2-22

Section 2.7.1
Reference 3
Section 2.7.2, ref. 110
Section 4.1, ref. 3

REFERENCE 2-22

Aquatic and Terrestrial Ecology Reconnaissance Surveys August 1980 Clinch River Breeder Reactor Plant Site

Prepared for
Clinch River Breeder Reactor Plant
Project Safety Division
Oak Ridge, Tennessee

November 1980

ENERGY IMPACT Associates
Pittsburgh, Pennsylvania

AQUATIC AND TERRESTRIAL ECOLOGY RECONNAISSANCE SURVEYS
AUGUST 1980
CLINCH RIVER BREEDER REACTOR PLANT SITE

Prepared for
CLINCH RIVER BREEDER REACTOR PLANT
PROJECT SAFETY DIVISION
OAK RIDGE, TENNESSEE

November 1980

Energy Impact Associates
P. O. Box 1899
Pittsburgh, Pennsylvania 15230

TABLE OF CONTENTS

(Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

SECTION 1.0
SUMMARY

Limited aquatic and terrestrial field reconnaissance surveys were conducted by Energy Impact Associates (EIA) on the Clinch River Breeder Reactor Plant (CRBRP) site and on the Clinch River adjacent to the site in August 1980 to identify apparent, significant changes since the 1974-75 baseline survey (CRBRP Environmental Report, Section 2.7). Additionally, new data, since 1975, obtained from available literature and personal contacts were reviewed.

1.1 AQUATIC ECOLOGY RECONNAISSANCE SURVEY

A one-day aquatic ecology field reconnaissance survey was conducted August 19, 1980 with the assistance of Tennessee Valley Authority (TVA) personnel and equipment. The field effort focused on a description of the physical habitat conditions of the river, in terms of bathymetry and general substrate character. Aquatic organisms incidentally encountered were also noted but not quantitatively sampled.

Bathymetric profiles of the Clinch River were obtained at the proposed intake, discharge and barge unloading areas using a recording fathometer. Results of this effort indicate that the Clinch River bottom profiles changed only slightly at the proposed intake and discharge locations from 1975 until 1980. At the proposed intake, the eastern side of the river bed appeared to be steeper than noted in 1974-75, whereas at the proposed discharge, the channel on the CRBRP side of the submerged bar was found to be deeper by approximately 6 feet. A bottom profile at the proposed barge unloading facility was also recorded. Since the barge unloading area was relocated since 1974-75, changes in the bottom profile at this location could not be determined.

Ponar bottom substrate grab samples indicated that bottom habitats have generally remained nearly the same since 1974-75. The Asiatic clam continues to be locally abundant in some grab samples. Macrophytes (large aquatic plants) were more abundant locally in 1980, apparently due to lower water flows, lower turbidity and warmer water temperatures in the Clinch River this year as compared to 1974-75.

Based on the one-day field reconnaissance and review of available literature and personal contacts, it is concluded that:

- In general, information examined in this effort did not indicate substantial changes in the aquatic ecology of the Clinch River since 1975. Apparent differences are as follows.

- There is an apparent increase in copper levels in the river.

- Aquatic macrophytes have increased in abundance; however, this is probably due to unusual weather and is not expected to persist.

- Two species of fish, the striped bass and the yellow bass, may be more abundant than in 1975.

- Sauger, an important game fish, may spawn in the section of the river bordering the CRBRP Site; the relative importance of this area for sauger spawning is unknown.

- Mature (4 years plus) striped bass in Watts Bar Lake use the Clinch River as a coolwater refuge during the approximate period of mid-July through October. The outside bend of the river between CRM 15 and CRM 17 appears to be a favored location.

- The blue sucker, listed as threatened in Tennessee, has been recently collected in Watts Bar Lake, but not in the Clinch River within approximately 15 miles of the Site.

1.2 TERRESTRIAL ECOLOGY RECONNAISSANCE SURVEY

A two-day field terrestrial ecology reconnaissance survey was conducted August 27 and 28, 1980. Personnel from Oak Ridge National Laboratory (ORNL) and TVA assisted with literature acquisition and description of changes to the site area. The EIA field effort centered upon visually evaluating disturbed lands

on the CRBRP site and examining populations of rare plant species observed during the 1974 baseline survey period that occurred near the CRBRP intake and discharge areas. The field effort also included sampling a shortleaf pine plantation that was established in 1976 and evaluating wildlife population changes on the CRBRP site based on habitat quality, limited sightings and published data. The sampled shortleaf pine plantation is designated "shortleaf pine plantation (1976)" in this report, to be consistent with ORNL forest categories.

Most of the site remains essentially as it was in 1974. Small areas disturbed by pre-construction activities have been partially revegetated by natural succession. Forest lands that were thinned, estimated at 550 acres, were moderately disturbed, while an area estimated at 25 acres that was clear-cut and planted with shortleaf pine was substantially changed. Forest management activities occurred according to the Oak Ridge forest management plan.

Rare plant species populations near the CRBRP intake and discharge areas remained undisturbed. The lizard's tail population consisted of approximately 200 individuals near the proposed discharge location, while the Carey's saxifrage population consisted of three individuals south of the proposed intake location.

Vegetation data obtained in the shortleaf pine plantation (1976) indicated low cover, low diversity and moderate tree growth. Diversity indices were low as expected for a young forest stand.

Wildlife activity during the survey period was low due to a severe local drought. However, published data indicated increasing whitetail deer populations for the Oak Ridge Reservation (ORR) as a result of hunting protection and abundant food. Wild turkeys were reported to be present and increasing on the ORR. Bobcat presence was confirmed and the population is increasing. Eastern cougar, listed as endangered in the U.S. and Tennessee, is a possible ORR resident. Eastern cougar and bobcat individuals travel over large areas in search of food.

Based on the two-day field reconnaissance and review of available literature and personal contacts, it is concluded that:

- Vegetation and wildlife on most of the site remains as during the 1974 baseline studies.

- Oak Ridge Reservation forest management activities, that were conducted per the ORR forest management plan, resulted in minor to major disturbances to CRBRP site forests. However, major management activities on the site are not expected again for at least 5 years.

- Weedy plant species and wildlife associated with early successional vegetation have increased in abundance on land disturbed by pre-construction activities. Approximately 25 acres of disturbed land remains sparsely vegetated.

- Whitetail deer and wild turkey populations have increased substantially since 1974.

- Other wildlife populations appear stable over the long-term based on habitat quality. Few species were observed during the survey as a result of drought conditions.

- The bobcat and possibly the eastern cougar apparently reside on the site part of the time. They both have large home ranges on the ORR. The eastern cougar is listed as endangered by the state of Tennessee and the U.S. Department of Interior.

- Rare plant species observed during 1974 surveys are not expected to be listed as threatened or endangered. Proposals to list three site species as threatened have been withdrawn.

- Several wildlife species listed as threatened or endangered by the state of Tennessee occur on the site, as discussed in the CRBRP Environmental Report, Section 2.7.1.4.5. Populations of these species are unknown, but habitat utilized by them has not changed significantly as a result of site disturbances.

