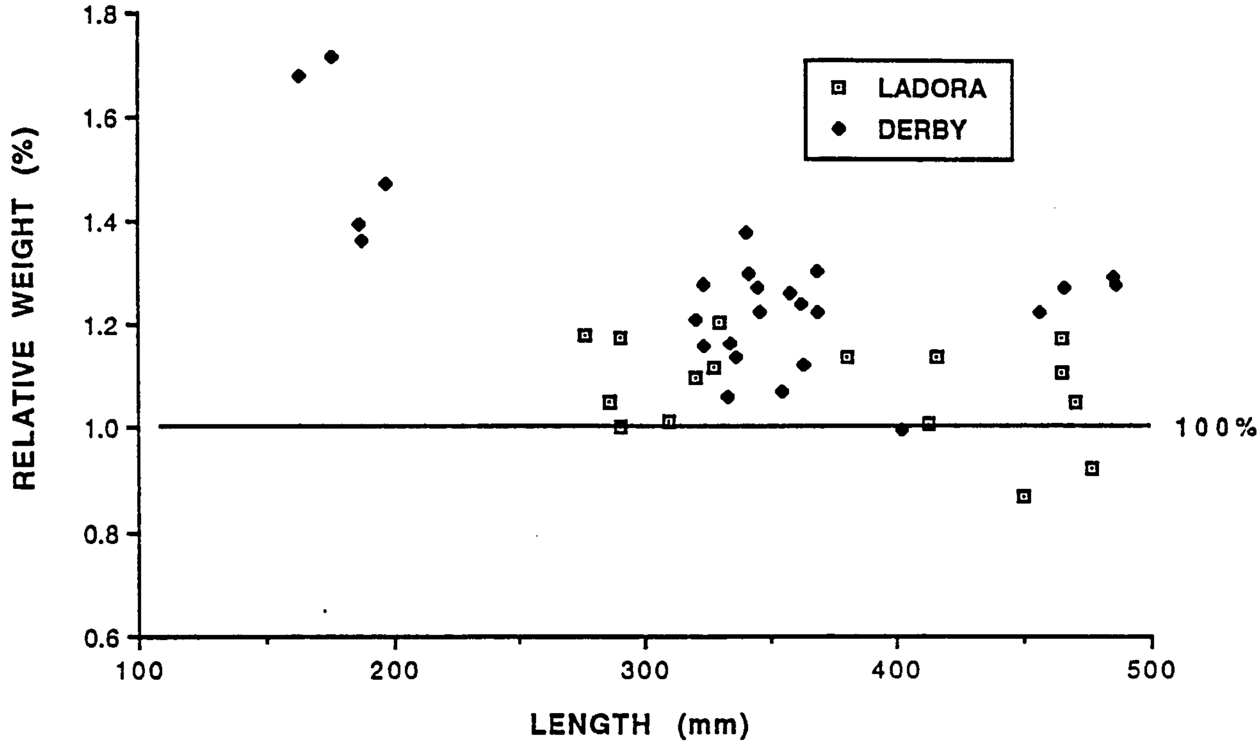


Figure 1: Relative weights for largemouth bass in Ladora and Lower Derby are given here. Relative weights (Wr) between 90-110% would be indicative of a strong predator population that is using its prey resource efficiently (typical of Ladora), while Wr greater than 110% would be more typical of underpopulated predators (Lower Derby). Angler catch rates reflect this same trend.

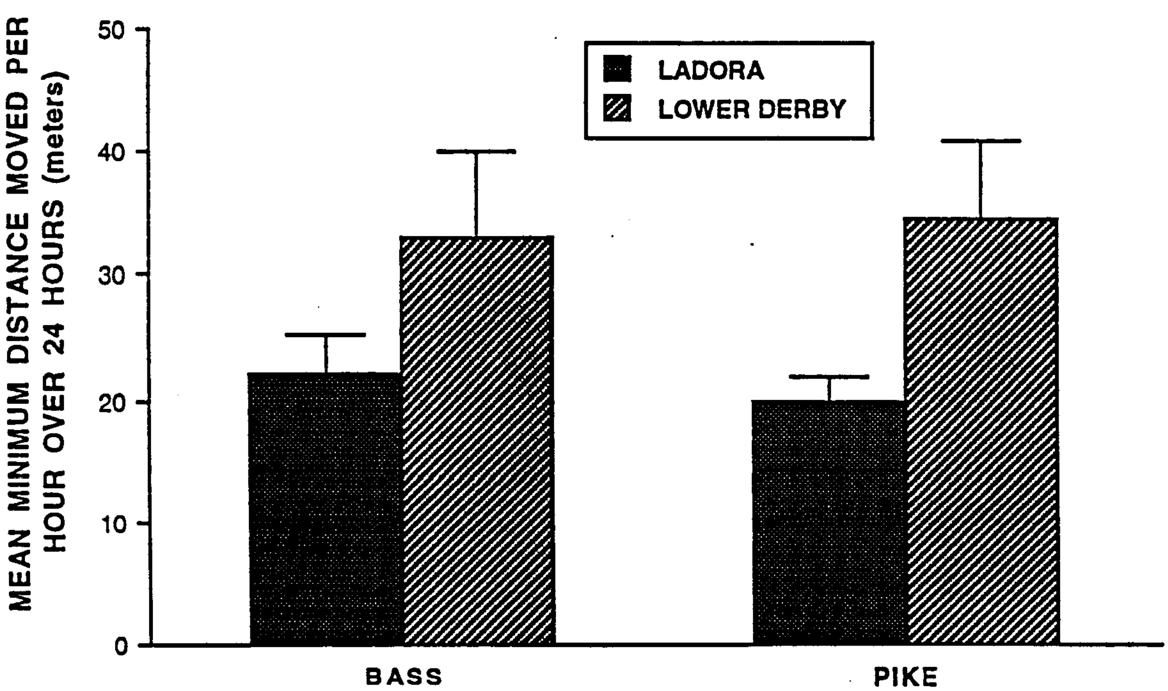


Figure 2: The mean minimum distance moved per hour over a 24 hour period for bass and pike in both lakes is given here with their standard errors. Only data for three full moon tracks (June, July, and August) are shown. As mentioned in the text, largemouth bass in Lower Derby were more active than the literature would suggest, while the pike in Ladora were more sedentary.

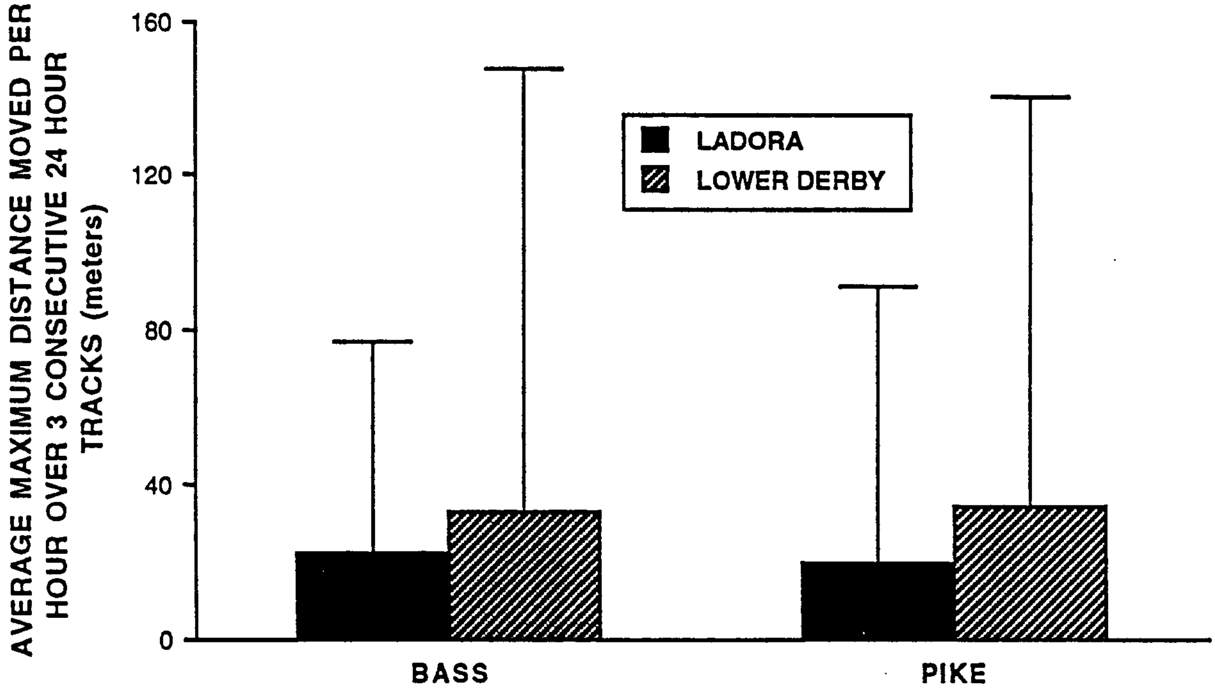


Figure 3: The average maximum distance moved per hour over three 24 hour periods for bass and pike in both lakes are given here. Only data for full moon tracks (June, July, and August) are shown. The average maximum distance was calculated by averaging the greatest distance traveled by each bass and is indicated by the lines. The bars represent the mean minimum distance moved, given in Figure 2.

APPENDIX A

I. Sinuosity:

Although perhaps the most straightforward index considered, this one reflects differences in structural diversity fairly well. This index is derived by taking the outline of the lake bottom contours from a given transect, divided by the surface distance traversed. A smooth lake bottom would yield an index value close to one while a complex bottom would display much higher values.

II. Shannon Index of Diversity:

This index, D=-Pi log e Pi where Pi=n/N (commonly used to evaluate species diversity), can be adapted to suit our needs as well. The range of depths across a transect are divided up into individual "species". A variable bottom will display a greater number of species, indicating a bottom rich in structural diversity.

III. Coefficient of Variation:

A coefficient of variation (CV=SD/mean) would be calculated for a series of points across a transect or over a three dimensional map of the lake in question. A high coefficient would imply increased structural diversity.

IV. Linear Regression Analysis:

The computer will take the incoming signals designating bottom structure over a given transect and fit a straight line to them. If the lake bottom is flat, the computed line will match that produced by the Lowrance x-16 yielding an R^2=1. As bottom structure becomes more complex, the straight line generated by the computer will appear less like the actual bottom contours measured by sonar. As a result, R will approach 0 with increasing complexity, providing the bottom is not horizontal.

V: Polynomial Fit Analysis:

In this analysis, the computer would fit an n^{th} order polynomial equation to points generated by the Lowrance x-16 such that complexity = $a+bx+cx^2+...+kx^{n-1}$. Simple lake bottoms could have their contours fitted to a first or second order polynomial while more complex bottoms would require larger orders to describe them adequately. By assessing the impact of each term, we can evaluate how complex the substrate really is.

A word of caution: High order polynomial fits tend to be over oscillatory and are therefore not accurate. Increasing sample size or using a spline fit equation (least bending moment solution) are both ways of circumventing this problem.

VI: Fourier Transforms:

Perhaps the most powerful means of describing bottom contour would be to utilize Fourier transforms, where $f(x)= \ A_i \sin w_i t$ or $F(w)= \int f(t)e^{iwt}dt$. Basically, different frequencies of sin waves are added to come up with a function that mimics bottom structure precisely. In doing so, we can generate a plot of sin wave frequency vs. amplitude. We would expect intermediate frequencies to be representative of structures most hospitable to fish. Low frequencies would be indicative of flat lake bottoms while high frequencies are a result of contours too narrow to be appreciated by fish. Once an optimum frequency from the fishes viewpoint is found, a reverse transform can be performed to yield the exact contours of the "ideal" lake. This information could prove to be invaluable in the construction of reservoirs that are intended to double as recreational fisheries.

VII. Theory of Runs:

As was the case with the Shannon diversity index, different depth increments would replace invertebrate taxa for this index. If a depth reading fell in the same range as the one acquired previously, then it would be part of the same run. If not, then it would be the beginning of a new run. The more runs you have in a given transect, the more diverse the bottom will have been.

APPENDIX F

DOCUMENTATION AND INTERPRETATION OF SELECTED WILDLIFE HABITAT RELATIONSHIPS AT ROCKY MOUNTAIN ARSENAL

TASK FIVE: VIDEO DOCUMENTATION

BY

David Baysinger

Elizabeth Gilmore

Department of Audio-Video

and

Dr. Charles R. Preston

Department of Zoology

Denver Museum of Natural History

City Park, Denver, Colorado

1991 Annual Progress Report

31 December 1991

INTRODUCTION

The following pages provide a log of all video footage shot during 1991 (approximately 2 hours of footage). Highlights include OSHA training, facility overview, general wildlife, change of command ceremony, small bird surveys, and lagomorph surveys.

PLANS FOR 1992

Videographers will focus more on Museum raptor and rodent studies and events such as "Eagle Day" in 1992. Also, the scope will be expanded to include more footage of non-museum researchers at work. Early in 1992, videographers and project director Preston will meet with Service and Army personnel to schedule video shoots of major events/activities anticipated through 1992. A draft script will be developed during 1992, and editing for specific video products will begin.

