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RANGE AND POPULATION SIZE OF THE AMERICAN BURYING BEETLE (COLEOPTERA: SILPHIDAE) IN THE DISSECTED HILLS OF SOUTH-CENTRAL NEBRASKA

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Abstract—The American burying beetle (Nicrophorus americanus Olivier) is the only insect found in Nebraska currently on the federal endangered species list. I conducted surveys in 1995, 1996, and 1998 to determine range and population size of the American burying beetle in south-central Nebraska. A total of 826 individuals were captured during these three years. A Sequential Bayes Algorithm was used to estimate population size based on mark and recapture data. Results from this study and other studies identify the range of this population in south-central Nebraska as an approximately 4,500 km² area located south of the Platte River in Gosper, Frontier, Dawson, and Lincoln counties. Mark and recapture data from 1998 indicate the population size within this area is greater than 3,000 individuals. This exceeds the recovery goal of 500 individuals/population established by the United States Fish and Wildlife Service, and as such, along with populations in Oklahoma and Arkansas, also meets the recovery goal of three separate populations of that size within the Midwest Geographic Recovery Area for the species as identified in the Recovery Plan.

Key Words: American burying beetle, endangered species, Nicrophorus americanus

Introduction

The American burying beetle (Nicrophorus americanus Olivier) is one of 11 species of burying beetles found in Nebraska (Ratcliffe 1996). These beetles locate small, dead vertebrates. One male and one female beetle work together to bury the dead animal and then both stay with the developing larvae until the grubs pupate, with both the adults and young feeding on the buried carcass (Ratcliffe 1996).
The American burying beetle was listed as an endangered species on 14 August 1989 (*Federal Register* 54 [133]: 29652-55) and is the only insect on the endangered species list presently found in Nebraska (personal communication with Nebraska Game and Parks Commission’s Natural Heritage Program). Once found throughout temperate eastern North America, this species has experienced one of the most drastic declines in range ever recorded (Anderson 1982; Wells et al. 1983). It is currently known from only isolated locations in six states (Szalanski et al. 2000).

Recovery goals (US Fish and Wildlife Service 1991) call for three populations of the American burying beetle to be reestablished or discovered within each of four broad geographical areas within the historic range of the species. Nebraska is one of 12 states within the Midwest Geographic Recovery Area. Each population within the geographical recovery area is to contain a minimum of 500 adults and demonstrate self-sustainability for at least five consecutive years. The results given here, along with those of Bedick et al. (1999), provide data to review the conservation status of the American burying beetle in the Midwest Geographic Recovery Area.

Peck and Kaulbars (1987) list five locations in Nebraska where specimens of American burying beetle historically had been collected. The University of Nebraska State Museum has 19 specimens from six counties (Antelope, Cherry, Custer, Lancaster, Lincoln, and Thomas) collected in Nebraska prior to 1994 (B. Ratcliffe personal communication). During 1994 I trapped four specimens of American burying beetle along the Platte River and 36 specimens in the loess hills south of the Platte River located roughly between North Platte (Lincoln County) and Lexington (Dawson County), Nebraska (Peyton 1995). That sampling demonstrated the existence of a previously unknown population of American burying beetle, which I studied in central Nebraska from 1995 through 1998. The purposes of that study were: (1) identify the habitat and range of American burying beetle south of the Platte River in central Nebraska and (2) estimate population size.

**Materials and Methods**

**Study Site**

The area in south-central Nebraska surveyed for American burying beetles is an approximately 40-km-wide rectangle extending 100 km southeast to northwest (Fig. 1) between North Platte (Lincoln County) and Lexington (Dawson County). Thick riparian forest, consisting primarily of
cottonwood (*Populus deltoides* Barr), willow (*Salix interior* Rowlee), ash (*Fraxinus pennsylvanica* Marsh), and eastern redcedar (*Juniperus virginia* L.), extends 200 to 500 m to either side of the main channel of the Platte River. The remainder of the valley floor, which extends from 2 to 8 km both north and south of the active channel, contains hay meadows and irrigated farmground. To the south of the valley are dissected loess hills with rugged canyons that run perpendicular to the Platte Valley escarpment. These canyons are utilized primarily as pasture and contain numerous eastern redcedar, cottonwood, and ash groves. Farther south are the uplands between the Platte and Republican River valleys where farmground again becomes dominant. Bordering the loess hills on both the east and west is gently rolling rangeland interspersed with farmground (Peyton personal observation).