SECTION 2.0
INTRODUCTION

Since the aquatic and terrestrial ecology field surveys were conducted in 1974 and 1975, ecological changes may have taken place in the Clinch River and on the Clinch River Breeder Reactor Plant (CRBRP) site (Figure 2-1). The aquatic baseline survey was conducted in 1974-75 and the terrestrial survey in 1974. In order to identify significant changes in the aquatic and terrestrial ecology of the site from that described in the Environmental Report (ER) through Amendment VIII,[1] the Aquatic Baseline Survey Report[2] and the Vegetational Data Report,[3] limited aquatic and terrestrial field reconnaissance surveys were performed and post-1975 literature and data examined. This effort was not intended to produce quantitative data for definitive comparison with baseline data, but rather to identify apparent, significant changes from baseline conditions noted in 1975. Locations of proposed facilities (for example, intake, discharge, barge unloading area and quarry) were determined from the site engineering plan.[4,5]

The aquatic field reconnaissance survey was conducted by Energy Impact Associates (EIA) with the assistance of Tennessee Valley Authority (TVA) personnel on August 19, 1980 to identify any apparent changes in the Clinch River adjacent to the CRBRP site with a focus on bottom profile (bathymetry) and bottom substrate. A terrestrial reconnaissance survey was conducted by EIA on August 27 and 28 with the assistance of Oak Ridge National Laboratory (ORNL) and TVA personnel on August 27 to evaluate site changes following timber harvest in 1975 and pre-construction site disturbances. Site evaluations included visually discernable wildlife population changes, rare plant population changes and vegetation changes on land disturbed by timber harvesting.

This report describes results of the one-day aquatic and two-day terrestrial reconnaissance field surveys along with a review of new information obtained since 1975. Apparent significant changes in the aquatic and terrestrial ecology baseline condition since 1975 are discussed in Sections 3 and 4, respectively. References cited are contained in Section 5. For the convenience of the reader, Figure 2.7-6 of the ER[1] (vegetation map and legend) is reproduced in Appendix A.

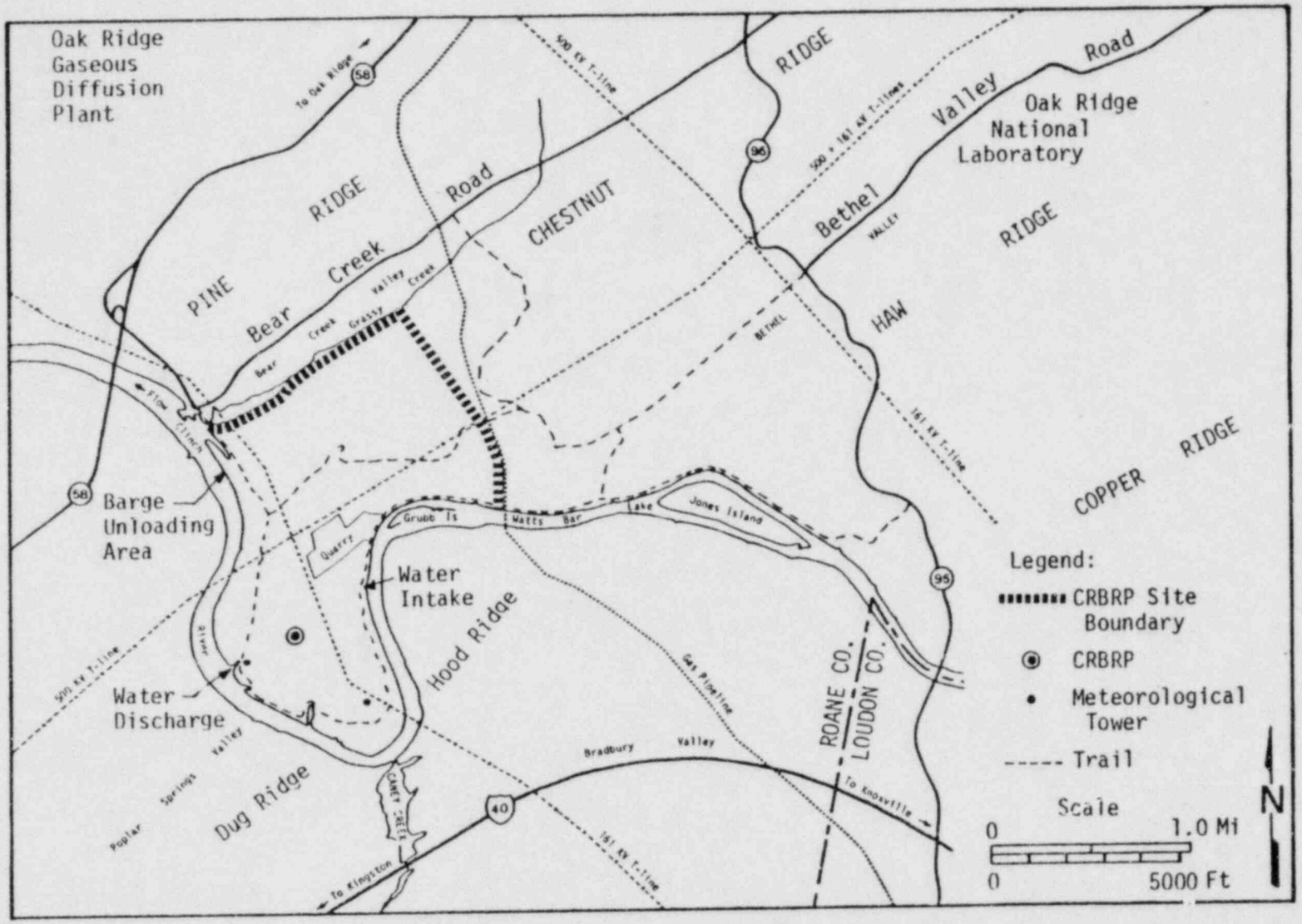


Figure 2-1. Clinch River Breeder Reactor Plant Site and Vicinity

SECTION 3.0
AQUATIC ECOLOGY RECONNAISSANCE SURVEY

Procedures and results of the aquatic ecology reconnaissance survey, including those utilized during the field reconnaissance survey and in obtaining current information (personal communications and literature), are described in the following sections.

3.1 PROCEDURES

3.1.1 FIELD PROCEDURES

A one-day field reconnaissance of the Clinch River bordering the site was conducted on August 19, 1980 by EIA, with the assistance of TVA personnel and equipment. The field effort included a visual inspection of the river and description of the physical habitat conditions of the river in terms of bathymetry and general substrate character. Aquatic organisms incidentally encountered were also noted, but no quantitative sampling of organisms was performed.

3.1.1.1 SAMPLING LOCATIONS

Field work was performed at the same approximate locations as were sampled during the aquatic baseline study[1,2] and included the area near the currently proposed barge unloading facility. Shoreline reference points established for the 1974-75 studies were not found, so minor location variations from the baseline program may have occurred. Bottom samples collected near the proposed intake were later found to have been taken approximately 400 feet downstream of the baseline transect location.