TAPE 91-12

START: ROCKY MOUNTAIN ARSENAL (AA#1) APRIL 22, 1991
WILDLIFE STUDY PHOTOGRAPHER: D. BAYSINGER

:00	HAZMAT training in Arvada with DMNH people and others in class. Tyvek suits, SCBA equipment
1:03	CU valve and student putting on gloves
1:31	Outside in the snow with people suited up and mudding
1:48	Best shot of man with yellow tape walking to cordon area
2:15	Project manager working with students
2:32	Caron Meany and Betsy Webb dressed out
3:20	Student being fitted with mask
3;41	LS of student operation in the snow at URIE course
3:50	RMA north plants LS showing piping going into plant
4:11	Tilt up to "block house" building
4:39	CU tower at north plants
4:59	South plants at RMA through barbed wire
5:10	Bus used by USFWA to carry visitors around RMA
5:26	loading stations for railcars at north plants facility
5:35	South plants with telephoto with bus moving in front
5:55	Main gate at north plants
6:00	Reflection of hazard sign on gate in pool of water
6:10	Zoom to sign in reflection (good)
6:22	Pull back and tilt up to main gate
6:36	CU of sign the right way to read it
6:50	Padlock on main gate
7:00	Sign: Gas Mask Required
7:13	Walking shot to employee entrance at north plants
7:31	Left to right pan and walk into turnstyle at north plants
7:53	CU barbed wire at north plants
8:05	Stack through barbed wire and chain link fencing
8:11	LS view of north plants from 3/4 mile SE of facility
8:28	727 jet on takeoff over north plants
8:43	Toxic storage yard main gate and pan and zoom to holding area with barbed wire and overhead lights. RR crossing sign
9:19	Prairie Dog along sign. Sign: Danger incindary Dud area.
9:45	Northern Harrier hawk working toxic storage yard and moving across roadway in back of car toward prairie dog area
10:18	Hawk moving over dog area and flies off with north plants in background. (good shot showing both sides!)
10:40	Barbed fence at toxic storage year
10:50	Eagle area along first creek showing nesting trees
11:10	Eagle watch facility from distance
11:20	disturbed grassland in sec. 32 RMA with zooms and pans
12:02	View from parking lot of Eagle watch facility
12:22	Canada geese moving into small lake on sec. 8
12:46	Trees and roadway showing diverse terrain
13:06	Budding trees in bloom
13:16	Two Canada Geese

13:28	Deer along roadside watching camera
13:42	Watching while camera is unsteady (no tripod)
14:06	Lower Derby Lake with tilt to south plants
14:24	Koot takes a bath in Lower Derby Lake
14:30	Two canada Geese eating in shallows
14:49	LS Lower Derby Lake with south plants in background
15:00	Zoom to south plants
15:20	Koot dives and out of sight
15:37	South plants from 1/4 mile
15:49	Mitigation of some kind in section 1
16:10	Left to Right pan and zoom of south plant
16:25	CU buildings in section 1 with tanks, etc.
16:50	Tilt to water tower
17:00	Steam coming from building in south plants complex
17:20	Downtown Denver from section 3 near Stapleton runway
17:40	Plane departs
17:50	Tilt from barged wire up to downtown buildings and rack
18:16	Lone tree near airport runway
18:20	Jack rabbit
18:40	727 departure...(good holding of shot, good sound)
19:12	Jack rabbit with traffic along I-70 in distance
19:31	Pullback to show fence
19:43	Pullback to show downtown buildings with jack rabbit in front to show full environment
20:13	Rabbit runs right to left
20:24	Another 727 departure with better side shot...
20:48	Departure of same aircraft over tree
21:13	Jet disappears into the sun (dramatic shot)
21:29	Basin "A" shot with zoom south to south plants
21:45	Right to left pan of south plants across basin "A"
22:00	Pullback to show polluted area of the basin "A" area

TAPE 91-13

START: ROCKY MOUNTAIN ARSENAL--U.S. ARMY/U.S. FISH AND WILDLIFE SERVICE PROJECT (AA#2) DATE: April 25, 1991
PHOTOGRAPHER: D. BAYSINGER
PRINCIPAL ACTIVITY: STOCK SHOTS OF GENERAL AREAS

:00 Sign: U.S. Army -- Rocky Mountain Arsenal
:20 Headquarters at the arsenal (with and without filter)
:55 Basin "A" RMA right to left lpan with clouds
1:15 Workers in tyvek doing surveying in Basin "A"
1:44 Pullback to show all of Basin "A" (patchy sun)
2:05 South plants to the west along Basin "A" access
2:14 Tilt down to tower at south plants (mostly cloudy)
2:36 South plants MS
2:52 More south plants shots
3:12 Survey crew at Basin "A"
3:30 DECON yard across from south plants
3:50 Right to left pan of Basin "A" (long shot with nearly full telelphoto lens (patchy sun)

4:17 Holding tanks at Basin "F" then zoom to downtown Denver
4:54 Two airplanes landing over holding tanks at Basin "F"
5:08 Small liquid holding pond at Basin "F" complex with warning speakers and gas guns
5:20 CU speakers emitting noise
5:34 Sign: Warning hazardous waste storage facility
5:43 Gas gun at Basin "F" area
6:06 Pan right to left of holding pond with air gun going off
6:18 Sign: Restricted Area No admittance
6:32 LS of tanks and liquid holding pond.
6:40 Red-tailed hawk circling over north plants

7:41 More circling of red-tailed hawk

7:48 BEGINNING OF CHANGE OF COMMAND FROM COLONEL VOSS TO COLONEL BISHOP AT THE ROCKY MOUNTAIN ARSENAL MAY 14, 1991

7:53 Color guard coming out onto field

8:00 Colonel's Voss and Bishop with other Commanders at attention

8:37 Saluting flag

9:40 Group of 4 Commanders ... listiening to opening remarks

10:00 Colonel Bishop ... "the passing of responsibility" ... the group steps forward to exchange the flag of command and they do so ...

11:09 Voss facing his commanding officer General McGrath
11:31 Group under the tent

11:39 John Welles in the audience

11:57 U.S. Fish and Wildlife Service badge on shoulder of member ... Patty

12:17 Rocky Mountain Arsenal Flag and U.?S. Flag waving together

12:35 Colonel Voss's remarks
... My work here has enableled me to take part in the beginning and the middle and I must leave before we finiish or come to a conclusion. Always difficult. ... Work done here has been so successful during my tenure. ... Hard work and dedication of employees ... persistence can and does pay off in many ways. ... The multitude of Wildlife on this 27 sq. mile expanse of prairie is an integral part and parcel of the RMA. I've stated before that the work now taking part at the Arsenal is as importatn as any war timeactivity that ever occured here in the past. It took years to get to where we're at and likewise, it's going to take years to effectively clean up the arsenal. Our efforst are tied to one of the premier concerns of the world today ... that of environmental pollution and its clean up. Many eyes are watchingour work here ... significatn proportion ... affords us the opportunity to repair the owrld for future generations. That's iMportant. Lead by example. Send message regarding the aRmy's commitment a through and exceptional job regarding clean up. The U.S. Fish and Wildlife
Service is also a strong asset to the work here. KLnowledge and expertise pertaining to all aspecxts of teh arsenal which extends well beyond the plant and animkal components has proven invaluable in our efforts to effect measurable and permanent change. There is much still to be done. I feel prividged to have played a part in whether in a hands-on or a decision making capacity., My thoughts reflect back to when I first came to RMA.
I felt an emmense degree of trepidation of the enormous task
that lay ahead. ... replaced by anticipation and even excitment ...
Take pride in the fact that ... every sample ... will ultimatley pave the way for a cleaner environment. Much work completed head of schedule and some goals attained."

16:32 General McGrath listening.

16:41 Group listening

17:00 More speech from Voss ..."from the aspect of wildlife management" ... picture is of color gaurd and Denver skyline ... "the performance out here will establish an enviornment that is unique to Denver and the Nation and secure a thriving wildlife area that will draw visitors to Colorado as well as citizens of Denver andmneigboring communities. RMA has so much to offer. Scarce resources between the Army and U.S. Fish and Wildlife Service focuses on the conservation and management of fish and wildlife resources at the Arsenal. Wildlife in a secure area that protects and nourishes them is indeed unique. More that ever before citizens are involved with the Arsenal. Proved invaluable in terms of input. Mark Twain quote ...only half of it is here (Even if yoyu are o9n the right track)..."you will get run over if you just sit there." So in parting, I ask all of you to have perserverance and not stop until your work here is completed to the satisfaction of all. ... more ... had a part in doing thigs right, instead of doing the right thing."

18:49 Group again

18:55 Colonel Bishop .,.."Good morning. ...Honor ... look forward... RMA unique ... Envirnoment created by former generations lack of understanding of the impact of what at one time we thougt where acceptable disposal practices. Now ... RMA is committed to being a leader for future solutions... a challenge I willingly aaccept. ... change of command represents a commentment to continuity ... learn from mistake, build on success and insure a steady balanced course for the future. Tributes to soldiers and contempories and family.

THE END OF TAPE 90-13

TAPE 91-24

START: ROCKY MOUNTAIN ARSENAL--U.S. ARMY/U.S. FISH AND WILDLIFE SERVICE PROJECT (AA#3) DATE: June 6 & 19, 1991
PHOTOGRAPHER: D. BAYSINGER
PRINCIPAL ACTIVITY: STOCK SHOTS OF GENERAL AREAS cont. TRANSECT BIRD COUNT WITH BETSY WEBB... INTERVIEW ON SITE

START:

:00	Downtown from RMA in early morning light
:17	West guard gate with extreme telephoto along 6th
:40	Sign: "Sensitive wildlife area..keep out"
:50	Sunrise over north plants with lots of orange
1:06	Sunrise looking north with pan to the NW
1:22	Tree in same asrea
1:30	Stapleton tower across RMA grassland
1:39	South Plants from SE area with mountains in background...then MS of buildings from same location with mountains in background (some snow) (some smog)
2:05	Grassland with mountains and some buildings
2:12	Storage of drums with rust and in long piles (South Plants buildings and water tower in background)
2:27	Zoom to water tower with rusting drums foreground
2:40	First creek (nice morning quiet looking)
3:10	Pullback along First Creek
3:25	Payloader working along road and left to right pan of First Creek (pretty)
3:47	South plants from first creek
4:00	6th avenue west toward South Plants with dark mountains as background
4:10	Deer at long range with North Plants as background
4:27	LS North Plants with tree foreground
4:33	Rusting drums in long lines...right to left long pan!
4:58	Jet landing at stapleton with drums in foreground
5:00	Follow jet left to right pan
5:14	Prairie Dogs waiting for camera to move (nice color)
5:35	Prairie Dog on alert
5:44	Hydrazine plant before tear-down LS
5:57	same plant in MS with rusting sides
6:05	South Plants with pan and zoom to major tank at hydrazine complex. Good light!
6:22	Red and White water tower at South Plants with Mt. Evans in background... CU same and best shot with tanks and pipes in foreground.... mountain shows smog contrast with white of tower.
6:51	Plan of hydrazine complex showing piping and large tank.
7:06	Basin "F" site with scrapers working on initial ground prep for new incinerator. Zoom to turning earthmover
7:35	Zoom allows view of operator in Tyvek suit and white hat
7:42	Closer of scraper with pullback to show large white holding tanks and mountains in background...

7:57	Good shot of operator in white Tyvek material
8:19	Scraper with pullback to show 3 tanks
8:30	Scraper MS head-on showing dirt falling from sides as operator drives in front of tanks
9:06	LS of operation at Basin "F"
9:12	ELECTRONIC SNOW
9:15	Deer (white tail) roused from thicket and running away out of camera
9:30	Deer along road in cover and walking
9:53	In car moving show with side view mirror looking NW along road "C" and showing open grassland
10:26	Basin "A" and South Plants in morning light with filter. Looks pretty with puffy clouds.
11:00	Zoom to barren area...then left to right pan of area.
11:29	Jet landing over basin "A"
11:50	Hydrazine plant from 1.5 miles
12:08	Zoom to equipment working in basin "A"
12:30	Rack focus with fence post
12:56	Long pan to South Plants
13:10	Deer departing along fence
13:21	Driving shot along basin "A"
	BLANK
13:36	June 19, 1991 Betsy Webb at RMA doing bird count
13:40	Webb explains bird counts and aircraft effect. Most audio is usable here
14:10	First audio is not good....here, except where covered by aircraft noise...it's ok
14:43	Explains about jet noise
15:03	Q: What is a transect?
15:05	Webb: "This is a bird count transect. And its 300 meters long and its 200 meters wide...and it's set up in 20 meter bands. This is the starter stake here which has the blue and yellow flagging on it. And then you'll see up over the rise shorter stakes which have paint on them. They are set up in a straight line right up and down that 30 meter center line. And what I do is walk along and I stop at each stake or band and I spend a certain amount of time counting all the birds that I see or hear in that band. And once I feel comfortable that I've gotten everything that I can, then I move on the next band. That usually takes about a minute or so at each band... (jet noise drowns her out!!!)
16:13	A count is different than a census. If I were censusing birds, I wouldn't have such a large area. I census means an absolute count of all the birds that are here. And you have to move along and sweep forward and flush them all. And you want to make sure that you get every one in a unit area. A count is different than a census in that it's as good as you can do. It does not necessarily represent all the birds that are here. But it is a fairly good estimate.

16:43 And what we're doing is taking the abundances of birds and comparing them with different sites and with different vegetation types and throughout seasons and years and whatnot...and that's called relative abundances. If we were doing censuses, we'd be taking densities of birds the absolute number of birds in a given area. So this is a little bit looser of a method and it give you a pretty good estimate of what's where and the differences between and among vegetation types."

