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Abstract. Movements and daily activities of the red fox (*Vulpes fulva*) were studied by visual observation and radio tracking in Buena Vista County, Iowa. Five fox were trapped with steel jump traps. Before release, three of the trapped fox were immobilized with a commercial tranquilizer to enable attachment of an ear tag and a collar-type transmitter on each fox. Range of the radio equipment when field tested showed an effective range of just under one-fourth mile. The diameter of the loop antenna on the receiver was critical, and probably indirectly contributed to the death of one fox. Two juvenile fox, thought to be from the same litter, showed little of no contact with each other. The fox usually traveled in cover during the day, but at night they frequently crossed open fields. Resting and sleeping periods, times of procurement of food and water, and a natural boundary were also observed.

The red fox (*Vulpes fulva*) in northwestern Iowa was studied to gather information on daily activities. Information was sought on home range, methods of procuring food and water, availability of food and water, and the effects of environmental and climatic conditions on its daily routine. Also sought was information on the periods of the day the fox devoted to food gathering, play, care of young, resting, and sleeping.

STUDY AREA

The majority of the field work was done in section 26 of Grant Township, Buena Vista County, Iowa. The landscape is flat except for a small river which crosses the section. The land was devoted to growing alfalfa, oats, red clover, corn, and soybeans. Surface soils vary from silt loam to clay loam, and are underlain by a 14- to 20-inch subsoil which varies from clay to clay loam. Then follows the light olive gray parent material which is often streaked with yellow and orange, and has a clay loam texture.

A glacier that receded about 14,000 years ago left this area, known as the Gary Till, much as it is today. Most of the land has good natural drainage, but in some areas tile networks remove excess water from the fields.

MATERIALS AND METHODS

Capturing and Handling. The home range of a family of fox was determined by the presence of numerous scats, trails, and tracks. Number three steel jump traps were used to capture the animals. Four traps were set on July 26, and that night fox A and B (Table 1)

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Table 1

Summary of Fox Trapped

Fox	Tag Number	Sex	Age	Date(s) Trapped	Weight	Released with Transmitter	Death Date	Cause of Death
A	12	M	Immature	July 26 and August 20	—	August 6	August 20	Chloroformed
B	24	F	Immature	July 26	—	August 6	August 18	Infection
C	—	M	Immature	July 27	3,111 g.	—	July 27	Chloroformed
D	—	F	Immature	July 27	2,904 g.	—	July 27	Chloroformed
E	47	F	Adult	August 20	—	August 24	Unknown	Unknown

were caught. The traps were reset the next night, and fox **C** and **D** were caught, but had to be destroyed because of injury in the form of broken legs. Fox **A** and **B** were caught by the paw. Although their paws became swollen, this swelling receded within a few days.
ment. During this waiting period the fox were given fresh tap water and chickens for food. They ate a chicken every four days. Prior to release, the injured paws were treated with sulfanilamide powder as a preventive against infection.

To facilitate handling, a commercial tranquilizer was injected intramuscularly at a dosage rate of 1 cc. per 10 pounds of body weight to subdue the fox. After waiting 45 minutes for the tranquilizer to take effect, a collar-type transmitter was attached to each fox, and a round, numbered, metal ear tag was fastened on one ear of each fox prior to release.

On August 20, four traps were set in the vicinity previously trapped. Since fox **B** died on August 18 (Table 1), another fox was needed for radio tracking. That night an adult female (fox **E**), believed to be the mother of the litter, was captured, and fox **A** was retrapped. This time fox **A** had a broken leg and was destroyed. The traps were reset and operated for the next three nights. No more fox were taken.

Fox **E** (Table 1) was in good condition except where the trap had closed on its paw. The injured paw was treated with sulfanilamide powder, and placed in a holding pen. Fox **E** was given the same food and water as the other fox, but was held four days prior to release. This short period of recovery may have been one of the factors contributing to its death.