Shown in Figure 3-1 are locations of transects for benthic (bottom) sampling (numbered) and for bathymetric profiles (lettered). Bottom samples were collected at three points along each of five numbered transects (Transects 1 through 5), approximately 0.3, 0.5 and 0.7 of the river width from the right

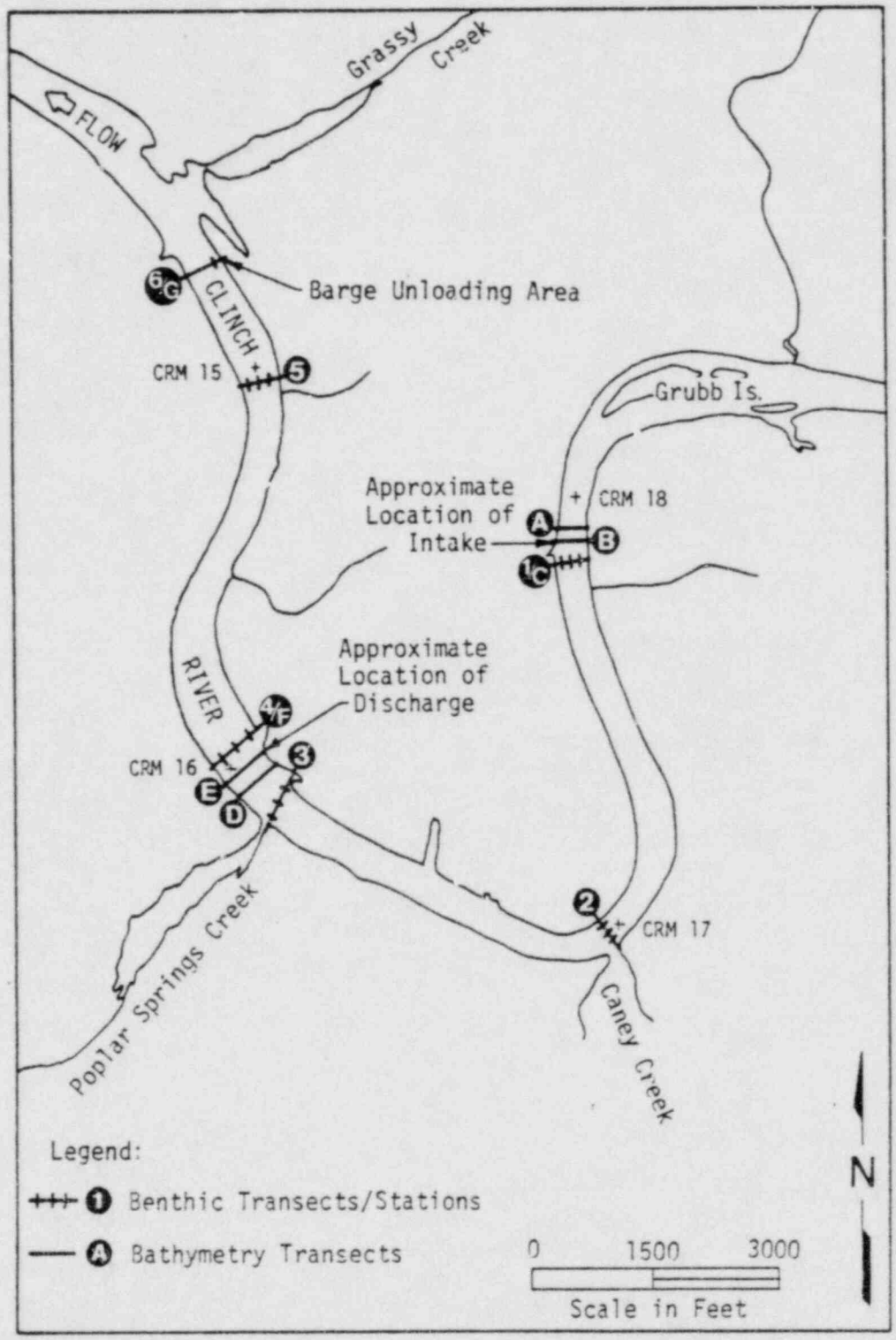


Figure 3-1. Location of Transects for Sampling Bottom Substrate (Numbered 1 through 6) and for Bathymetric Profiling (Lettered A through G) in the Clinch River, August 19, 1980

bank facing downstream. These points are indicated in Figure 3-1 as short dashes crossing the transect. Near the proposed barge unloading facility location (Transect 6), the bottom was examined only near the right shore (where dredging and other activities would occur), at approxmately 0.1 of the river width distance.

Bathymetric profiles were restricted to series near the proposed intake and discharge locations, and a single profile at the barge unloading area (Figure 3-1).

3.1.1.2 FIELD METHODOLOGY

Bathymetric profiles were taken using a boat-mounted Lowrance recording fathometer. Accuracy of the fathometer was checked using a calibrated depth chain. Boat speed was maintained as constant as possible during recording periods. River width was estimated to the nearest 50 feet from U.S. Geological Survey maps showing the shoreline at river elevation of 741 feet MSL.

Bottom substrate type was sampled using a Ponar grab operated by means of a powered winch. As was the practice during the baseline survey, two to five attempts were made to collect a composite sample at each station. Materials collected were visually examined, substrate qualitatively described, and presence of organisms noted. If three attempts yielded no bottom material, it was assumed that the bottom consisted of large rock or other large impenetrable hard surfaces.

Observations were also made of visible features of the aquatic habitat and of submerged macrophyte beds. Samples of several macrophytes were returned to EIA's laboratory for examination.

3.1.2 ACQUISITION PROCEDURES FOR CURRENT INFORMATION

The availability of aquatic ecology data collected in the vicinity of the CRBRP site since 1975 was determined through phone and personal contacts with

personnel from TVA, Oak Ridge National Laboratory (ORNL), the Tennessee Wildlife Resources Agency (TWRA), and Tennessee Technological University (including former graduate students) and through review of available literature and data. Information learned during phone conversations is noted as such unless written materials substantiating the communication have also been reviewed.

3.2 RESULTS OF THE FIELD RECONNAISSANCE

August 19, 1980 was hot, humid and sunny. Thundershowers occurred sporadically in the afternoon. During the period of the field reconnaissance (9:30 a.m. to 1:30 p.m.), the river changed according to operation of Melton Hill Dam from zero flow to 10,000 cubic feet per second (cfs).[3] This resulted in a variation in water surface elevation from approximately 740 feet above mean sea level (MSL) to approximately 740.5 feet MSL.[3]

In general, the river appeared similar to the descriptions in the ER.[1] Shorelines were generally steep and wooded, with the exception of pastureland on the east side of the river near the proposed intake location. In the wooded areas, fallen trees frequently provided cover close to the shorelines. The water was moderately turbid; for example, the ponar grab was visible only within approximately 2 feet of the water surface.

3.2.1 BATHYMETRY

Bathymetric profiles of the river near the proposed water intake, discharge and barge unloading facility are presented in Figures 3-2, 3-3 and 3-4, respectively.