17:25 END OF INTERVIEW ON SITE

17:30 Cut aways of wheat grass showing areas of field and CU of heads. Tilt down (with tripod noise)
18:22 Betsy MS in field with binoculars raised and Meadow Lark in background sound
18:50 CU stake
19:01 Pullback from downtown Denver to starter stake
19:15 757 jetliner taking off overhead against "grey" sky
19:45 LS of Webb in field of wheat grass doing count
19:50 Loud!!! jet noise as video tilts down to 20m stake

19:53 Grassland with pan to Webb doing count
20:10 Drive-by of Army crane headed for basin "F".

20:32 Webb: "The status sheet has the same number of bands that I walk along the center line here. So I mark down what I've seen or heard, whether or not it was a male singing. If it was a male singing, then I know there is a pair in the vicinity. So I can actually multiply that male singing by two because I know there would be two individuals here. And I note the location ... the range off to each side and then also of course what species it is. And I've got a three letter key for all the different species to expect here. Then if I have any comments, I have a little column there. For example if I find a nest, or if I find some interesting behavior, that I want to note, like flight songs of a particular species, I've got a little space to write down those notations. And then when I'm done with each transect, I tally up how many birds I've seen....(jet noise loud)

21:26 Webb walks off to do another band count...
21:45 Stake with DMNH on the side
21:50 Webb watches and listens for more birds along the transect center line.

END OF TAPE 91-24

TAPE 91-25

START: ROCKY MOUNTAIN ARSENAL--U.S. ARMY/U.S. FISH AND WILDLIFE SERVICE PROJECT (AA #4) DATE: June 25,26, 1991
PHOTOGRAPHER: D. BAYSINGER
PRINCIPAL ACTIVITY: MAMMAL POPULATION STUDY ... BUNNY COUNTING WITH CARRON MEANEY ... WITH DOGS AND PEOPLE AS FLUSHERS 6/26/91

00 Carron lining everybody up to tell them what they are doing. O.K. what we are going to be doing today is we are walking 3 different 3 mile long transects. Transects are 200 meters wide. which means we'll each be walking 28 meters apart on the average. There will be 8 of us. Now turn to your illustration ... 8 different people walking the main line. There will be 2 people further in front those are the squares on your illustration. Those are in front ... on the sides those are called the lead points ... the 2 people straight back that I have also drawn in as squares ... I call them side points. The 8 round dots are flushers. Each person that took those jobs has a slightly different function.

1:11 The average distance between us will be 28 meters, but that will vary some .. talk about that later. The 6 flushers ... those people will have the dogs. The lead points will be John and Barry. They will have compasses and binoculars to set a course. Barry has come along and developed these transects and put allot of stakes in 'cause a mile is quite a distance ... so the lead points will set that for us so the rest of us just keep an eye on them. The lead points will also count any bunnies that cross over the side edge lines in front of them. When they get to the end ... the top end line they will stop and as bunnies are flushed over the top end line they';I'll count them going into the middle.

2:19 Then the side points count bunnies that are off of the side of the grid behind the lead point and in front of the side point0int. For side points let's go ahead and have ... I'll be one side point and huh, ... O.K. I'll assign you as a side.

2:50 Shot of one of the dogs as Carron says ... "Make use of the dogs. You're not going to walk a perfectly straight line. shot goes up to people listening ... Carron says, 'You'll want to develop a mental picture of what 28 meters is so you deviate from it", ... shot of Carron ... "our object ... this is a census not a sample. Our object is to count every bunny that's there e and that's why the dogs are going to be useful. If your dog is encouraging you to go sideways a bit, take advantage of it because there very well may be a rabbit there to be flushed.

But, keeping in mind that you don't want to bias it by having all the dogs clumped in one area. There's a little bit of judgment there. 28 meters is a guideline from which you're welcome to deviate to make sure we find all of the bunnies.

3:52 In regard to the flushers, the two lead points and the two side points will have clip boards and data sheets, the flushers won't, they'll have they're hands full with the dogs.

4:03 John Boone and two dogs ... Carron is saying ... "To their right ...

4:15 L/S of Carron and group from pavement level.

4:27 C/U of Carron's hand pointing our section on map ... "Down to the next section line, and these illustrations are meant to portray 200 meters wide by 1 mile long. hen down to 2 in bottom left. ?With #1 we're going to drop some cars off at the west edge, drive to the east edge, compact ourselves into three cars, do our walk, get back into the cars, go back and pick up cars.
Camera moves out so you can see the back of Carron's head.

5:06 Md/S of Carron from the rear ... more group and dogs ... pan left to find more group.

5:19 Dogs and people filing across the grassland to begin 1st walk. Ron is in place as left point man. Md/S

5:27 L/S of group getting into place ... clouds in the sky.

5:36 Low shot and pan of people getting in place.

5:47 Carron hustling to get ;into place as right point man.

6:02 L/S of grassland ... tower in back ... clouds in sky pan right to find line of flushers.

6:20 John Boone walking toward camera as point ... can hear grass crunch ... he walks by

6:33 Grass again with L/S of flushers moving through grass ... zoom in to see flushers better

6:56 Rack focus of Carmine (?) and her dog ... Can see older man come into picture with "Zack" (dog) and mover through picture plane ... he has to turn around to keep from getting tangled with his dog's leash.

7:36 L/S of grass ... older man in front to other flushers ... big concrete bldg. in background ... more people and dogs between ... can see them working their dogs.

8:05 Closer shot of walkers ... more RMA stuff in the background.

8:19 Carron on right hand point walking ... pull back to see more flushers across the horizon line ...

8:38 Older man and his "flushing" dog ...

858 Another shot of a woman flusher and dog ... can see some RMA bldgs in background and then some houses across Quebec Street (?)

9:10 Carmine and dog .. Dave follows them through the Yucca ... first on the right and then on the right.

9:35 Following at a lower angle ... right behind the dog ... stays with the dog as much as possible ... see him sniffing and looking ... DAve nearly trips ...

10:13 Getting to the road. Middle shot.

10:18 Older man crossing a Yucca patch with his dog ... can see line of mountains in front of him.

10:34 More doggie shots ... <u>sound</u> <u>here</u> ... walking behind older man ... and dog ... more dog shots. ... can hear radio on Dave's belt ...more walking ... plane noise

11:23 L/S of walker and dog with sound ... zoom in a little closer ... wait for other woman and then back to Carmine. Dog sniffing in the Yucca

11:54 Silhouette of walker on horizon with dog. ...Pan left to other silhouette of walker further away. Jet sounds and meadowlark in background ...

12:40 Walker on horizon ... mid shot ... more meadowlark and plane noise

12:54 C/A of plane with cloudy sky behind. and meadowlark again

13:08 Walker and dog Mid shot ... This is Sam Rob's dog

13:25 Older man with Tower behind on the left ... pan left ... Jitter starts here. Another walker Carmine coming toward the camera ... Lots of jitter ... (Tracking or skew)

14:35 Another plane shot. More Jitter .. pull back to see horizon

15:24 Walker and dog ... right beside them. Zoom into dog as he pulls and works No jitter here

15:38 Carron walking and looking ...has binoculars on catches up to Barry and they walk to the trucks and cars ... Some people have the bright pink marker flags .. Group discussion at cars.

16:16 Carron walking toward the camera ... shouting, "Go slowly". She walks past camera. ... camera pans over to see people with dogs going through Mullen patch .

17:10 Carron says .... off camera ..."you're beating the bushes with your stick?" Can see horizon and other people far away ... gives and idea of how big 28 meters can be.

17:43 Shot of walker through dried Mullen stalks and thistle ... shows what hard walking some of this can be. Pan and lead walker ... pull back to see other walkers through Mullen ... pull back and they are almost gone from sight. ... just a little movement gives them away ...

18:51 Older man through Mullen and thistle, working his dog.

19:26 Horizon out to the east where new airport is being built. Pan right ...

19:49 L/S of heavy construction machinery on horizon ... can see traffic between camera and machinery ...

20:00 More heavy equipment and buildings that look like silos. Pan right ... stop at oil rig pumping.

END OF TAPE 91-25

START:	ARSENAL #7 NIGHT TIME BUNNIE HUNT 8/8/91
:00	Shot at the rear view mirror reflecting light ... pan out to see light scanning the grass ... moving along in a pick up truck
	Barry Bennett and Robert De Baca ... hear radio in truck
1:23	View out the front of the truck.
2:20	Over the top of the truck ... goes to black occasionally
2:51	Robert driving and looking ... pan to light
3:10	Over hood to light on the ruts (road) ... hand held light
4:40	Dave's question to Barry... "Barry, why are you doing this?" "Trying to find out where the rabbits eat at night. What habitat they are using for food." Q. So when you find a rabbit what do you do? "Take a flag and put it out and mark the spot we saw the rabbit at. The come back in the daytime and measure the vegetation and round it out."
4:46	More bouncing in the truck
4:50	Bunny running in the light.
5:04	Light again ... Barry junping out to place flag.
5:32	Back in the truck ... Robert on top with light
	Can see lights of Commerce City (?) on the horizon
6:00	More stuff from the top of the truck ... light scanning the ground
8:13	Light off the side of th truck
8:30	C/U of light ... halo around light appears purple
9:04	Pics of Robert on top of the truck with light
9:26	Pics of Barry with light from inside or on top of the truck (hard to tell).
10:00	Truck leaves David behind ... shots of truck going and coming ... headlights are star filtered
11:40	END OF TAPE 91-47B

START:	ARSENAL #8	VEGETATION SURVEYS 8/12/91 RODENT TRAPPING 10-17-91

:00	N.E. corner of Rocky Mountain Arsenal with Barry Bennett and Steven Kaye as they use cord and knots to survey vegetation in bunnie habitats.
:22	Kaye is followed by camera while placing cord in transect
:50	Barry "reading" sample under the knot and standing up to write plant types on clipboard.
1:05	Writing and writing on clipboard
1:35	Walking down knot line with Kaye
1:40	End of walk shot. Vege types can easily be seen!
1:48	Placing of knot line by Barry then workingclosely with Ron as he writes "upsidedown" on board
1:54	Interview in field with Rob DeBaca. Explains what they are doing there.
3:35	Silouette 2-shot of guys standing with the pole and clipboard and raising knot line...and moving
3:47	Ground level shot of plants with Kaye working in background. Sky is grey and light breeze is blowing
4:00	3-shot from ground level. Kaye walks r to l with pole...then Barry leaves
4:14	Ground shot along line with 2-shot workers
4:40	ECU ground shot of knot line and tag #15 with plants in front then pullback
4:53	Clipboard with Rob studying it...looking and writingon board
5:12	2-shot of bending over line and identifying plants
5:50	Interview: Barry Bennett. Tells of process adn relates today's work with bunny counts in various areas. Explains a few types of habitats. Hand held camera, but fairly steady.
7:13	Prairie Dog at top of burrow...then at ground level
7:38	Long shot of 3 guys working towasrd the road with fence behind.
8:06	Ground level 3-shot of identification process.
8:28	More of same along road
8:35	Walking shots along line....usable!
9:06	Barry and Steve working the line
10:05	3-shot then following truck on road outside arsenal showing the proximity of "real" world.
10:20	End of vegetation sequence...
10:25	Video Snow
10:30	USFWS staff meeting
10:31	Larry Malone heading meeting showing full staff
10:55	Low shot of Malone
11:04	Greg Langer and pullback to show end of table
11:19	Barry Bennett at meeting

10:30	Malone listening...LS of staff
11:45	Denver Museum Zoology staff in arsenal meeting
11:48	Charles Preston officiating
12:00	Attending with pictures. Ron Beane, John Boone, Carron Meaney, Betsy Webb, Mike Smith, Rob Debaca, Marianne
12:45	Beane explains his plans for fall and winter work. Group is estimating their needs for work hours over various projects.
13:15	Cut away of Dr. Preston
13:25	CU Beane
13:40	Beane answers questions
13:57	LS with r to l pan of entire group
14:17	Laughter
14:43	Webb and Meaney cut-away
14:58	Preston with tilt down to Beane
15:12	Kaye and Meaney...zoom to Meaney writing
15:40	Marianne with over-the-shoulder shot of notes
15:49	Full group shot with people sitting on floor with note pads, etc.
16:00	Barry gets into picture with Kay, Webb and Meaney
16:33	Ground level shot up at Meaney...zoom to her as she talks to group. Good shot
17:10	More Meaney from other direction ...
17:33	END OF DMNH ZOOLOGY MEETING
17:35	RMA Sunrise through chainlink fence. Flashing light at south plants along power lines. Really pretty!!
18:03	Left to right pan across power lines to south plants
18:15	Rodent trapping 10/17/91
18:21	Harvest mouse on scale (kicking)
18:32	Pullback and brief interview with DeBaca
19:18	Walking up on Rozinski and Shatil as they set up their still photo "box"
19:41	Sky as sunrise approaches...tilt down to photo operation. Rob holds mouse... strobe lights are set.
20:41	LS of group at photo session... location is along Quebec Ave.
20:30	End of tape 91-58B

DOCUMENTATION AND INTERPRETATION OF SELECTED WILDLIFE HABITAT RELATIONSHIPS AT ROCKY MOUNTAIN ARSENAL

TASK SEVEN: EAGLES BOOK

BY

Betsy Armstrong

Publications Program

and

Dr. Charles R. Preston

Department of Zoology

Denver Museum of Natural History

City Park, Denver, Colorado

1991 Annual Progress Report

31 December 1991

PROGRESS IN 1991

The outline, and first and second drafts of the manuscript for <u>Eagles: Hunters of the Sky</u> was written by Ann C. Cooper, reviewed by U.S. Fish and Wildlife Service, U.S. Army, Shell, and the following staff of the Denver Museum of Natural History:

- *Dr. Charles Preston, Curator of Ornithology, Department of Zoology
- *Diana Lee Crew, Public Programs
- *Michelle Conger, Natural Sciences Educator, Education Division
- *Joyce Herold, Curator of Ethnography, Department of Anthropology
- *Karen Nein, editor/writer, Exhibits Division
- *Gail Kohler-Opsahl, book designer and illustrator, Exhibits Division
- *Betsy Armstrong, Publications Program Manager
- *Lucille Echo Hawk and Gene Poor Bear, Lakota Sioux Indians (outside consultants who reviewed the story for accuracy).