**Habitat and Range Size**

Under permits required by both the US Fish and Wildlife Service and the Nebraska Game and Parks Commission, the following protocol was
approved. Nonlethal traps, consisting of either a 20-liter bucket or a piece of 7.6 cm diameter PVC pipe 30 cm in length, were buried in the ground so the lip of the trap was flush with the surface of the ground. Bait consisted of salvaged roadkill small mammals or commercially acquired euthanized white lab rats. This bait was placed whole into a small container with a screen top and then put in the bottom of the trap. A lid was placed on raised platforms over the trap for protection from rain and sunlight. A 2-4 cm gap between the lid and the top of the trap allowed access for the beetles. Bedick (1997) compared these two trap types and found that both were equally effective at attracting American burying beetles. Traps were checked each day prior to 9:00 A.M. CDT to reduce heat stress on the beetles. All beetles found dead in the traps were deposited at the University of Nebraska State Museum as per federal and state permits.

Starting in May and ending in September 1995 traps were installed at 22 different locations (Fig. 2). The selection of trap locations was coordinated with Jon Bedick of the University of Nebraska State Museum (Bedick et al. 1999) to avoid overlap. The purpose was to identify the range of

Figure 2. Trap locations in 1995.
American burying beetles within the study area. Each location contained one trap and was trapped a minimum of five consecutive nights (5 trap nights). If no specimens of American burying beetle were trapped the trap was removed. If a specimen of American burying beetle was captured it was marked and released, and trapping continued at that site for the next seven days.

Seven locations were within 0.5 km of the Platte River, three locations were in the open rolling grasslands south of the Platte River valley, and 12 locations were in the steep canyon areas of the dissected loess hills south of the Platte River valley. Trap locations were a minimum of 5 km apart.

**Estimates of Population Size**

The size of the population within the study area was estimated from a mark-recapture protocol. When individual American burying beetles were trapped, they were marked with various colors (based on trap location) of an oil-based model paint (Testor Gloss Enamel) in a pattern of 1 to 4 dots placed on the elytra, and released. Once the first specimen was trapped at a site, trapping was continued at that site for seven nights.

Population size was estimated from the 1996 and 1998 data using a Sequential Bayes Algorithm. This method was used by Kozol et al. (1988) in estimating the population size of American burying beetles on Block Island, and, according to Gazey and Staley (1986), is preferable when dealing with rare species to the traditional method of sequential mark-recapture methods. Where low numbers of recaptures occur, the algorithm yields smaller confidence intervals and larger mean abundance estimates. It also predicts a more accurate minimum population number, whereas in traditional methods the lower population estimate may actually be less than the number sampled.

In 1996 the mark-recapture studies were conducted at three sites (Fig. 3) where specimens of American burying beetle were collected during 1995. Site 1, a canyon located in the loess hills south of Gothenburg (Dawson County), contained one trap and was trapped for 12 nights from 15 May to 22 May and again from 3 June to 9 June 1996. This site is easily accessible and was used primarily to identify when the beetles became active. Sites 2 and 3, Gilman and Calla Han Canyons, are also located in the loess hill southwest of Gothenburg (Lincoln County). All three sites are open pastures in which eastern redcedar, cottonwood, and ash are abundant in and among the side canyons. Sites 2 and 3 are approximately 5 km apart.
Figure 3. Trap locations in 1996.

At Site 2 (Gilman Canyon), I placed five traps approximately 50 m apart and ran them for 22 nights between 3 June and 11 July 1996 (110 trap nights). At Site 3 (Calla Han Canyon), the traps were in operation for 13 nights between 17 June and 11 July 1996 (65 trap nights).