The river bottom near the location of the proposed intake (Figure 3-2) forms a broad river channel with a maximum depth of 23 to 26 feet. A narrow (less than 50 feet in width), shallow (5 feet deep or less) bench occurs along the western shore of the river (on the CRBRP site side). Comparison of Figure 3-2 with Figures 2.5-5 and 2.5-7 of the Environmental Report[1] indicates that

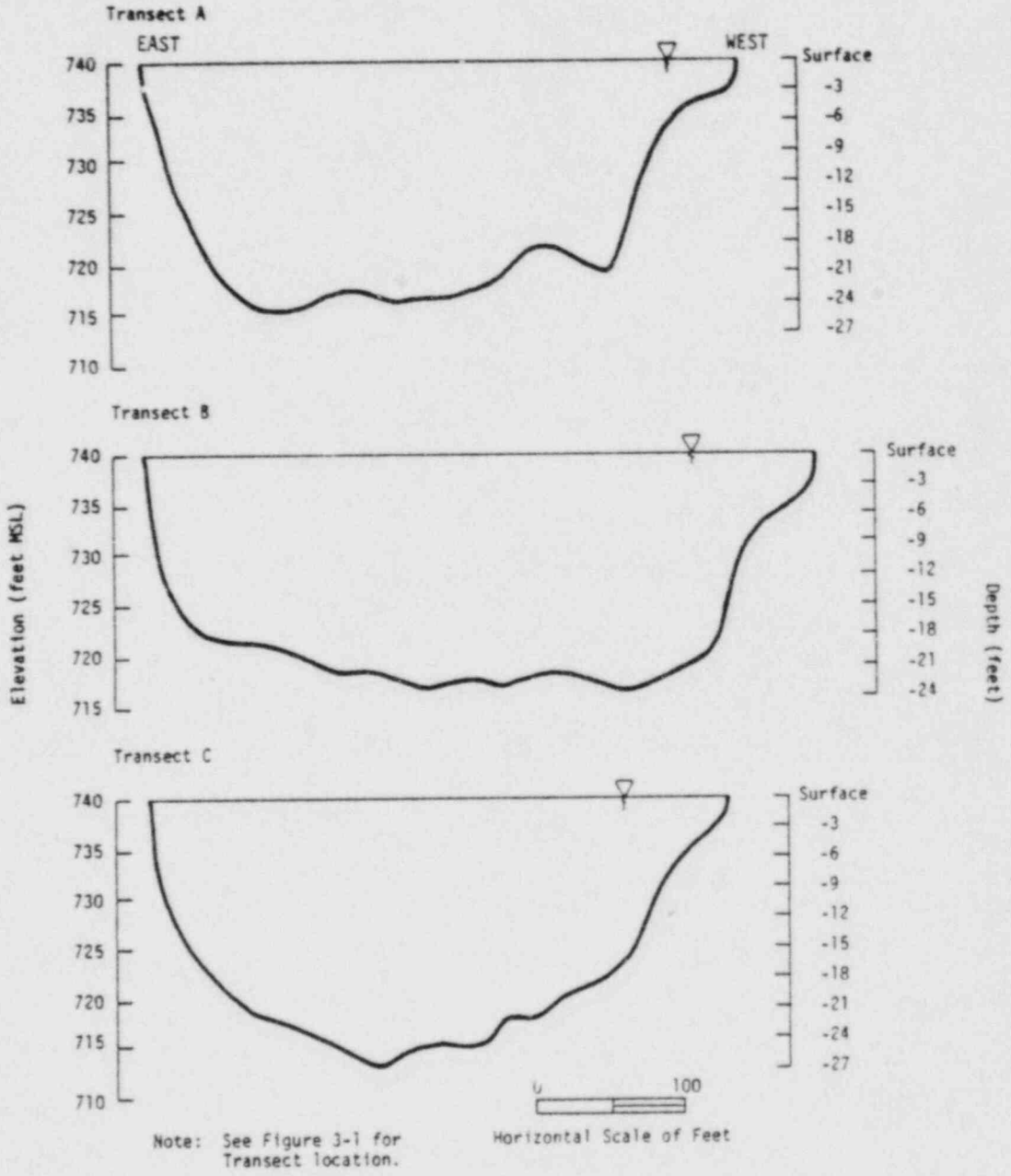
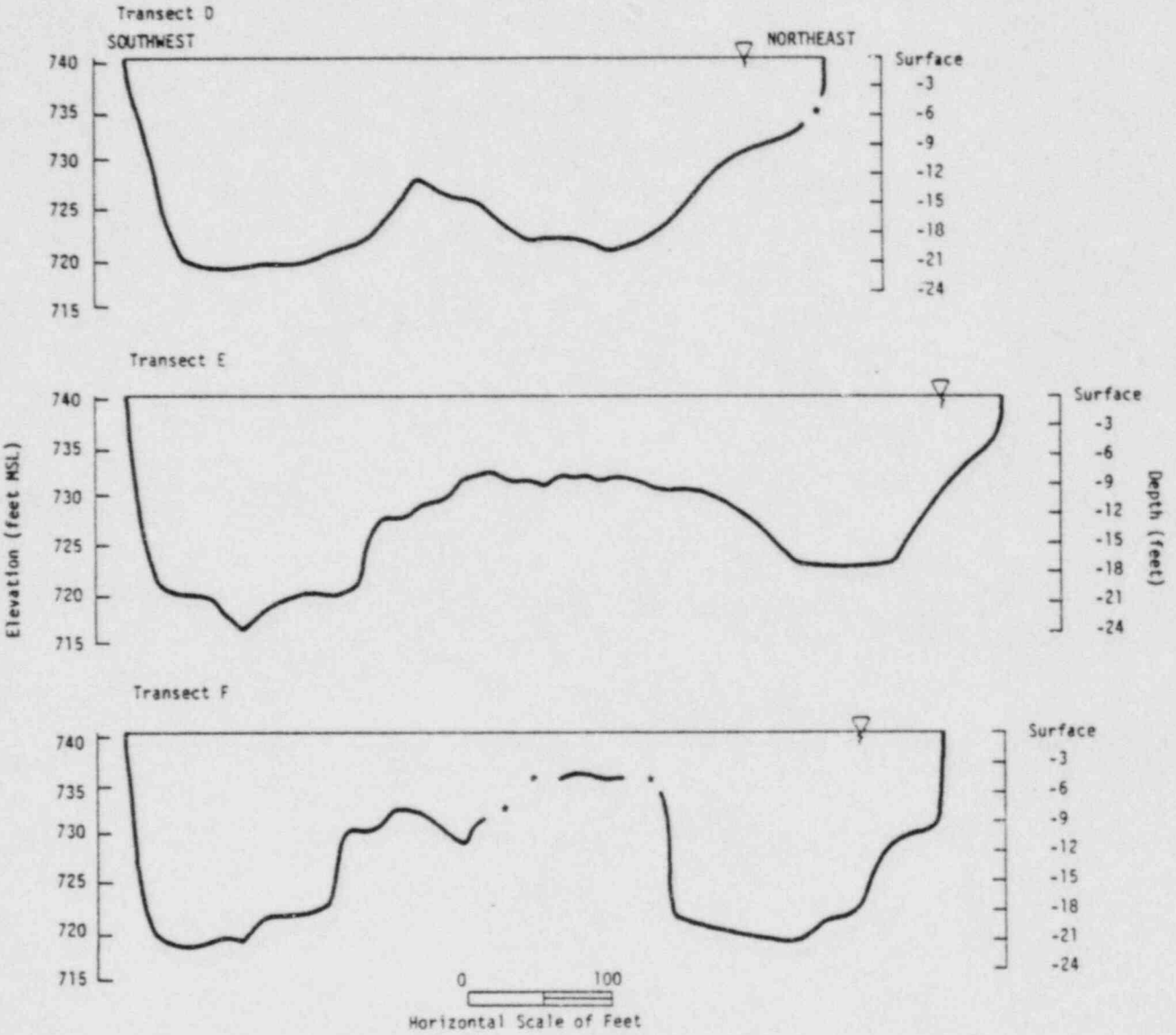