Additions and corrections have been made and the manuscript has been accepted by the agencies and individuals listed above.

Cover illustration and two activities were prepared for testing, which will begin in January 1992.

Gene Poor Bear and his son, Michael, came to the Museum to be photographed in both street clothes and in their Lakota Sioux pow-wow costumes, for use by the illustrator to create the drawings for the back cover and the story.

Museum staff gathered reference material for the activities, for illustration purposes and to work out the complexities of engineering (e.g. building a pop-up activity that shows the eagles' food chain, and creating an eagle's wing, showing the skeleton overlaid by the muscle structure, which is overlaid by the feathers and folds out of the book).

PLANS FOR 1992:

January-February 1992:
Test the activities with children and parents and/or teachers.
Prepare final manuscript for copyediting

March 1992:
Refinement of text and illustrations, final composition to camera-ready pages

April 1, 1992:
to printer for publication in May 1992

revised budget and task plan, as well as a mock-up of RMA Guide, as requested by Army. Developed activities and outline in more detail. Met with Army, Fish and Wildlife, and Shell Oil representatives to discuss content, marketing, and goals of Guide. Developed proposal with DMNH Audio-Visual Department for educational video program of Arsenal. Submitted revised budget and mock-up of RMA Guide to Army at the end of April.

July - September:

Suspended work on RMA Guide while waiting for Army approval of revised budget and mock-up. Budget and mock-up approved September 5, but we were unable to work on project in September due to prior work commitments of CK.

October - December:

Continued to develop activities, reading list, glossary, and resource list for RMA Guide, developed proposed new timeline for Guide (project was delayed for several months while waiting for approval of revised budget, timeline, and mock-up of Guide). Met with Fish and Wildlife representatives to discuss new developments in environmental education programs at Arsenal and how their needs can best be met. Attended Urban Design Forum conference focusing on future potential of Rocky Mountain Arsenal as a wildlife refuge.

PLANS FOR 1992-1993

The final printed version of the Guide is scheduled for April, 1993. In the original Task Plan, the printing was scheduled for December 1992. However, a 4 month delay in final approval of the

Task Plan by Army has caused a delay in the final deadline.

DOCUMENTATION AND INTERPRETATION OF SELECTED WILDLIFE HABITAT RELATIONSHIPS AT ROCKY MOUNTAIN ARSENAL

TASK TWO: SMALL BIRDS

By

Elizabeth A. Webb
Barry Bennett
Dr. Charles R. Preston

Department of Zoology
Denver Museum of Natural History
City Park, Denver, Colorado 80205

1991 Annual Progress Report

31 December 1991

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

Abstract: We studied small bird communities and vegetation characteristics in 7 representative grassland types at the Rocky Mountain Arsenal. Results yielded the presence of a diverse array of grassland bird species, most notably specialists associated with ungrazed sites with dense, tall grass cover or with high shrub canopy cover and density. Bird species of note on the Arsenal were Cassin's Sparrow (*Aimophila cassinii*), Brewer's Sparrow (*Spizella breweri*), Lark Bunting (*Calamospiza melanocorys*), Grasshopper Sparrow (*Ammodramus savannarum*), and Eastern Meadowlark (*Sturnella magna*), grassland specialists that are becoming rarer in this region as their habitat is altered or destroyed. This information will serve as a baseline for assessing the response of small birds to physical habitat disturbances in the upcoming years of the Museum project.

INTRODUCTION

The U. S. Army (Army), through a cooperative agreement with the U. S. Fish and Wildlife Service (Service), is committed to maintaining Rocky Mountain Arsenal's natural resources throughout the environmental cleanup process. In spring of 1990, the Denver Museum of Natural History signed a cooperative agreement with the Army, Service, and the National Fish and Wildlife Foundation to examine habitat ecology of selected bird and mammal populations. The specific objectives of the small bird task are to determine relative diversity and habitat use patterns of small birds in representative vegetation types and to quantify the response of small birds to physical habitat disturbance associated with contamination cleanup activities. Birds, because they are ubiquitous, mobile, and familiar, are widely recognized as a valuable barometer of environmental integrity (Bock and Webb 1984). They play a vital role in the distribution and development of native plant communities and are often used as indicators of ecosystem condition (Welsh 1987).

This report summarizes the field work conducted during the summer of 1991 on bird habitat use. We established 28 semi-permanent study sites in representative grassland types throughout the Arsenal that will be used in the multi-year project. At each site, we determined bird species composition and richness, as well as vegetation characteristics.

METHODS

Bird Transects

We selected 7 prominent grassland types to compare avian communities: 1) crested wheatgrass (CW) dominated in descending order by crested wheatgrass (Agropyron spp.), sand dropseed (Sporobolus cryptandrus), and cheatgrass (Bromus tectorum); 2) sand dropseed (SD) dominated by sand dropseed and cheatgrass; 3) native perennial grassland (SG) dominated by needle-and-thread

(*Stipa comata*), cheatgrass, sand dropseed, and blue grama (*Bouteloua gracilis*); 4) sand sagebrush (SS) dominated by needle-and-thread, cheatgrass, western ragweed (*Ambrosia psilostachya*), and sand sagebrush (*Artemesia filifolia*); 5) weedy forb with prairie dogs (PD) dominated by summer-cypress (*Kochia iranica*), red three-awn (*Aristida longiseta*), cheatgrass, and field bindweed (*Convolvulus arvensis*); 6) weedy forb without prairie dogs (WF) dominated by cheatgrass, musk thistle (*Carduus nutans* ssp. *macrolepis*), summer-cypress, field bindweed, and Canada thistle (*Cirsium arvense*); and 7) yucca grassland (YG) dominated by sand dropseed, red three-awn, cheatgrass, needle-and-thread, blue grama, and yucca (*Yucca glauca*). We located 4 transect sites (A-D) for each of the 7 grassland types at least 0.5 km apart (Figure 1). We conducted 3 counts at each of the 28 transects along a 300 x 200-m transect marked with color-flagged stakes. We walked along a center line and stopped at 20-m marked intervals to count birds by sight or sound. We recorded observations from June 24 to July 14, 1991, between 0530 to 0930 and 1900 to 2030 hours.

Vegetation Measures

We located 14 vegetation plots within each of the 28 bird transects using the Latin hypercube sampling method (McKay et al. 1979) to obtain random yet representative coverage across each transect. We measured plant cover, vegetation height, height diversity profile, and distance to nearest woody vegetation for each vegetation plot. We determined plant cover by using 40 randomly-placed points within a 10-m-radius circle around the center of each vegetation plot. Using a random number table, we located 10 points each along 4 perpendicularly-radiating strings tied with knots at 25-cm intervals; orientation of each set of strings was also random. At each knot we classified the vegetation as bare ground, litter, or by plant species. We measured vegetation height as the tallest plant in each of the 90-degree arcs of the 10-m-radius circle surrounding the center of each sample plot.

The height diversity profile is a measure of the physical plant community structure. It was measured by placing a 2.5-cm-diameter PVC pipe in 4 random locations at each plot. We recorded the number of plant parts that touched the pipe at 0-5, 5-10, 10-20, 20-30, 30-50, and >50-cm-height intervals. We measured the distance to woody vegetation by pacing off the distance to trees or shrubs from 4 randomly-placed points in each plot. Only plant species richness is examined in this report, pending further analysis (see `Plans for 1992' section).

Analysis of Avian Communities in Grassland Types

Total number of bird observations and species richness among 7 grassland types were compared using 1-way analysis of variance (ANOVA) with Duncan's multiple range *a posteriori* pairwise comparisons of means. We used a simple regression to compare bird species richness with vegetation species richness. The data were log-transformed for normalization and and 0.1 was added to all values to eliminate of zeros in the data matrix.

RESULTS

Results from the bird transect counts show that there were 36 species observed in the study sites (Table 1), with a mean of 18.50 individuals and a range of 4-66 per transect. Mourning Dove (Zenaida macroura), Western Kingbird (Tyrannus verticalis), Lark Bunting, Grasshopper Sparrow, and Western Meadowlark (Sturnella neglecta) were present in all vegetation types (Table 1). The vegetation type that supported the least number of individuals was weedy forb with prairie dogs (mean = 10.83 individuals); the vegetation type that supported the most was weedy forb without prairie dogs (mean = 33.25 individuals) (Table 2). Bird species richness was lowest in native perennial grassland (mean = 6.50 species) and highest in sand sagebrush (mean = 10.50 species) (Table 3).

Among the 7 vegetation types, we did not find any significant differences in the total number of birds observed ($F = 2.496$, $df = 6$, $P = 0.056$), but did in species richness ($F = 2.821$, $df = 6$, $P = 0.036$) (Figure 2). Two vegetation types (sand sagebrush and sand dropseed) had significantly more species than all other types; 2 vegetation types (native perennial grassland and crested wheatgrass) had significantly fewer species than all others (Figure 2). We also found a significant positive relationship (but with little variation accounted for) between bird species richness and plant species richness (Table 3, $\underline{F}$ = 13.603, $\underline{df}$ = 1, $\underline{P}$ = 0.001, $\underline{R}^2$ = 0.2).

DISCUSSION

Because of the exclusion of grazing, farming, and human activity at the Rocky Mountain Arsenal for the past 50 years, the Arsenal supports large and diverse populations of breeding birds in several grassland types. Even though these grasslands are in various states of disturbance and invasion by introduced plants, sites dominated by sand sagebrush, sand dropseed, weedy forb, and yucca grassland were particularly productive. Bird species of note are grassland specialists such as the Cassin's Sparrow, Brewer's Sparrow, Lark Bunting, Grasshopper Sparrow, and Eastern Meadowlark that, in Colorado, are mostly limited to ungrazed sites with dense, tall grass cover. In addition, the Cassin's and Brewer's Sparrows are strongly associated with areas of high shrub canopy cover and density. These species have declined across Colorado's Front Range due to habitat destruction and fragmentation, yet they are fairly common breeding birds on the Arsenal.

Lark Bunting, the second most numerous bird counted after Western Meadowlark, was very abundant in the weedy forb sites without prairie dogs. This bird actively perched on musk thistle which was fairly dense on all weedy forb sites. It is interesting to note that this species was absent altogether from site WF-C, a weedy forb site that is periodically inundated with stormwater overflow. Musk thistle appears to be an important wildlife plant on the weedy forb sites with good grass cover, yet on parts of the Arsenal it is being controlled; this policy may need reevaluation.

Although this report is the result of only one summer field season, it confirms the value of Arsenal grasslands for supporting diverse populations of breeding birds. We hope that the long-term analysis of avian communities and response of small birds to experimental disturbance will provide specific management-oriented information for evaluating the potential effects of cleanup and remediation activities at the Arsenal.

PLANS FOR 1992

A three-step process which is anticipated as part of the cleanup and remediation process at the Arsenal includes: 1) a weed control program to reduce the abundance of exotic, disturbance-adapted species such as musk thistle which is an important habitat component of several grassland bird species at the Arsenal, 2) deep plowing or discing to isolate contaminant residues beneath the soil surface, and 3) reseeding and other restoration practices on affected areas. The specific nature and extent of the manipulations we will perform to mimic this protocol are currently being formulated in conjunction with the USFWS and Arsenal contractors.

The 28 bird transects (4 transects in each of 7 vegetation types) each will be divided into 2 subplots; one subplot will remain as a control and the other will receive experimental manipulations. Birds will be counted on all subplots during the breeding and nonbreeding seasons, and vegetation sampled on all manipulated subplots during the summer season. Mist-netting and sound recording of meadowlarks will be required to verify species identification. Seasonal and yearly data on avian communities and vegetation structure within and between plots will be analyzed using statistical techniques outlined in the 1991 Small Bird Task Plan.

Further analysis of summer 1991 field data will include a comparison of bird species diversity among 7 grassland types using ANOVA, principal components analysis to compare the various vegetation plots with respect to avian community make-up, and canonical correlation analysis, if warranted, to compare all vegetation characteristics with all bird species present.

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Table 1. Bird species composition in seven vegetation types.

SPECIES	CW	SD	SG	SS	PD	WF	YG
Great Blue Heron		x					
Swainson's Hawk		x		x			x
Ferruginous Hawk							x
Northern Harrier				x			
American Kestrel		x	x	x		x	x
Ring-necked Pheasant	x			x			
Killdeer		x			x		
Upland Sandpiper	x						
Rock Dove	x						
Mourning Dove	x	x	x	x	x	x	x
Burrowing Owl					x		x
Western Kingbird	x	x	x	x	x	x	x
Eastern Kingbird		x			x	x	x
Horned Lark	x	x	x		x		
Tree Swallow				x			x
Black-billed Magpie		x		x	x	x	x
House Wren		x					
American Robin		x		x	x	x	
Northern Mockingbird		x					
European Starling		x		x	x		
Common Yellowthroat		x					
Cassin's Sparrow			x	x	x		x
Brewer's Sparrow							x
Vesper Sparrow				x	x	x	
Lark Sparrow							x
Lark Bunting	x	x	x	x	x	x	x
Savannah Sparrow							x
Grasshopper Sparrow	x	x	x	x	x	x	x
Eastern Meadowlark*	x	x	x	x		x	x
Western Meadowlark	x	x	x	x	x	x	x
Brewer's Blackbird					x		
Common Grackle	x			x		x	
Northern Oriole		x		x		x	
House Finch	x	x		x		x	
American Goldfinch						x	
House Sparrow				x	x		

*needs confirmation by mist-netting

Table 2. Mean number of birds[1] per transect[2] per vegetation type.