During 1998, mark-recapture studies were conducted using 76 traps along eight transects (Fig. 4). Transects were located along county roads that run roughly north and south across the study area and are spaced approximately 10 km apart west to east. Transects were 20-40 km in length with 6-12 traps spaced approximately 4 km apart. The traps were in operation for 7-10 consecutive nights (652 trap nights) from 14 to 24 June 1998.

Results

Habitat and Range

I collected 201 specimens of American burying beetle at 11 of the 22 sites investigated during 1995 (Fig. 2). Nine of the sites, accounting for 199
Figure 4. Trap locations in 1998.

(99%) of the specimens captured, were in the canyons of the loess hills south of the Platte River valley. One beetle was collected in open, treeless grasslands, also within the loess hills. Only one specimen was collected in the eleven sites outside the loess hills south of the river, and that was along the Platte River within 3 km of the edge of the loess hills (Table 1).

Based upon locations from which sampling produced beetles in this study, plus work done by personnel from the University of Nebraska State Museum (Ratcliffe 1990; Jameson and Ratcliffe 1991; Ratcliffe 1996; Bedick et al. 1999), it appears the range of this species south of the Platte River in south-central Nebraska is primarily the dissected loess hills located south of the Platte River in Dawson, Frontier, Gosper, and Lincoln Counties.

Mark and Recapture Population Estimates

During 1995, 201 specimens of American burying beetle were trapped. Of those, 178 —were marked and released, 4 died in the trap, and 19 were
TABLE 1
TRAPPING SUCCESS FOR Nicrophorus americanus IN THREE HABITATS IN SOUTH-CENTRAL NEBRASKA DURING 1995

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Dissected hills south of the Platte River</th>
<th>Open grasslands south of the Platte River</th>
<th>Within 0.5 km of the Platte River</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trap nights</td>
<td>163</td>
<td>54</td>
<td>107</td>
</tr>
<tr>
<td>Percent of total effort</td>
<td>50</td>
<td>17</td>
<td>33</td>
</tr>
<tr>
<td>Number caught</td>
<td>199</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Percent of total caught</td>
<td>99</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Beetles/trap night of effort</td>
<td>1.22</td>
<td>0.02</td>
<td>0.009</td>
</tr>
</tbody>
</table>

captured on the last day of trapping at a given site and were released without marks. Eleven of the marked specimens (6.2%) were subsequently recaptured. All 11 were recaptured within five days of marking and 10 were recaptured in the same trap as originally trapped. One was recaptured in a trap 1.6 km away from the initial trapping location.

Of the 246 samples of American burying beetle collected in 1996, 231 were marked and released, 5 died in the trap, and 10 were captured on the final day of trapping at a given site and were not marked prior to release. Eighteen of the marked specimens (7.8%) were recaptured. One beetle was recaptured 13 days after and one beetle 22 days after the initial trapping. The recaptures were at the same trap location as the initial capture. One beetle was recaptured 30 days after marking, 11 km from the site where it was marked. All other beetles were recaptured within five days within 50 m of the location at which they were marked.

During 1998, 379 specimens were trapped. Of those, 297 were marked and released, 6 died in the trap, and 76 were trapped on the final day of the study and released without marks. Twenty-one of the 297 (7.1%) were recaptured, all within five days at the same location at which they were marked.

Collections in 1995 were designated to test the marking procedure and were helpful in identifying the range of the species. Population estimates were impossible to calculate from the data because sampling occurred at different sites during different times of the summer.
Range and Population Size of the American Burying Beetle

TABLE 2

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of locations</th>
<th>No. of trap nights*</th>
<th>No. of (N.) americanus captured</th>
<th>No. marked and released</th>
<th>No. recaptures</th>
<th>Percent recaptures</th>
<th>Population estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>22</td>
<td>324</td>
<td>201</td>
<td>178</td>
<td>11</td>
<td>6.2</td>
<td>NA</td>
</tr>
<tr>
<td>1996</td>
<td>3</td>
<td>187</td>
<td>246</td>
<td>231</td>
<td>18</td>
<td>7.8</td>
<td>1,602</td>
</tr>
<tr>
<td>1997</td>
<td>76</td>
<td>652</td>
<td>379</td>
<td>297</td>
<td>21</td>
<td>7.1</td>
<td>3,136</td>
</tr>
</tbody>
</table>

*a trap night is defined as one trap in operation for one night

Population estimates based on the 1996 data collected over three weeks at two locations were 1,602 (SE 425, 95% CI 970-2,614). Based on data collected over 10 days at 76 locations (Fig. 3) during 1998, the estimated population over the entire range is 3,136 (SE 713, 95% CI 2,023-4,791). Collections and population estimates for 1995, 1996, and 1998 varied (Table 2).