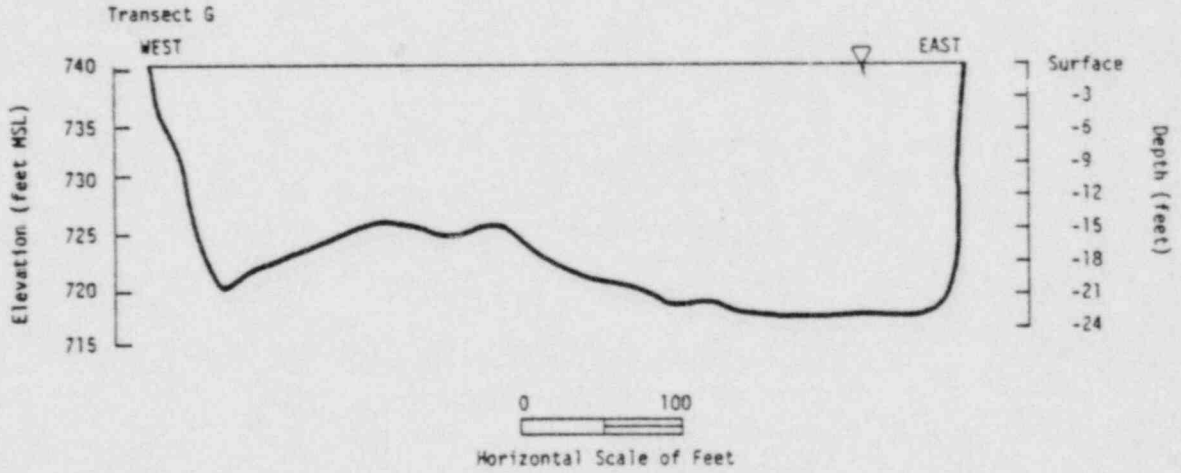
Figure 3-2. Bathymetric Profiles of the Clinch River Near the Proposed Location of the Water Intake



Note: See Figure 3-1 for Transect location.

* Depth obscured by dense macrophyte growth.

Figure 3-3. Bathymetric Profiles of the Clinch River Near the Proposed Location of the Wastewater Discharge



Note: See Figure 3-1 for Transect location,

Figure 3-4. Bathymetric Profile of the Clinch River Near the Proposed Location of the Barge Unloading Area

the bottom is only slightly changed from 1974-1975: the eastern side of the river bed appears to be steeper than that recorded in 1974-75.

Profiles taken near the proposed discharge location show the continued presence of a large submerged bar in the center of the river (Figure 3-3). Comparison of Figure 3-3 with Figures 2.5-6 and 2.5-8 of the ER[1] indicates that the channel on the northeast side of this submerged bar, that is, the channel nearest the CRBRP site, is currently deeper by approximately 6 feet.

These results suggest that some enlargement of the river channel has taken place since 1975, but that subsurface features of the Clinch River are otherwise similar to those of 1974-1975. Differences in results may also be due in part to some variation in the precise measurement points used during the 1980 and 1974-1975 surveys.

A bottom profile was also determined for the river in the area of the proposed barge unloading facility (Figure 3-4). In this area, the edges of the river fall steeply to a maximum depth of approximately 23 feet (elevation 717.5 MSL). A small rise (10 feet maximum height above the river bottom) occurs toward the western side of the river. Because the barge unloading area location was changed after the baseline surveys were completed, no previous data for this area are available. Therefore, direct comparison with 1974-75 data is not possible for this location.

3.2.2 SUBSTRATE

Ponar grab samples were collected in locations corresponding to those sampled in the 1974-75 baseline survey,[1] except in the area of the intake where samples were taken approximately 400 feet downstream of the 1974-1975 baseline transect. Samples were also collected near the location of the currently proposed barge unloading facility. Locations are shown in Figure 3-1. The results are summarized in Table 3-1.

Comparison of these results with Tables 3.0-22 through 3.0-28 in the Aquatic Baseline Survey Report (ABSR)[2] indicates that the bottom substrates have

TABLE 3-1

RESULTS OF PONAR GRAB SAMPLING IN THE CLINCH RIVER, AUGUST 19, 1980

Transect*	Station**	Substrate†	Organisms
1	0.3	Gravel (4-5 cm)	none
	0.5	Hard bottom ††	none
	0.7	Clay, coarse sand	Corbicula shells
2	0.3	Hard bottom,†† some small gravel	none
	0.5	Hard bottom††	Corbicula shells, 2 cm
	0.7	Granule, gravel-boulder	Corbicula shells, up to 1.5 cm
3	0.3	Clay	none
	0.5	Sand to gravel (to 7.6 cm)	none
	0.7	Clay, fine sand	2 live Corbicula, 0.8 and 2.0 cm
4	0.3	Clay, some organic matter	snail shell; mayfly (Ephemeridae)
	0.5	Coarse sand to granule	none
	0.7	Coarse sand to granule	several live Corbicula, <0.5 cm
5	0.3	Gravel	Corbicula shells
	0.5	Coarse sand	none
	0.7	Granule, gravel (0.3-1 cm)	several live Corbicula, 2+ cm; snail shell
6	0.1	Gravel-boulder	several live Corbicula, 0. cm

* Refer to Figure 3-1 for location.

** Approximate fractions of river width from right bank facing downstream.

† Approximate designation following Table 2.7-36 in ER.(1)

†† Ponar grab did not penetrate substrate.

remained nearly the same since 1974-75. Small differences between these two sampling periods at individual stations are probably due to slight variations in sampling locations or to localized water changes. In no case were the 1980 results inconsistent with the range of observations made at each station during the baseline survey.[2]

The bottom type near the proposed barge unloading area (Transect 6 on Figure 3-1) had not been evaluated previously. A series of Ponar grabs were taken in this area on August 19, with large rocks (up to 15 cm) being the only bottom material recovered.

Although it was not the purpose of the reconnaisance survey to sample aquatic organisms, ponar samples were also visually scanned in the field for signs of aquatic life. Live Asiatic clams (Corbicula sp.) or their shells were collected in several locations (Table 3-1). This organism was regularly abundant in the 1974-75 collections.[1,2] Live individuals were collected during the reconnaissance survey at Transects 3, 4 and 5 along the left bank facing downstream (away from the CRBRP site), and near the proposed barge unloading area. Compared with 1974-75 data (Tables 3.0-111 through 3.0-119 in the ABSR),[2] these results suggest a more restricted distribution of this organism than previously noted. Although benthic grabs such as the Ponar are relatively inefficient sampling gear for Corbicula,[4] this methodology was consistent with that used in the baseline survey. Other surveys in various areas of Watts Bar Lake suggest that this organism is still generally increasing in abundance, although sporadic, unexplained die-offs occur yearly in some locations.[5]

Several aquatic snail shells were collected, but no live individuals. One aquatic insect, a burrowing mayfly nymph (Ephemeridae) was taken in the soft bottom at Transect 4, Station 0.3. Hexagenia (a member of the Ephemeridae) was collected on several occasions in 1974-75.[1]

In summary, it appears that changes in the bottom substrate of the Clinch River near the CRBRP site since 1975 have been slight. Benthic organisms noted in August 1980 were also collected in the 1974-75 surveys.