VEGETATION TYPE	MEAN NUMBER BIRDS
Crested Wheatgrass	17.33
Sand Dropseed	16.58
Native Perennial	13.75
Sand Sagebrush	21.92
Weedy Forb With Prairie Dogs	10.83
Weedy Forb Without Prairie Dogs	33.25
Yucca Grassland	15.83

[1] *n*=3 surveys per transect
[2] *n*=28 transects

DOCUMENTATION AND INTERPRETATION OF SELECTED WILDLIFE HABITAT RELATIONSHIPS AT THE ROCKY MOUNTAIN ARSENAL

TASK SIX: TEACHER RESOURCE GUIDE

BY

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1991 Annual Progress Report

31 December 1991

INTRODUCTION

In 1991, much progress has been made on the Teacher Resource Guide for the Rocky Mountain Arsenal. The objectives of the guide are to introduce Colorado educators and students (Grades 4 - 12) to the unique wildlife, ecological diversity, and historical background of the Arsenal, and to involve them in the process of finding solutions to the ethical and environmental issues connected with clean-up operations at the site.

Meetings with representatives from the Museum, U. S. Army, U. S. Fish and Wildlife Service, and Shell Oil Company during 1991 have resulted in decisions about format, content, marketing, and distribution of the guide. As outlined in the 1991-1992 Task Plan and Budget, 1000 copies of the Guide will be printed. The Guide will consist of 96 pages (48 pages printed on both sides) in a loose-leaf binder with a 2-color cover. It will include interdisciplinary activities, activity sheets for teachers to copy, a glossary, a resource list, a 4-color poster, and a prairie dog mask.

METHODS AND RESULTS

January - March:

Toured Arsenal and met with Fish and Wildlife personnel to gather background materials for Guide, developed preliminary outline began researching and developing activities.

April - June

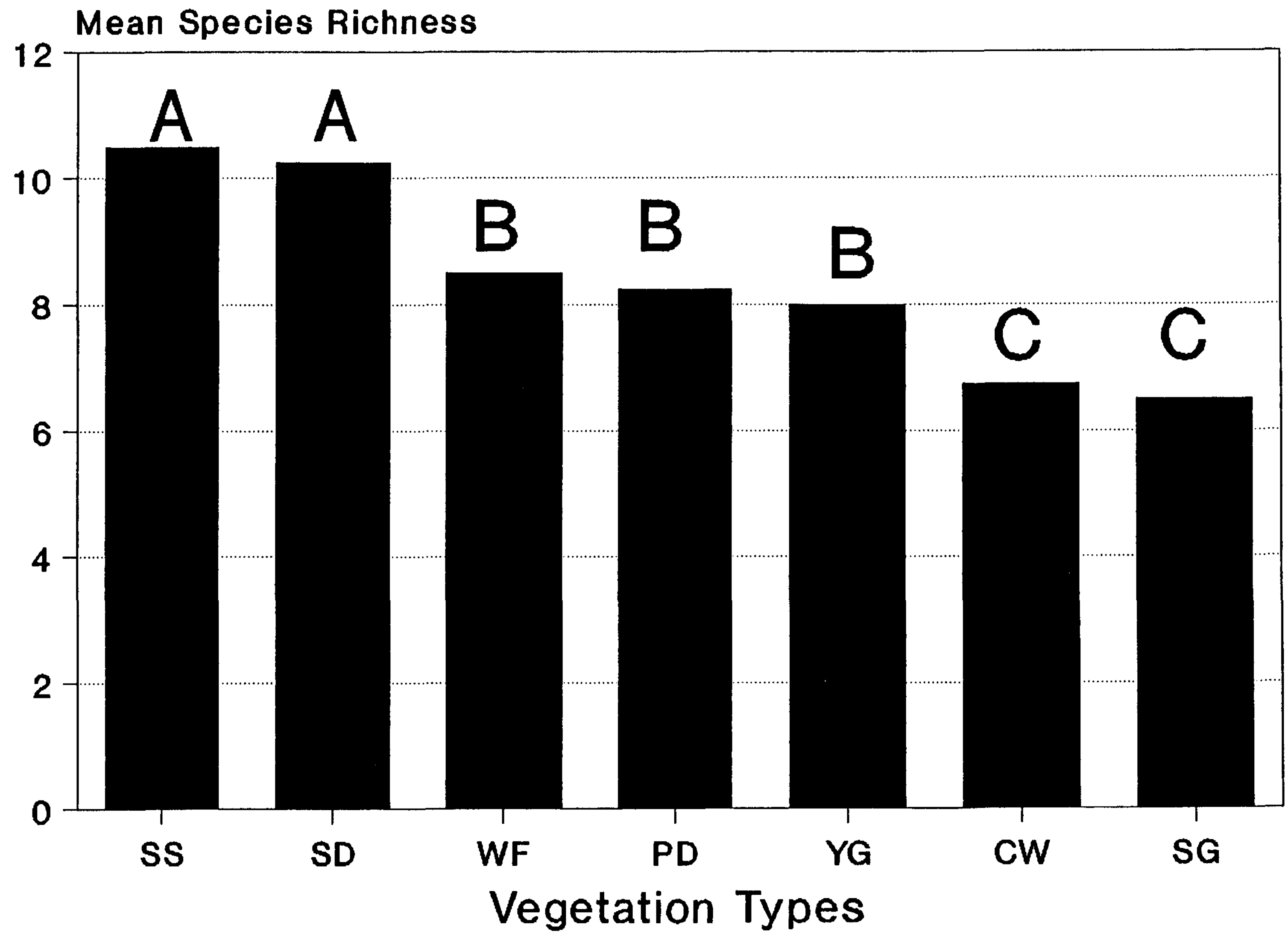
Worked with DMNH Graphics and Publications Departments to develop

Table 3. Mean bird[1] and plant[2] species richness per transect[3] per vegetation type. Regression analysis shows a positive relationship at $\underline{P} = 0.001$.

VEGETATION TYPE	BIRDS	PLANTS
Crested Wheatgrass	6.75	12.50
Sand Dropseed	10.25	15.50
Native Perennial	6.50	14.00
Sand Sagebrush	10.50	18.25
Weedy Forb With Prairie Dogs	8.25	13.25
Weedy Forb Without Prairie Dogs	8.50	14.50
Yucca Grassland	8.00	16.75

[1] $\underline{n}$=3 surveys per transect
[2] $\underline{n}$=14 vegetation plots per transect
[3] $\underline{n}$=28 transects

Fig. 2. Mean bird species richness in seven vegetation types. Different letters (A, B, C) indicate significant differences ($\underline{P}$ = 0.001) in species richness among vegetation types.


Mean Species Richness
12
10
8
6
4
2
0
A
A
B
B
B
C
C
SS
SD
WF
PD
YG
CW
SG
Vegetation Types

DOCUMENTATION AND INTERPRETATION OF SELECTED WILDLIFE HABITAT RELATIONSHIPS AT ROCKY MOUNTAIN ARSENAL

Task Three: Lagomorphs

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1991 Annual Progress Report

31 December 1991

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

Abstract: Black-tailed jackrabbits (*Lepus californicus*) and one or two species of cottontails (*Sylvilagus audubonii*, *S. floridanus*) were studied at Rocky Mountain Arsenal to determine habitat preferences. Four different techniques, two diurnal and two nocturnal, were evaluated for effectiveness: headlight counts, spotlight counts, flush counts, and walk counts. Spotlight counts and flush counts proved the most effective and will be retained. In terms of habitat type, flush counts revealed that jackrabbits were most abundant on native perennial grassland and yucca grassland, whereas cottontails were more widely distributed over native perennial grassland, yucca grassland, western wheatgrass, and mowed grass. Spotlight transects showed a dip in lagomorph abundance in mid-summer, and a strong similarity between jackrabbits and cottontails in their preference of vegetation types.

INTRODUCTION

Lagomorphs and prairie dogs constitute a significant component of the food resource base for predators at Rocky Mountain Arsenal. These predators, various raptors and eagles, coyotes, and badgers, are maintained by healthy prey populations. The decimation of prairie dog populations as a result of sylvatic plague on RMA in the fall of 1988 (Ebasco Service, In. 1989) placed a particular emphasis on the significance of lagomorphs. The ability of the various habitats to support a diverse and abundant prey base of lagomorphs is a key element in the diversity and potential stability of the RMA ecosystem.

The purpose of this study is to determine the habitat preferences of the lagomorphs (black-tailed jackrabbits, and either one or both of the two species of cottontails that may occur there, the desert cottontail and eastern cottontail). This knowledge then can be applied as management decisions and cleanup mitigation activities are carried out. This report covers the first field season of lagomorph work by DMNH staff at RMA, from 15 May through 31 December 1991. This first year was instrumental in developing techniques and determining which ones were effective, and in gathering some preliminary data.

METHODS

Four different techniques were used to generate counts of animals and to determine habitat associations: headlight counts, spotlight counts, flush transects, and walk transects. The first two are nocturnal and the latter two are diurnal. At this point, the goal was to assess the effectiveness of these different sampling techniques to select one diurnal and one nocturnal sampling method that would be continued in subsequent years. Sampling techniques were also developed for data collection of the vegetation.

Headlight Counts

Headlight counts involved driving 31 km (19 miles) along section roads and counting lagomorphs seen in the headlights of the vehicle (see Figure 1 for route used). Two people were involved, the driver and the counter. These counts were carried out between one hour after sundown until midnight, once in June and once in July.

Spotlight Counts

Spotlight counts (Smith and Nydegger 1985) were used to document lagomorph abundance at night in different vegetation types. They involved three people, one driver and two spotters standing in the bed of a pickup truck, driving 36 km on dirt roads. Spotters each held a spotlight (Brinkmann Q-Beam spotlight, 200,000 candlepower) and counted animals seen in the spotlight. The driver was responsible for noting any animals seen in the road. Spotlights were continuously swept from the road ahead out to the side, 90 degrees from the direction of travel. When an animal was sighted, one of the spotters paced out the distance perpendicular from the road and placed a flag at the position where the animal was first seen. The next day, the flag was used as the center point of a vegetation plot. Figure 2 shows the roads used. Virtually all available dirt roads were used except where a general vegetation type was already well-represented.

Flush Counts

Eight transects were established for flush counts, measuring 1.6 km by 200 m. The transects were described in terms of the following dominant vegetation types: Native perennial (transects 1 and 2), sandsage prairie (transect 3), yucca grassland (transect 4), western wheatgrass (transect 5), crested wheatgrass (transect 6), mowed site (transect 7), and weedy forbs (transect 8). Ten people and 6 dogs were employed. Eight people were spread evenly across one end, 28 m apart; 6 of these held dogs on 4.6 m leashes. The outside edge people, called side points, did not have dogs but did record data. Additionally, two lead point people walked about 40 m in front of the side points, and counted any lagomorphs that flushed in front. All animals on the plot were counted as they were flushed.

Walk Counts

Walk counts were carried out two weeks after the flush counts, in July and October 1991. These involved one person walking along the midline of the flush transects and counting any lagomorphs flushed.

Vegetation Measures

Each flag placed during spotlight transects was the center of a sample plot. Four types of vegetation measurements were taken at each sample plot: plant cover, height diversity profile, vegetation height, and distance to woody vegetation. Plant cover was determined using forty randomly placed points within a 10 m circle of the flag. The points were located using knots on string and a random numbers table. At each knot the vegetation was classified as bare, litter, or one of 25 plant species; plant species were subsequently lumped into annual grass, perennial grass, annual forb, and perennial forb.

The height diversity profile is a measure of the physical plant community structure. It was measured by placing a 2.4 cm diameter PVC pipe in four random locations at each plot. The number of plant parts that touched the pipe at predetermined height intervals (0-5 cm, 5-10 cm, 10-20 cm, 20-30 cm, 30-50 cm, and greater than 50 cm) was recorded. Vegetation height was measured as the tallest plant in each of the 90 degree arcs of the 10 m radius circle surrounding the flag. Distance to woody vegetation was measured by pacing off the distance to trees or shrubs from four randomly placed points in each plot. Only plant cover is examined in this report.

RESULTS

Headlight Counts

June headlight counts had a total of 45 lagomorphs (24 jackrabbits, 17 cottontails, and 4 undetermined). July headlight counts had a total of 25 lagomorphs (14 jackrabbits, 10 cottontails, and 1 undetermined). Relative proportions were 54% jackrabbits, 39% cottontails, and 7% undetermined.

Spotlight Counts

Figure 4 shows the number of jackrabbits and cottontails seen on spotlight transects in June, August, September, and

November. Jackrabbit numbers were highest in June and September. Cottontails start out in June with a relative high number, but peak in November. Both species show a mid-season decline, jackrabbits in August, and cottontails in September, as is more clearly reflected in the combined total for all lagomorphs (top line).

Figure 5 shows the number of jackrabbits and cottontails pooled over months, in each of six plant categories: litter, bare ground, annual grass, perennial grass, annual forb, and perennial forb. Most notable is the similarity between jackrabbits and cottontails in the different plant categories. Both species were most frequently seen in perennial grasses and annual forbs.