Discussion

Anderson (1982) hypothesized that the American burying beetle was a forest species and that deforestation of the eastern United States was a major cause in the decline of the species. This idea was supported by Lomolino and Creighton (1996) who determined that the American burying beetle was biased to forested sites with relatively deep soils and was more successful in breeding in the loose soils common in mature forests. Based upon this hypothesis the primary habitat of the American burying beetle in Nebraska was expected to be the riparian forests of the state’s major rivers, including the Platte River (Ratcliffe 1990; Jameson and Ratcliffe 1991).

However, recent study contradicts this idea. My work in 1994 (Peyton 1995), this study, and that of Bedick et al. (1999) resulted in trapping approximately 1,400 individual beetles in the dissected loess hills south of the Platte River in central Nebraska. The beetle does not appear to be common in other habitats, such as flat open grasslands and riparian forests,
as evidenced by this and other studies. First, I made an extensive effort to search habitats along the Platte River in 1994 (Peyton 1995) and 1995 and found only five beetles. Second, extensive trapping efforts made by Bedick and colleagues in areas surrounding the dissected hills produced no collections of American burying beetle (Bedick et al. 1999). Third, tapping of riparian forest habitats along the Missouri and Platte Rivers elsewhere in Nebraska have resulted in no collections of American burying beetle to date (B. Ratcliffe personal communication).

Results from the mark-recapture efforts indicate a population size within this range of about 3,000. However, problems occur using mark and recapture methods to establish estimates. Unfortunately, the American burying beetle violates two critical assumptions common to mark-recapture estimates which may have resulted in an underestimation of total population. These assumptions are that population size remains constant for the sampling period and that all individuals are available for recapture during each sampling interval. If beetles locate prey of suitable size and bury it, they stay and assist with the development of the young and are no longer a part of the population available for recapture. This is one reason I didn’t attempt to estimate population based upon the 1995 work that spanned the entire summer. During 1996 and 1998 all mark and recapture work was conducted in a shorter period of time (two to three weeks in 1996 and 10 days in 1998) in an effort to limit the impact on the population estimate caused by beetles leaving the population.

In addition, the low number of recaptures resulted in large standard error using the standard mark-recapture formulas. This reduces confidence in the estimate and can actually predict the lower limit of the population as less than the actual number trapped. Kozol et al. (1988) also experienced this problem when trying to estimate the size of the American burying beetle population on Block Island. They used the sequential Bayes algorithm method as suggested by Gazey and Staley (1986) to develop their population estimates of American burying beetles on Block Island. The algorithm accounts for low recapture data in relation to total population, and according to Gazey and Staley, “should prove quite useful in the initial estimation and monitoring of the population trends of rare species.”

Bedick et al. (1999), using more traditional mark and recapture formulas and fewer trapping locations, estimated a population of 1,600 individuals within this area, which was similar to the results I derived from trapping at only two locations in 1996. By using the data from 76 different trap locations spread evenly over the entire area and collected over the same
time period, along with the Bayes algorithm as suggested by Gazey and Staley (1986), I arrived at an estimate of over 3,000 individuals within the loess hills south of the Platte River in central Nebraska. This would identify this population as one of the largest known in the United States. It far exceeds the recovery goal of 500 individuals/population established by the US Fish and Wildlife Service, and as such, along with populations in Oklahoma and Arkansas, also meets the recovery goal of three separate populations of that size within the Midwest Geographic Recovery Area for the species as identified in the Recovery Plan.

Acknowledgments

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