3.2.3 MACROPHYTES

The major difference between the present aquatic ecology as noted during the August 19 reconnaissance field survey and that of 1974-75 was an increased abundance of macrophytes (large aquatic plants). In the 1974-75 aquatic baseline study, macrophytes were characterized as sparse, with only occasional collection of Eurasian water milfoil (Myriophyllum sp.), the bryophyte (Fontinalis sp.) and the liverwort (Scapania sp.).

In contrast, during the August 19 reconnaissance survey at least six species[6] of macrophytes were observed in scattered beds in shallow water, as indicated in Table 3-2. The most common macrophyte was pondweed (Potamogeton pectinatus), which formed the bulk of most of the observed beds. Also occasionally abundant were coontail (Ceratophyllum demersum) and water milfoil (Myriophyllum sp.). The macrophytes Potamogeton crispus, Potamogeton pusillus and Najas sp. were also present.

The macrophyte beds observed, while dense, were generally not large enough to cause a nuisance. An exceptionally large stand of plants was observed on the shallow bar in the vicinity of the proposed discharge (bathymetric Transect F on Figure 3-1); this bed was approximately 150 feet wide and several hundred feet long.

A phone conversation with Leon Bates, TVA biologist at the Muscle Shoals, Alabama facility, provided information that macrophyte growth had increased throughout eastern Tennessee in 1980.[7] The exact cause is uncertain, but is probably related to unusual summer weather. A prolonged hot, dry period decreased water flows and turbidity and increased water temperatures during the summer of 1980. These conditions are favorable for macrophyte growth. When the weather moderates, macrophyte growth is expected to subside. Bates also substantiated that water milfoil (Myriophyllum), Potamogeton pusillus and Najas minor are common near the CRBRP Site[7]

TABLE 3-2

AQUATIC MACROPHYTES OBSERVED IN THE CLINCH RIVER, AUGUST 19, 1980

Transect*	Station**	Species Observed
A	0.9	Potamogeton pectinatus, Ceratophyllum demersum
B	0.1	Potamogeton crispus†, Najas sp., P. pectinatus
C	-	no macrophytes observed
D	0.9	Potamogeton pusillus†
E	0.1	Myriophyllum sp., Potamogeton pectinatus
F	0.5	Potamogeton pectinatus†, Myriophyllum sp.
G	--	no macrophytes observed

* Refer to Figure 3-1 for transect location.

** Approximate fraction of river width from right shore, facing downstream.

† Specimen collected and identification verified in laboratory.(6)

3.3 CURRENT INFORMATION

In addition to the results of the aquatic ecology field reconnaissance survey discussed above, conversations with TVA, ORNL, TWRA and Tennessee Technological University personnel and review of literature provided information in the following sections.

3.3.1 WATER QUALITY, BENTHIC MACROINVERTEBRATES, PLANKTON AND PERIPHYTON

Water quality appears unchanged in the Clinch River except for an apparent increase in the concentration of copper.[8,9] This trace metal was below detection limits during the baseline survey, but was sometimes detected during the pre-construction monitoring program. The average copper concentration at five locations ranged from 30 to 40 µg/l with a standard deviation of 19 to 36 µg/l.[8] There is little information to suggest significant changes in most groups of organisms, including benthic macroinvertebrates (bottom-dwelling animals visible to the unaided eye), zooplankton and phytoplankton (free-floating microscopic animals and plants, respectively) and periphyton (the algal community attached to submerged surfaces), since 1975.[8] It is apparent that dominant species may vary; this is especially true of algal species. Such differences are consistent with natural yearly variation. Differences in sampling stations and methodology may have enhanced observed differences.

3.3.2 FISH

The fish community has received the most intensive examination since 1975, but much of the information is as yet unpublished. Differences between current information and 1974-1975 baseline survey results are as follows.

- The Clinch River near the CRBRP site may be used by sauger, an important game fish, for spawning.[10,11] The importance of the site area in this regard relative to other locations in Watts Bar Lake is unknown. This was not suspected in 1975 for at least two reasons: (a) the common presumption was (and still is) that

these fish spawn in dam tailraces in the Tennessee Valley, and (b) no sampling of adult fish occurred during April, which appears to be the primary spawning month for this species in the Clinch River.

- Striped bass and yellow bass appear to be more numerous than in 1975.[12,13] The increase in the former is due to stocking by the Tennessee Wildlife Resource Agency which began in 1971 and increased in intensity beginning in 1975.[14]

- Very recent information shows that larger (4 years +) striped bass use the Clinch River in general as a coolwater (less than 75°F) refuge during the warmer months (mid-July through October).[14-17] The outside bend of the river from approximately CRM 15 to CRM 17 (Figure 3-1) appears to be a favored location;[14-17] the proposed CRBRP discharge is on the inside of the bend at approximately CRM 16. Another preferred location appears to be the western side of the river near the Grubb Islands,[15] from approximately CRM 18 to CRM 18.5.

- The blue sucker, a species of threatened status in Tennessee,[18] has been collected in Watts Bar Lake twice since 1975. One fish was collected at CRM 0.3 in 1975,[19] and one was collected in the Tennessee River near Loudon in 1977.[20] Although habitat in the Clinch River appears to be suitable for this species,[21,22] no blue suckers have been reported from the river near the Site.

- More species of fish larvae[10] have been collected in the Clinch River downstream of the CRBRP site than were reported in the ER. Location and methodology differences may account for the varying results.

- Otherwise, there does not appear to have been any discernable change in the fish community.

There is more information on the fish community of the Clinch River near the CRBRP site that has not yet been obtained for review. This includes a report in preparation by ORNL personnel and an environmental report prepared by Exxon Nuclear, Inc.

3.4 CONCLUSIONS

Based on the one-day field reconnaissance and review of available literature and personal contacts, it is concluded that:

- In general, information examined in this effort did not indicate substantial changes in the aquatic ecology of the Clinch River since 1975. Apparent differences are as follows.

- There is an apparent increase in copper levels in the river.

- Aquatic macrophytes have increased in abundance; however, this is probably due to unusual weather and is not expected to persist.

- Two species of fish, the striped bass and the yellow bass, may be more abundant than in 1974-1975.

- Sauger, an important game fish, may spawn in the region of the river bordering the Site; the relative importance of this area for sauger spawning is unknown.

- Mature (4 years plus) striped bass in Watts Bar Lake use the Clinch River as a coolwater refuge during the approxiamte period of mid-July through October. The outside bend of the river between CRM 15 and CRM 17 appears to be a favored location.

- The blue sucker, listed as threatened in Tennessee, has been recently collected in Watts Bar Lake, but not in the Clinch River within approximately 15 miles of the Site.

SECTION 4.0
TERRESTRIAL ECOLOGY RECONNAISSANCE SURVEY

Procedures and results of the terrestrial ecology reconnaissance survey, including those utilized during the field reconnaissance survey and in obtaining current information (personal communications and literature), are described in the following sections.