Flush Counts

During the flush counts 66 animals were seen: 22 animals in June (11 jackrabbits and 11 cottontails), and 44 animals in October (30 jackrabbits and 14 cottontails). Except for transects 1 and 5, the number of lagomorphs sighted in each transect was similarly high or low regardless of month. Table 3 shows the data pooled over the two sample periods and broken down by vegetation type. Transect 2, perennial grassland, contained the greatest number of animals (25, 38% of all animals seen), and transect 4, yucca grassland, contained the second highest number of animals (14, 21%). The percentages for each species separately show that jackrabbits were most abundant in two transects (2, native perennial and 4, yucca grassland), whereas cottontails were relatively abundant in four different transects (1, 4, 5, and 7, native perennial, yucca grassland, western wheatgrass, and mowed grass, respectively).

Walk Counts

No lagomorphs were flushed on 6 of 8 transects during walk counts in both July and October. One cottontail was flushed on transects 2 and 8 in July, and 1 cottontail and one jackrabbit were flushed on transects 1 and 6, respectively, in October.

DISCUSSION

Both the headlight counts and the spotlight counts showed a dip in animal numbers during the summer. Headlight counts were lower by almost half in July (25 lagomorphs) compared to June (45 lagomorphs). Spotlight counts revealed a similar pattern in that jackrabbit numbers were lowest in August, and cottontail numbers were lowest in September (Figure 4). Reproduction begins in mid-March for desert cottontails, February for eastern cottontails, and probably around January for black-tailed jackrabbits. Thus June counts reflect a minimum of two litters for each species. The decline is less easily explained, and may be affected by vegetation growth that blocks visibility at the later times in the summer season. The quality of data and amount of information from the spotlight counts is far greater than for the headlight counts, and the two are sufficiently redundant that the headlight counts will no longer be conducted.

The percentage dominant ground cover (Figure 5) reveals the surprising similarity between the jackrabbits and cottontails in the ground cover type in which they are most frequently found. The height diversity profiles are not evaluated at this point, and may reveal differences that the ground cover type do not pinpoint. The relationship between lagomorph habitat use and habitat availability remains unclear. Both of these issues will be covered in 1993.

The flush counts, also extremely labor-intensive, proved fruitful in evaluating broad categories of habitat preferences. The jackrabbits were concentrated in only two different habitat types, one of the native perennial transects (the one closest to the airport that also houses prairie dogs) and the yucca grassland. In contrast, they are represented in other habitat types by substantially lower frequencies of occurrence. In contrast, the cottontails were more broadly distributed over four different habitat types, including a native perennial transect not adjacent to the airport. This may reflect the presence of two different species of cottontails. Unfortunately, the species are almost impossible to distinguish in the field and that clarification awaits the collection of specimens.

Walk counts proved extremely unproductive and will be abandoned as a useful technique at RMA. They have been useful in areas where much greater distances are walked (Gross et al. 1974).

OTHER ACTIVITIES THIS PERIOD

1. Experimentation with camera units.
2. Established transects.
3. Mapped vegetation on spotlight transects.

PLANS FOR 1992

1. Analyze vegetation data for spotlight transects.
2. Develop comparison of vegetation used with vegetation present on spotlight transects.
3. Continue experimentation with camera units and develop experimental approach.
4. Attempt to resolve whether both species of cottontails occur at RMA, and if so, to address habitat partitioning.
5. Evaluate responses to disturbance on existing plots as such disturbances arise.

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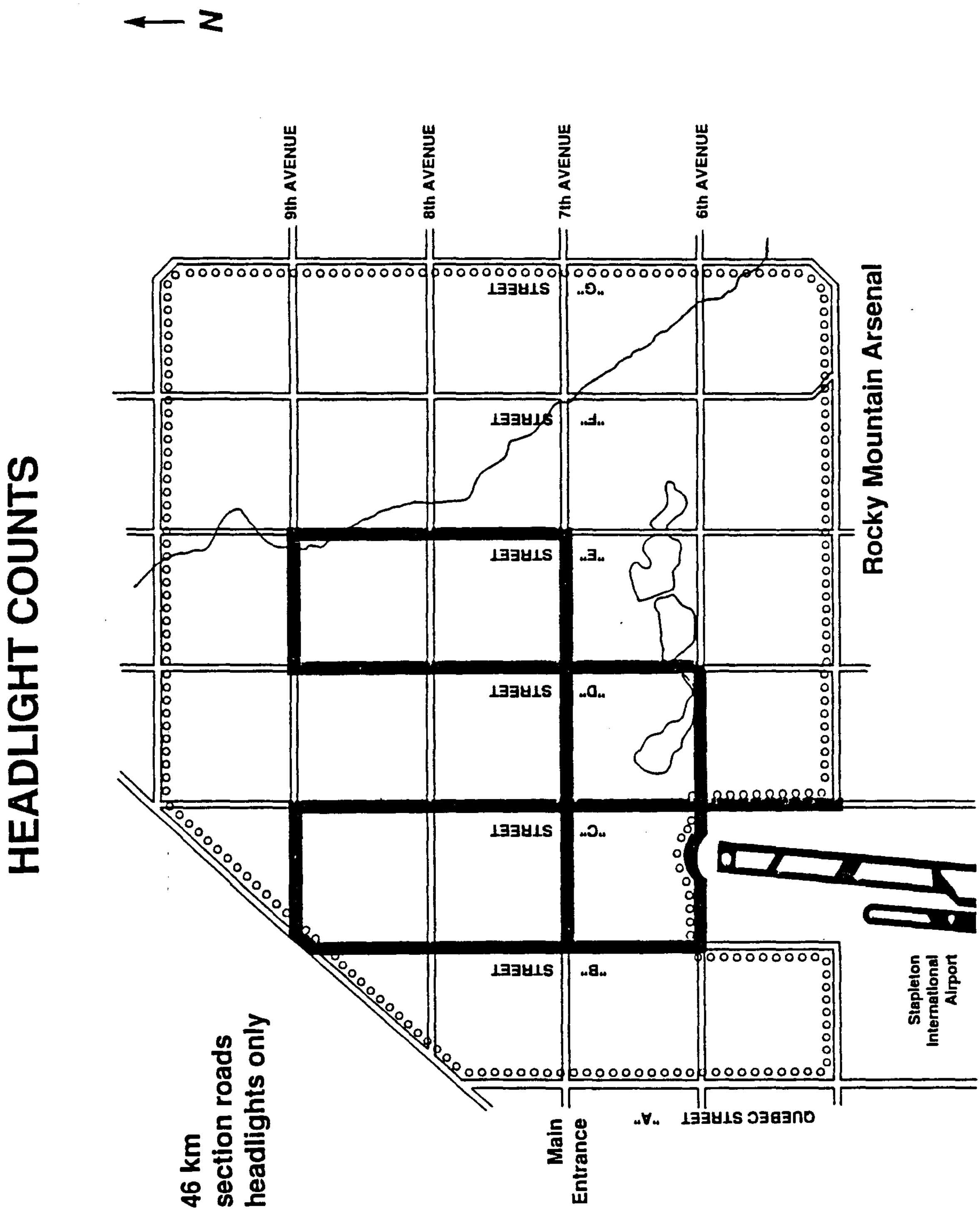

Figure 1. Headlight Count Transects for Lagomorphs at RMA.

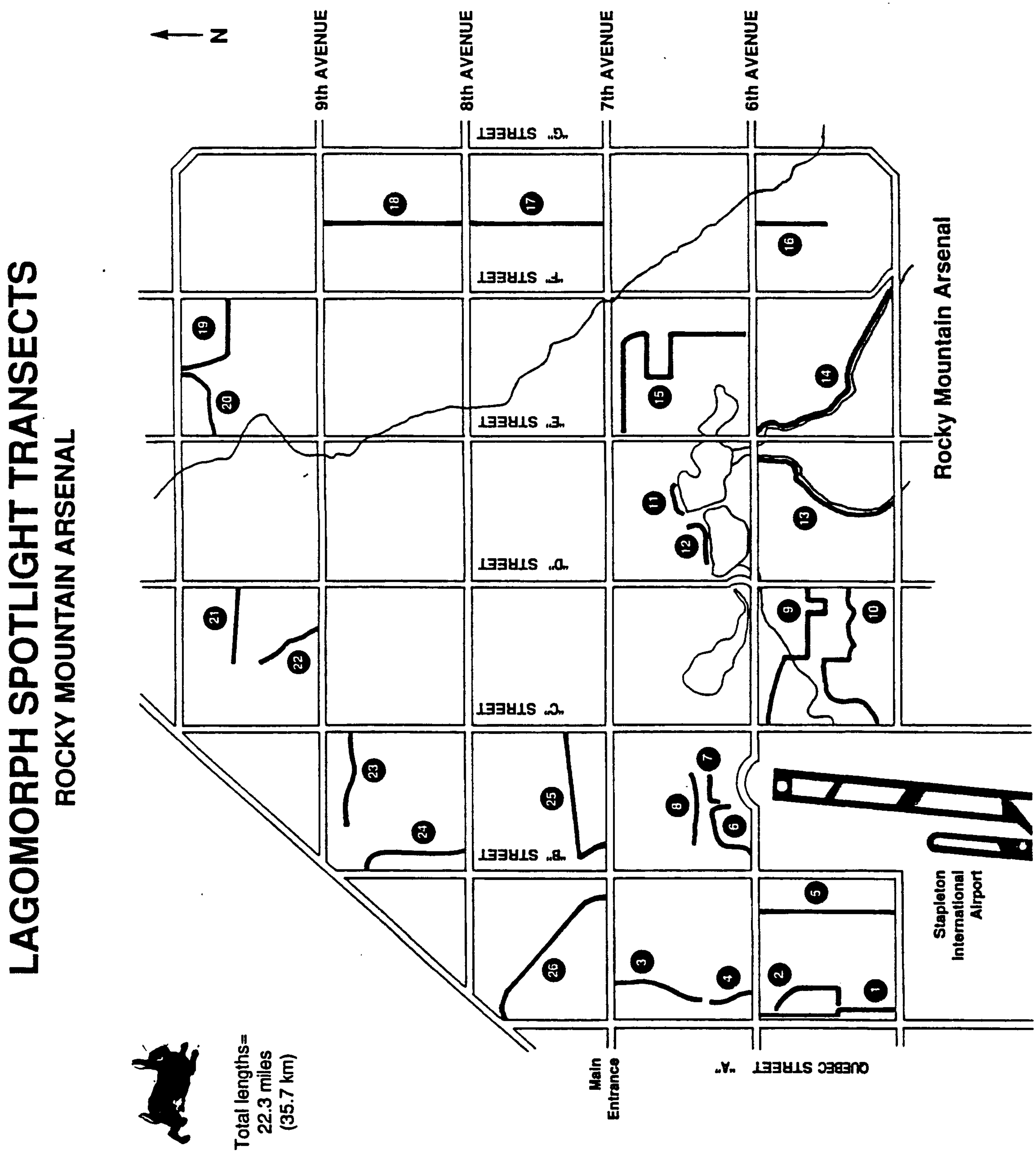

Figure 2. Spotlight Transects for Lagomorphs at RMA.

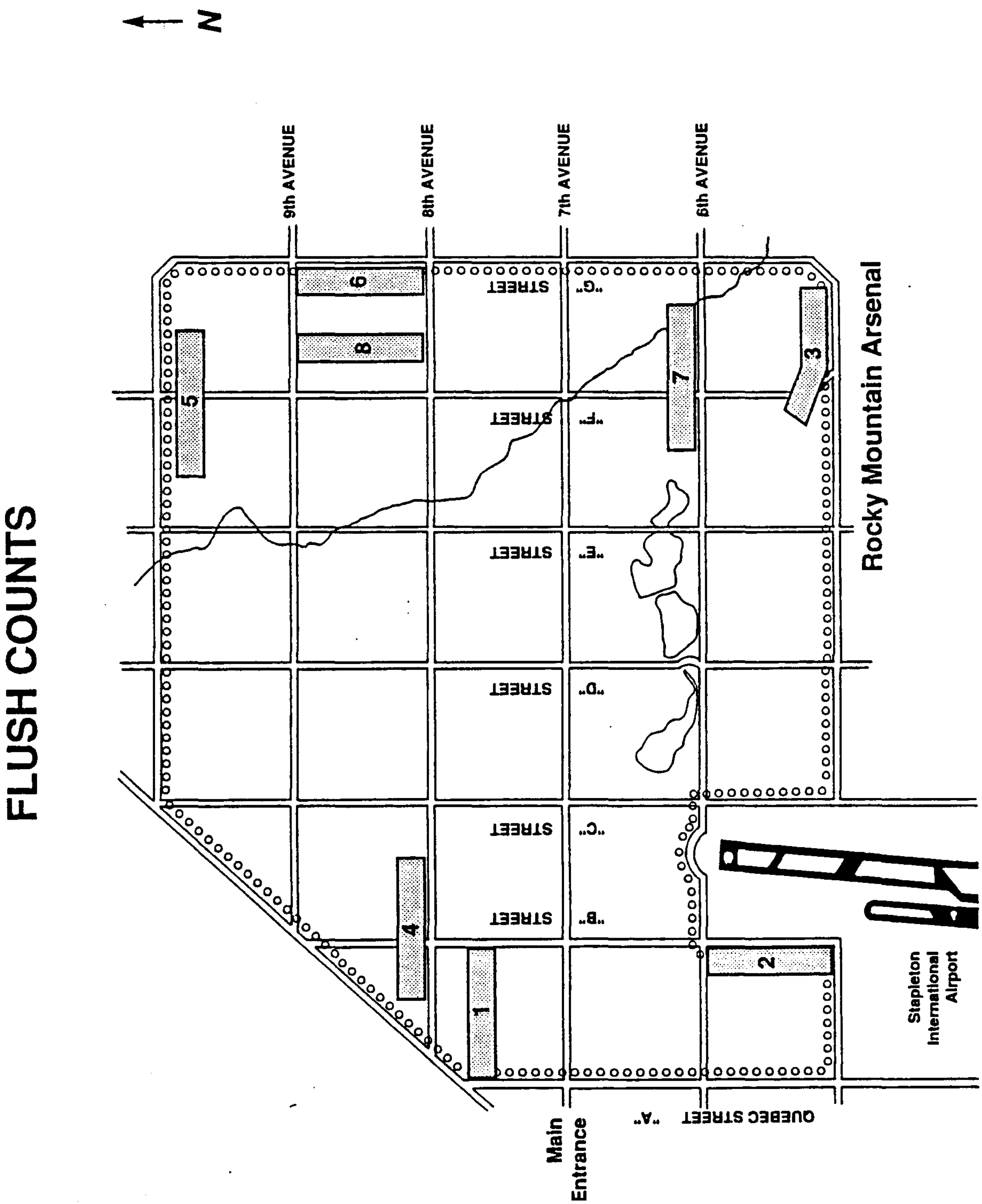

Figure 3. Flush Count Transects for Lagomorphs at RMA.