Radio Equipment. The radio receiver was designed and built by Mr. William L. Watton of Fort Huachuca, Arizona. It was a 12-transistor, superhetrodyne, portable, direction-finding receiver operating on a fixed frequency of 29.895 megacycles. The receiver was mounted on the front of a car. The base of the receiver was calibrated in degrees enabling the investigator to secure bearings from fixed positions on the fox range. The resulting vectors were plotted on a map to determine the location of the fox.

The transmitters, also designed and built by Watton, consisted of a battery power source, a crystal controlled oscilator, and a tuned loop antenna. Each transmitter unit was sealed in epoxy resin, and used two number eight Mallory mercury cells. They were designed to operate up to six months. The two transmitters could be identified by their pulse rate, one having a rate twice as fast as the other.

Radio Tracking. The study area included nine sections of land around the capture and release point.

Although the range of the radio equipment was supposed to be three miles, field tests before placement of transmitters on the fox revealed

a signal range of just under one-fourth mile. Time involved for returning and servicing the equipment to provide increased range was too great for this short-term study. The limited range of the radio equipment made it necessary for the investigator to leave the roads in order to get radio bearing records on the fox. Two or three vectors were established and the position of the fox was plotted on a map. On random occasions the fox were purposely disturbed in order to provide visual contact. This made it possible to check the radio equipment and determine the condition of the fox.

Results and Discussion

Effects of the Collar-Type Transmitter. The effect the collar-type transmitter may have had on the behavior of the fox was not determined, however it became apparent that the antenna size could be improved. The loop antenna must have a diameter large enough to slip over the fox's head, but small enough to prevent the fox from putting its front foot through the antenna loop. The importance of the antenna diameter was illustrated by fox **B**. In an attempt to remove the transmitter, fox **B** put its right front leg up through the loop antenna, and then pulled the antenna under its right shoulder. This pulled the collar so tight that it impaired the fox's movement, and eventually opened a wound, which probably caused its death.

Interaction Between Fox. Death of fox **C** and **D** (Table 1) may have decreased competition for food, and thus reduced interaction between remaining fox. Fox **A**, **B**, **C**, and **D** were believed to be from the same litter, and fox **E** was assumed to be their mother. The male fox that mated with fox **E** may have left the area, since it was not seen or trapped. Fox **A** and **B** were about five months old, and seemed to have little or no contact with each other or with their mother.

Movements. The fox usually traveled in cover during the day, but frequently crossed open fields at night. Fox **A** and **B** were never located more than one-half mile from the release site. The majority of the foxes' movements occurred during the two or three hours preceding and following darkness. On August 10 at 8:30 p.m., fox **B** was located moving south in a cornfield along a fence line. On August 11, fox **A** was located moving south along the west river bank. In only a few minutes fox **A** moved about one-fourth mile. During the light hours, fox **A** and **B** were frequently found stationary in thickets or in a patch of tall weeds. On August 16, fox **B** was located resting in a steel culvert at the north end of the stubble field where it was released.

No attempt was made to determine what if any effect the temporary confinement may have had on the behavior of the fox after release.

Resting and Sleeping. Fox **A** and **B** had randomly occurring resting and sleeping periods, although they were more frequently found resting and sleeping during the daylight hours. Location of resting places

varied for both fox. Fox A was frequently located resting in the trees on the north end of the stubble field where it was released, but it was also found resting in other locations around the stubble field. Similarly, fox B was often found in the trees at the southeast corner of the stubble field, but it was also located resting in other locations around the field.

Procurement of Food and Water. The fox were assumed to do most of their hunting in the evening and early morning. Since the fox were beyond the transmitter's range during these hunting periods, no evidence could be secured to verify this assumption. The times and locations for getting water appeared to be random. The river on the study area provided an ample water supply, however there were no trails leading to the river's edge except from a den. Two distinct trails could be seen between the den and the river. The pups were assumed to use the den and the trails to the water shortly after they were born, however, only fox E was located near the den after tagging. It was probably the only fox tagged that used the trails from the den to the water.

Natural Boundary. The river provided a natural boundary which the fox were not observed to cross during the tracking session. The natal den of this fox family, however, was believed to have been on the opposite side of the river from where captured and released.

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