4.1 PROCEDURES

A two-day field reconnaissance survey and data gathering trip was conducted by EIA on August 27 and 28, 1980. ORNL and TVA personnel assisted with the survey on August 27. General visual evaluation of site changes since baseline conditions (1974), as reported in the CRBRP Environmental Report (ER)[1] and the Vegetational Data Report (VDR)[2], were made along the peripheral and cross-site trails shown in Figure 2-1 and at the proposed reactor site, discharge, intake and quarry.[3] Vegetational plots were emplaced in the shortleaf pine plantation (1976) to evaluate species present, importance values and diversity. Rare plant species populations near the CRBRP that were observable at this season were examined for numbers of individuals and changes since 1974. Wildlife observed during an early morning survey and during general visual evaluations of site changes were recorded. Field sampling was supplemented with information obtained by conversations with personnel from ORNL and TVA during site evaluations August 27 and with literature provided by the participants.

4.1.1 GENERAL VISUAL OBSERVATIONS

On August 27, selected portions of the site were visually examined by EIA, ORNL and TVA personnel for changes since 1974. These portions included harvested forest stands, the proposed reactor location, access roads (peripheral and cross-site, as shown in Figure 2-1), proposed quarry site, rare plant population locations near the proposed intake and discharge, the cedar forest near the proposed intake and the oak-tulip poplar natural area near the eastern site boundary. Disturbed land was photographically documented and the type and extent of disturbance recorded. Significant species observations were also recorded.

Vegetation communities noted in the text refer to those shown on Figure 2.7-6 of the CRBRP-ER.[1] This figure is reproduced in Appendix A for the convenience of the reader.

4.1.2 VEGETATION PLOT SAMPLING

On August 28, EIA sampled two point-centered vegetation plots in a shortleaf pine plantation that was established in 1976. This 25-acre plantation was Community C, a former shortleaf pine-Virginia pine forest that was clear-cut, scarified and replanted with shortleaf pine seedlings in 1976. The plantation is termed "shortleaf pine plantation (1976)" in this report. The vegetation plots included a 53.8 ft^2 ground cover plot (4.14 ft. radius) for herbaceous plants and woody stems shorter than 4.5 feet tall and a 538 ft^2 woody sapling plot (13.1 ft. radius) for woody stems 4.5 feet and taller but less than 0.5 inch diameter at 4.5 feet above the soil surface. No woody stems larger than 0.5 inch diameter at 4.5 feet above the soil surface were observed in this clear-cut community. Species name, number of plants per species, number of stems per species and percent cover per species data were recorded for each plot size. Total percent of soil surface shaded by vegetation, percent not shaded, percent shaded by dead stems and leaves, slope, direction, aspect, stand age and canopy height were also recorded for each plot. In addition, species observed in the vegetation type but not present on a vegetation plot were recorded to document their presence.

Vegetation data analyses are as described in the Clinch River Breeder Reactor Plant, Vegetational Data Report.[2]

4.1.3 WILDLIFE OBSERVATIONS

Wildlife sightings, tracks and other signs observed by EIA during site activities were recorded. In addition, EIA personnel conducted an early morning survey. Beginning at sunrise August 28, EIA personnel drove the peripheral site road slowly from the entrance gate to the proposed quarry site (Figure 2-1) and recorded wildlife calls, songs and sightings.

4.1.4 ACQUISITION PROCEDURES FOR CURRENT INFORMATION

The availability of terrestrial ecology data collected in the vicinity of the CRBRP site since 1974 was determined through phone contacts with ORNL and TVA personnel. Literature and personal communications are cited as appropriate in the following sections.

4.2 RESULTS OF THE FIELD RECONNAISSANCE

Weather on both August 27 and 28 was foggy in the early morning and partly cloudy (5 to 10 percent cover) from 9 A.M. until evening when a light fog formed. The region was enduring a prolonged drought. Soil moisture had been so depleted that the leaves on many understory trees were wilted by late morning. Leaves on a few overstory trees were wilted from late morning until early evening on August 27. Soil was dry and hard. Springs that normally flowed freely were dry.

As a result of the severe drought conditions, bird and mammal activity was very low even during early morning hours. No reptiles or amphibians were observed during the brief survey period.

4.2.1 GENERAL OBSERVATIONS

General observations include those associated with forest management, preconstruction disturbances and special site features.

4.2.1.1 FOREST MANAGEMENT DISTURBANCES

In accordance with planned 1975 Oak Ridge Reservation (ORR) forest management,[3] all pine trees on the site that were affected by southern pine beetle were cut, loblolly and white pine plantations were thinned and shortleaf and Virginia pine stands were either clear-cut and replanted to pine or just thinned. The shortleaf-Virginia pine stand identified as Community C in Appendix A was clear-cut in 1975, scarified and replanted with shortleaf pine seedlings in 1976, based on observed tree age. Other pine stands were thinned as planned

to promote vigorous growth of crop trees or to promote reproduction of pines or hardwoods depending on site capability. A total area estimated at approximately 500 acres was affected by pine thinning activities and 25 acres by clear-cutting and replanting.

Hardwood forest (Community K, Appendix A) on the upper north-facing part of Chestnut Ridge was thinned as planned by removing diseased and poorly formed trees. Approximately 50 acres (Appendix A, Figure 2.7-6)[1] were affected by this thinning operation. One 40-foot tall chestnut sapling in this hardwood forest was observed to be dead from chestnut blight. Other smaller chestnut saplings nearby appeared to be healthy.

4.2.1.2 PRE-CONSTRUCTION DISTURBANCES

Core-drilling activities and pre-construction stability tests and excavation activities observed from 1973 to 1975 had disturbed portions of the CRBRP site near the proposed reactor core structures and nearby land. Approximately 33 acres in an area estimated at 360 acres were observed to be disturbed by these activities. Tests for a quarry site, conducted in 1976 and 1977 as indicated by ages of tree saplings and stump sprouting disturbed approximately 3 additional acres.

Land disturbed by pre-construction activities was observed to consist of unimproved roadways and cleared land for 2 meteorological towers, subsurface stability tests, water permeability tests and miscellaneous tests. Herbaceous vegetation has stabilized approximately 25 percent of disturbed land (eight acres). The remaining 25 acres were sparsely vegetated and subject to water erosion.

4.2.1.3 SPECIAL SITE FEATURES

The hillside southeast of the proposed quarry (Figure 2-1) was observed to have layered rock strata dipping approximately 30 degrees southeastward toward the Clinch River. Portions of these rock strata were exposed on two steep rock faces dipping outward toward the river. Portions of individual rock layers

had weathered loose and fallen to the roadside of the peripheral road. Other portions of these layers had weathered sufficiently that they were only weakly in contact with underlying layers, a condition suggesting a significant rockslide potential. However, depth of rock weathering or actual rockslide potential could not be determined from visible surface conditions.