Figure 4. Spotlight Counts by Month

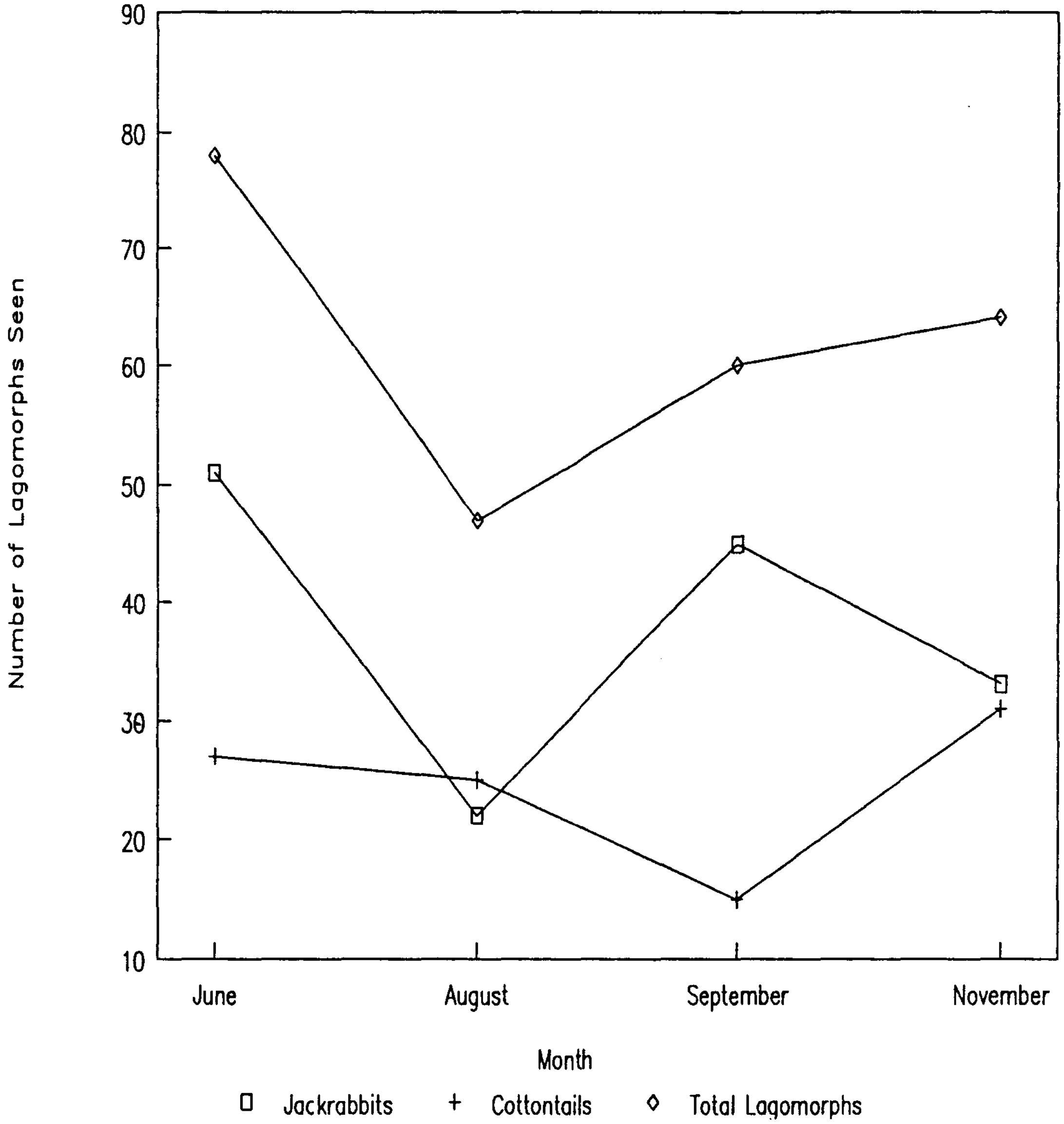

Figure 5. Percentage Dominant Ground Cover at Points where Jackrabbits and Cottontails were Sighted during Spotlight Counts.

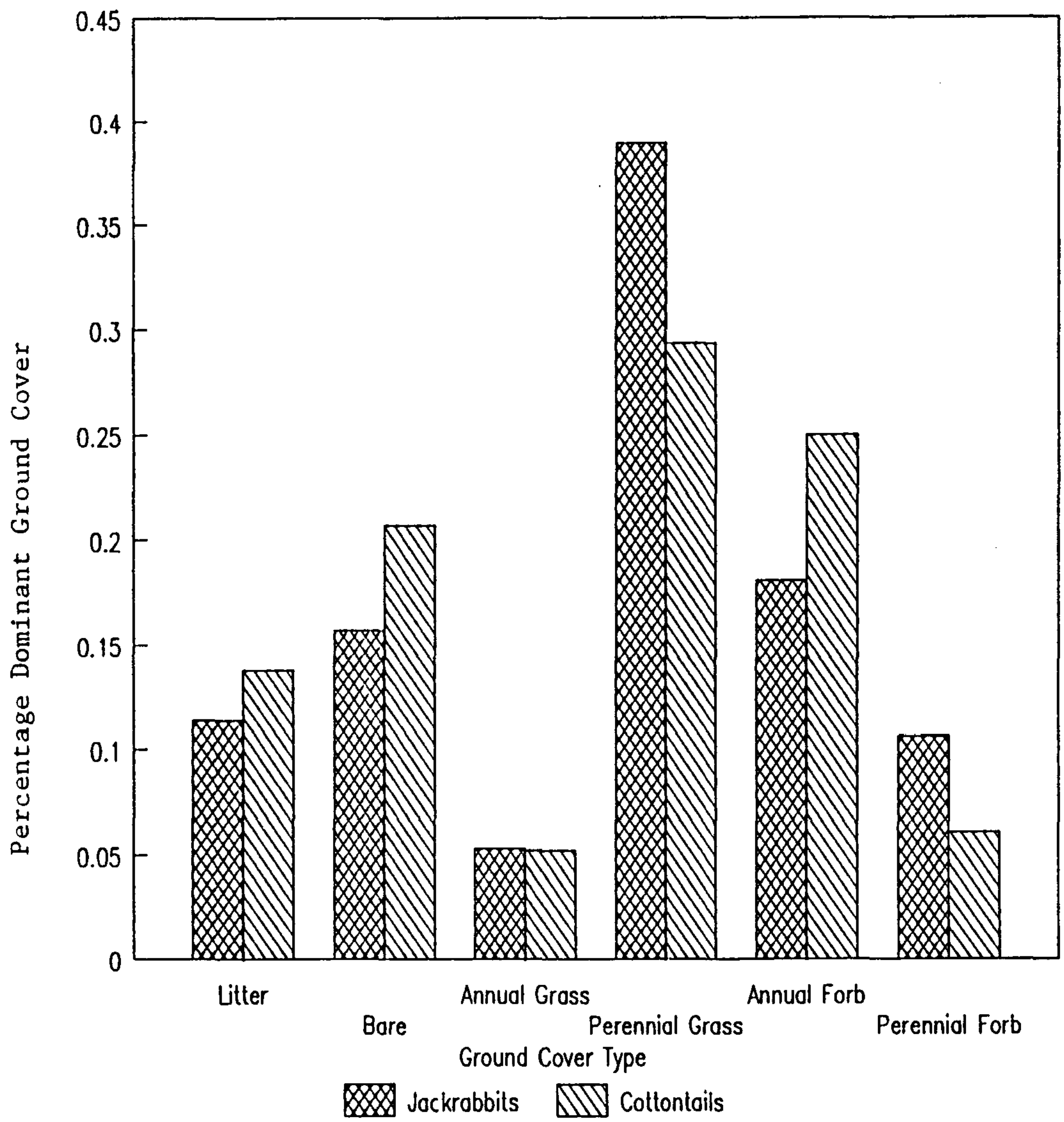

TABLE 1. Flush counts of black-tailed jackrabbits and cottontails on 8 transects pooled over June and October 1991. Percentages for jackrabbits and cottontails, respectively, in parentheses.

TRANSECT	HABITAT	JACK-RABBITS	COTTON-TAILS	TOTALS
1	Native perennial	3 (7%)	4 (16%)	7
2	Native perennial	22 (54%)	3 (12%)	25
3	Sandsage prairie	1 (2%)	0 (0%)	1
4	Yucca grassland	9 (22%)	5 (20%)	14
5	Western wheatgrass	2 (5%)	5 (20%)	7
6	Crested wheatgrass	0 (0%)	1 (4%)	1
7	Mowed grass	1 (2%)	4 (16%)	5
8	Weedy forbs	3 (7%)	3 (12%)	6
	TOTALS	41	25	66

DOCUMENTATION AND INTERPRETATION OF SELECTED WILDLIFE HABITAT RELATIONSHIPS AT THE ROCKY MOUNTAIN ARSENAL

TASK FOUR: FERRUGINOUS HAWK

by

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1991 Annual Progress Report

31 December 1991

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

Abstract: The abundance, distribution, average home range, and diet of Ferruginous Hawks (*Buteo regalis*) overwintering at the Rocky Mountain Arsenal (RMA) is currently being investigated. Ferruginous hawks were captured using the Lockhart method and fitted with tail-mounted radio-transmitters. Ferruginous Hawks will be monitored throughout the winter and spring 1992 and again during the winter and spring of 1993 to develop distribution and home range estimates. Monitoring will be conducted from three permanent radiotelemetry towers located on RMA using triangulation estimates and multiple relocations. Radio-tagged hawks will also be monitored individually using hand-held receivers and visual observations. Habitat use of all falconiformes was investigated during roadside surveys. Castings and prey remains were collected from beneath Swainson's Hawk (*Buteo swainsoni*) nests and Ferruginous Hawk winter roosts for diet analysis.

INTRODUCTION

In 1991 the Denver Museum of Natural History (DMNH) entered into a cooperative agreement with the U. S. Army (Army), U. S. Fish and Wildlife Service (Service), and the National Fish and Wildlife Foundation to conduct a comprehensive ecological study at the Rocky Mountain Arsenal (RMA). This multi-faceted study involves the ecological relationships between habitat and vertebrate communities including, small birds, small mammals, lagomorphs, and raptors. Current interim actions and eventual remediation of hazardous waste associated the RMA could potentially destroy thousands of acres of wildlife habitat. Management decisions and mitigation measures will be implemented based on the best available information. Therefore, it is pertinent to understand wildlife-habitat relationships, including raptor-habitat relationships, prior to remediation.

Diurnal raptors are the most visible predators at RMA. Because of their position at the top of the food chain and their great mobility, they are valuable as environmental barometers. Diurnal raptors are especially integral in the functioning of grassland ecosystems. The Ferruginous Hawk is an important overwintering raptor at the Arsenal; its yearly occurrence and density have been roughly associated with estimated population densities of known prey animals (e.g. black-tailed prairie dog, (Cynomys ludovicianus) (M. Lockhart, pers. commun.).

This report summarizes field work conducted on RMA from June through December 1991.

METHODS

Twice monthly roadside surveys (Fuller and Mosher 1981, 1987) began on June 15, 1991. Raptors observed along the route were identified to species, age and sex when possible. The location of all raptors were recorded and marked on a map. Other data collected during roadside surveys included perch type, behavior, distinguishing physical characteristics and dominant vegetation. The vegetation of the arsenal was classified into seven major habitat types:

- o Shortgrass prairie
- o Shrub grassland
- o Weedy forb
- o Crested wheatgrass
- o Wooded/Riparian
- o Prairie dog town
- o Cropland/disturbed

Castings were collected from beneath five Swainson's Hawk nests after all young had fledged. Castings were collected from beneath nests in the following sections:

- o NE 1/4, Section 9
- o SW 1/4, Section 4
- o Mid Section 22
- o SW 1/4, Section 7
- o SE 1/4, Section 3 (Staff Quarters)

Castings were collected from beneath the following Ferruginous Hawk roosts:

- o SE 1/4, SW 1/4, Section 33
- o SE 1/4, SW 1/4, Section 4
- o SW 1/4, SE 1/4, Section 4
- o SE 1/4, SW 1/4, Section 3

- NW 1/4, NW 1/4, Section 27
- Mid Section 22
- SW 1/4, SE 1/4, Section 24

Castings will be processed according to methodology adapted from Marti (1987).

RESULTS

Roadside Surveys

Eighteen roadside surveys were conducted between 15 June 1991 and 21 December 1991. Preliminary results show the presence of four major species, Red-tailed Hawk (Buteo jamaicensis), Swainson's Hawk, American Kestrel (Falco sparverius), and Northern Harrier (Circus cyaneus), nesting on the Arsenal, as well as occasional non-breeding Ferruginous Hawks, Cooper's Hawks (Accipiter cooperii), Turkey Vultures (Cathartes aura), Golden Eagles (Aquila chrysaetos), and Prairie Falcons (Falco mexicanus). All nesting buteos had fledged young and vacated nest sites by early September. Fall migration began in September and the number of Ferruginous and Red-tailed Hawks counted during road surveys increased. Migrating Ospreys (Pandion haliaetus) were occasionally observed. Winter surveys show the presence of Ferruginous Hawk, Red-tailed Hawk, Rough-legged Hawk (Buteo lagopus), Bald Eagle (Haliaeetus leucucephalus), and Golden Eagle. Occasionally, Northern Harrier, American Kestrel, Merlin (Falco columbarius), Prairie Falcon, and Peregrine Falcon (Falco peregrinus) were observed. Preliminary habitat analysis reveals

Ferruginous Hawks concentrated near prairie dog towns and shortgrass prairie; Rough-legged Hawks occurred in more wooded areas, and Red-tailed Hawks occurred in all habitat types. Results of roadside surveys are presented in Table 1.

Radio-telemetry

Raptor tracking began in September with a total of six Ferruginous Hawks being trapped and equipped with transmitters as of 26 December 1991. Two hawks trapped in early November immediately left the area and have not been relocated. Eighty-eight hours of observations have been logged radio-tracking the remaining four hawks. Preliminary home range analysis reveals that radio-tagged hawks occupy relatively distinct home ranges generally centered in the following areas:

- 120th and Quebec
- The eagle watch
- Stapleton International Airport
- Buckley Air National Guard Base

DISCUSSION

Tracking from towers has not been conducted during 1991 because equipment shortages and the small number of hawks equipped with transmitters. Radio-tracking towers are currently being refurbished and tracking from the towers will be initiated in January 1992.

PLANS FOR 1992

Trapping of raptors will be continued throughout the next quarter with Ferruginous Hawks being the primary target. trapping methods will use both the Lockhart method and bal chtri traps. Radios will be attached to Ferruginous Hawks and telemetry studies will continue using the telemetry towers located on the Arsenal and hand held equipment. Roadside surveys will continue and castings will be processed and food items identified during the next year.

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DOCUMENTATION AND INTERPRETATION OF SELECTED WILDLIFE HABITAT RELATIONSHIPS AT THE ROCKY MOUNTAIN ARSENAL

Task One: Small Rodents

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1991 Annual Progress Report

31 December, 1991

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

Abstract: Small rodents on the Rocky Mountain Arsenal were sampled by live trapping on twenty-eight sampling grids distributed over seven habitat types in the summer (June-July) and fall (October) of 1991. Over 700 animals representing eleven species were captured. Deer mice (*Peromyscus maniculatus*) were the most common rodents, occurring on all habitat types. Thirteen-lined ground squirrels (*Spermophilus tridecumlineatus*) were also common on low cover sites during the summer, but were hibernating during the fall. Western harvest mice (*Reithrodontomys megalotis*) and prairie voles (*Microtus ochrogaster*) were fairly common in grids with dense grass cover. Other species were present at low to moderate densities. Total rodent density in fall was about half the summer density, mostly because of the absence of ground squirrels and a reduction in deer mouse density. Habitat selection by small rodents does not appear to be strongly influenced by specific habitat type, but may correlate with certain elements of habitat structure, particularly density of cover. Further analyses should elucidate these relationships.

Much of the current controversy surrounding the future of the Rocky Mountain Arsenal (RMA) results from the perceived conflict between thoroughly decontaminating the site and protecting its wildlife resources from excessive disturbance. The primary goal of the research project being conducted on the

RMA by the Denver Museum of Natural History is to experimentally assess the impact of simulated cleanup and remediation activities on selected wildlife populations. Such information should prove useful to decision makers in balancing these competing interests.

Small rodents are often very numerous in grassland ecosystems like those of the RMA, and comprise an important food resource for various predators. Consequently, a significant reduction in small rodent populations because of widespread habitat disturbance could potentially affect other wildlife species. Additionally, their high densities, restricted home ranges, reproductive capacity, and ease of trapping make small rodents nearly ideal study subjects for manipulative field experiments involving disturbance.

The long-term approach of the small rodent study is as follows:

1) 1st year: Collect basic information on distribution and abundance in several typical RMA habitat types to be used for later comparison to experimentally altered habitats,

2) 2nd year: Perform simulated disturbances, and

3) 3rd year: Assess affects of disturbance on small rodent populations.

During 1991, the goals of the first year of the study have been largely met. Continued analysis of data already collected should also yield insights into the factors important in determining small rodent distribution and abundance patterns, and will aid in designing the most appropriate experimental disturbance regime.

This study is being conducted with the cooperation of the Department of Environmental, Population, and Organismal Biology at the University of Colorado at Boulder, where JDB is currently a graduate student.

METHODS

Sampling Layout

Sampling grids were selected in May, 1991, on seven grassland habitat types on the RMA, designated by their most distinctive vegetative cover; yucca grassland (YG), sandsagebrush (SS), sand dropseed grassland (SD), shortgrass (SG), weedy forbs (WF), crested wheatgrass (CW), and prairie dog towns (PD). Four independent grids were established in each habitat type. Four trapping grids were also placed in riparian zones.

Live Trapping

Small rodent data were collected by live trapping. A 5x5 array of sampling stations with 10 m spacing was positioned on each sampling grid. During a trapping session, one large Sherman live trap was placed at each station. Traps were prebaited three days prior to sampling to acclimate animals to traps. Traps were then baited and set on three consecutive evenings and checked for animals the following mornings. Captured animals were marked by ear-tagging or fur-clipping, identified by species and sex, weighed and measured, and then released at point of capture.

Vegetation Sampling

Vegetation sampling was conducted on every sampling grid at nine uniformly distributed sampling stations. Percentage cover of bare ground, litter, and individual plant species were measured with a knotted string utilizing a randomization process. Vertical vegetative structure was estimated by counting the number of points of contact between plants and a length of PVC pipe, for each of six height categories. Additionally, maximum vegetation height and distance to nearest woody vegetation were determined at each of the sampled stations.

Analysis

Analysis of 1991 data is currently in progress. Summary statistics (rodent density, rodent diversity, etc.) will be compared between habitat types and between seasons using standard parametric and non-parametric statistical techniques. Additionally, multivariate techniques (including Principle Components Analysis) will be utilized to highlight relationships between rodent community attributes and habitat characteristics.

RESULTS

Live Trapping

Live trapping was conducted in June-July (Summer) and in October (Fall). All twenty-eight grassland grids were sampled for one trapping session during both seasons; therefore sampling effort was equivalent for each season, as was trapping procedure. A total of 1212 captures of 704 individual animals was recorded over 4200 trap nights (excluding riparian grids, which were only sampled in Summer), yielding an overall capture rate of 28.9%. Eleven species of small rodents were captured (Tables 1 and 2); the deer mouse (*Peromyscus maniculatus*), thirteen-lined ground squirrel (*Spermophilus tridecumlineatus*), Western harvest mouse (*Reithrodontomys megalotis*), prairie vole (*Microtus ochrogaster*), plains pocket mouse (*Perognathus flavescens*), hispid pocket mouse (*Perognathus hispidus*), Ord's kangaroo rat (*Dipodomys ordii*), Northern grasshopper mouse (*Onychomys leucogaster*), spotted ground squirrel (*Spermophilus spilosa*), house mouse (*Mus musculus*), and the meadow vole (*Microtus pennsylvanicus*) (captured only in one riparian grid). Because statistical analysis of the data is not complete, results will be discussed qualitatively.

Species Results

Deer mice accounted for about half of the individuals captured, and occurred in all habitat types. Thirteen-lined ground squirrels were common in summer in all habitats except SD and SS. Western harvest mice were common in SD, SS, and SG habitats. Prairie voles were present at moderate to high densities on some SS and SD grids, but largely absent from other areas. Other species were present in low numbers on trapping

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grids (Tables 1 and 2).

Habitat Results

YG habitat supported the greatest density of small rodents, but was largely dominated by a single species (deer mice). SS and SD habitats supported nearly as large a density of rodents as YG, but species richness was greater. Rodent communities on WF, CW, and PD grids were generally similar, with intermediate densities (Tables 1 and 2). Riparian habitat (summer only) was dominated by deer mice, with a few meadow voles present in one of the four grids.

Seasonal Trends

Total small rodent density was lower in fall than in summer on most grids. Deer mouse population density during fall was about half the summer density, while thirteen-lined ground squirrels were absent from the fall sample (due to hibernation). Western harvest mouse density in fall was nearly twice the summer level. Kangaroo rats and both pocket mouse species appeared to be slightly more numerous during the fall sample (Tables 1 and 2).

Plant Sampling

Vegetative sampling was conducted on all grids during July and August. Compilation and analysis of these results are in progress.

DISCUSSION

Although formal analysis of the results is not complete, several patterns and trends (or their absence) are suggestive enough to merit discussion. First, overall small rodent density does not appear to be strongly correlated to habitat type (i.e. gross habitat physiognomy). Although some habitat types, such as YG, had higher mean densities than others, the variation in density between the four replicates of each habitat type appeared equal to or greater than the variation between habitat types. This impression is reinforced by a preliminary examination of Principle Components Analysis of rodent species densities and habitat type. Neither of the principle component axes from either season explained more than 30% of the observed variation.

It seems likely than finer grained habitat variables, such as those measured by the vegetation analysis, may play a greater role in rodent habitat selection than does gross habitat physiognomy. Multivariate analyses currently in progress should be informative in this regard. It appears that high cover habitats (SS, SD, some SG) support a rodent fauna somewhat distinct from that of low cover habitats (WF, CW, PD). Deer mice and ground squirrels tend to dominate the latter, with Western harvest mice and prairie voles more numerous on the former. It should be stressed that this impression is not yet verified by statistical analysis, and that much species overlap exists between all habitat types.

Second, seasonal variability in rodent communities appears to be relatively large, even apart from the disappearance of ground squirrels because of hibernation. Deer mouse densities decreased by about one-half between summer and fall, although this species is active year round. Deer mice apparently do not increase their density in response to the hibernation (and removal from potential competition) of ground squirrels. However, Western harvest mouse population increases in fall might be correlated with lower deer mouse densities, although causality cannot be assumed.

Finally, the coverage of the RMA afforded by the twenty-eight grassland grids may not be sufficient to include many of the small rodent community patterns, or types, that may be present. For instance, during ancillary small mammal sampling, a large small mammal community comprised almost entirely of kangaroo rats and grasshopper mice was discovered that is quite unlike any community on the twenty-eight permanent grids. Although this possibility in no way invalidates the premise of our experimental design, managers should be aware that our sampling coverage may not be exhaustive.

FURTHER WORK

Analyses to be completed in the near future are:

1) Multivariate analysis of vegetative habitat variables and rodent densities,

2) Statistical comparison of rodent densities between habitat

types and seasons,

3) Calculation of and analysis of diversity indices, and comparisons between habitats and seasons, and

4) Finalization of an experimental disturbance protocol for the following field season. This will require selecting pairs of grids based on similarity of rodent and vegetative variables, and the subsequent disturbance of one grid from each pair, with the remaining grid serving as a control. The specific disturbances to be performed are currently being determined by museum personnel in cooperation with USFWS and arsenal contractors. Possible disturbance types could include deep plowing and remediation, alterations of vegetative structure and/or cover, and surface disturbances by heavy equipment.

Table 1. Minimum number of small mammals alive on trapping grids for seven habitat types on the Rocky Mountain Arsenal, summer 1991. Each value is the average for four grids. Species codes are the initials of the latin name. Habitat type codes are given in the text.

	HABITAT TYPE							
SPECIES	SS	YG	SD	SG	WF	CW	PD	TOTAL
PM	25	85	9	24	36	35	32	246
ST	1	10	1	36	26	13	15	102
RM	22	0	17	0	6	6	0	50
MO	12	2	7	0	0	0	0	21
DO	1	0	0	0	0	2	0	3
SS	0	0	0	2	0	0	0	2
OL	0	0	0	5	0	0	4	9
PF	1	0	0	1	1	0	0	3
PH	0	0	2	0	0	0	0	2
TOTAL	62	97	36	68	69	56	51	439

Table 2. Minimum number of small mammals alive on trapping grids for seven habitat types on the Rocky Mountain Arsenal, fall 1991. Each value is computed as in Table 1.

	HABITAT TYPE							
SPECIES	SS	YG	SD	SG	WF	CW	PD	TOTAL
PM	18	45	4	6	13	16	11	113
ST	0	1	0	0	0	0	0	1
RM	26	12	34	14	0	8	0	94
MO	12	2	7	0	0	0	0	21
DO	1	3	0	2	0	2	3	11
SS	0	0	0	0	0	0	0	0
OL	1	0	0	0	0	3	6	10
PF	4	0	1	0	0	0	2	7
PH	0	0	1	0	0	0	4	5
MM	0	1	0	0	0	0	2	3
TOTAL	62	64	47	22	13	29	28	265