Two rare plant species populations identified near the proposed water intake and discharge locations were examined. Lizard's tail population evaluation near the proposed wastewater discharge on August 27 indicated an approximate population of 200 plants.[4] The population had not been disturbed since 1974 and has been stable since then. Carey's saxifrage was observed August 28 on a limestone rock face approximately 400 feet south of the proposed intake location. The population consisted of three plants in a very restricted area near the river.[4]

The cedar forest adjacent to the proposed intake was undisturbed since 1974. Species presence, small topsoil piles and cedar trees remained as they had been in 1974.[4]

The oak-tulip poplar natural area (Community A, Appendix A) remained essentially as in 1974. The only changes were 6 years of growth on individual trees, recent clearing of shrubby vegetation on the adjacent gas pipeline corridor with a bush-hog pulled by a tractor and herbicide spraying on the corridor. Tulip poplar, oak and hickory trees adjacent to the pipeline right-of-way were dying from herbicide injury.

4.2.2 VEGETATION DATA

Vegetation in the shortleaf pine plantation that replaced Community C (Appendix A, Figure 2.7-6)[1] was sampled during this brief reconnaissance field survey to evaluate vegetation present on this clear-cut and replanted land. Shortleaf pine had grown to a maximum height of 5.5 feet and therefore was absent from the overstory plots (stems > 6.0 inches diameter) and only poorly represented in the understory plots (stems > 4.5 feet tall). Ground cover and understory

vegetation data are summarized in Tables 4-1 and 4-2 using the same format as in the VDR.[2]

The four-year-old shortleaf pine plantation had a weak but developing canopy at 4 feet that shaded nearly 15 percent of the soil surface. The ground cover vegetation category covered 65 to 70 percent of the soil surface leaving 30 to 35 percent of the soil bare and exposed to soil erosion. Dead stems covered less than 5 percent of the plot area.

4.2.2.1 IMPORTANCE VALUES AND SPECIES PRESENCE

Decumbent panic grass (Panicum sp.) dominated the ground cover representing 33 percent importance; average panic grass cover on each plot was 45 percent (Table 4-1). Bush-clover (Lespedeza violacea), dwarf cinquefoil (Potentilla canadensis) and shortleaf pine were second, third and fourth in importance having importance values of 14.3, 5.8 and 4.7, respectively. Seedlings of sweetgum (Liquidambar styraciflua), biltmore ash (Fraxinus americana var. biltmoreana) and tulip poplar (Liriodendron tulipifera) were also sampled in this shortleaf pine plantation (Table 4-2). Tree seedlings of seven other species were also observed in the plantation (Table 4-3). Twenty-three of the 50 taxa observed in the plantation were weedy. Nineteen woody and six herbaceous taxa observed had previously been sampled in Community C, while sixteen of these occurred in both Communities D and J.

4.2.2.2 DIVERSITY INDICES

Shannon-Weaver diversity indices were calculated from 1980 and 1974 data[2] using the formula in Reference 5. These indices were summarized by general forest category (hardwood, successional pine, pine plantation, cedar and hardwood-cedar) and presented in Figures 4-1 and 4-2. Data indicated as SP-80 were obtained in 1980. All other indices were computed from 1974 data.[2] Diversity indices of sampled overstory trees included a standard error (SE) of the mean estimate as indicated by a box surrounding the mean in Figures 4-1 and 4-2 (SE equals standard deviation divided by number of observations in the mean). A

TABLE 4-1

GROUND COVER VEGETATION DATA FOR THE CLINCH RIVER SITE - SHORTLEAF PINE PLANTATION (1976) - AUGUST 28, 1980*

Species	Number of Quadrats	Number of Stems	Percent Cover	Relative Percent Frequency (% F)	Relative Percent Density (% D)	Relative Percent Cover (% C)	Importance Value (IV)
Panicum sp. (Decumbent panic grass)	2	1,296	91.0	5.1	64.4	30.0	33.2
Lespedeza violacea (Bush-clover)	2	476	43.0	5.1	23.7	14.2	14.3
Potentilla canadensis (Dwarf cinquefoil)	2	27	33.0	5.1	1.3	10.9	5.8
Pinus echinata (Shortleaf pine)	2	2	27.0	5.1	.1	8.9	4.7
Conyza canadensis (Horseweed)	1	46	18.0	2.6	2.3	5.9	3.6
Solidago nemoralis (Gray goldenrod)	1	19	17.0	2.6	1.0	5.6	3.0
Lespedeza repens (Creeping bush-clover)	2	10	9.3	5.1	.5	3.1	2.9
Rhus copallina (Winged sumac)	2	4	7.5	5.1	.2	2.5	2.6
Andropogon virginicus (Broomsedge)	1	48	8.0	2.6	2.4	2.6	2.5
Rubus hispidus (Groundberry)	2	5	6.5	5.1	.2	2.1	2.5
Rubus betulifolius (Birch-leaved blackberry)	2	6	5.2	5.1	.3	1.7	2.4
Lonicera japonica (Japanese honeysuckle)	1	9	12.0	2.6	.4	3.9	2.3
Gnaphalium obtusifolium (Sweet everlasting)	2	7	3.4	5.1	.3	1.1	2.2
Liquidambar styraciflua (Sweetgum)	2	5	2.7	5.1	.3	.9	2.1
Erianthus alopecuroides (Plume grass)	1	28	7.0	2.6	1.4	2.3	2.1
Verbascum thapsus (Mullein)	1	3	3.7	2.6	.1	1.2	1.3
Eupatorium hyssopifolium (Hyssop-leaved thoroughwort)	1	2	3.0	2.6	.2	1.0	1.2
Geum canadense (White avens)	1	4	1.4	2.6	.2	.5	1.1
Stylosanthes biflora (Pencil-flower)	1	1	1.5	2.6	.05	.5	1.0
Solidago canadensis var. scabra (Canada goldenrod)	1	1	.8	2.6	.05	.3	1.0
Smilax glauca (Glaucous greenbrier)	1	2	.4	2.6	.1	.1	1.0
Carex sp. (Sedge)	1	2	.3	2.6	.1	.1	.9
Rhamnus caroliniana (Carolina buckthorn)	1	2	.3	2.6	.1	.1	.9
Vitis aestivalis (Summer grape)	1	1	.4	2.6	.05	.1	.9
Fraxinus americana var. biltmoreana (Biltmore ash)	1	1	.3	2.6	.05	.1	.9
Rhus radicans (Poison ivy)	1	1	.3	2.5	.05	.1	.9
Liriodendron tulipifera (Tulip poplar)	1	1	.2	2.5	.05	.1	.9
Phytolacca americana (Pokeweed)	1	1	.2	2.5	.05	.1	.9
Euphorbia supina (Milk-purslane)	1	1	.1	2.5	.05	.0	.9
TOTALS	39	2,011	303.5	100.0	100.00	100.0	100.0

* Two 5-square meter circular plots were utilized.

TABLE 4-2

UNDERSTORY VEGETATION DATA SUMMARY FOR THE CLINCH RIVER SITE - SHORTLEAF PINE PLANTATION (1976) - AUGUST 28, 1980*

Species	Number of Quadrats	Number of Stems	Basal Area (DO in ft^2)	Relative Percent Frequency (% F)	Relative Percent Density (% D)	Relative Percent Dominance (% DO)	Importance Value (IV)
Pinus echinata (Shortleaf pine)	1	1	.0003	50.0	50.0	50.0	50.0
Rhus copallina (Winged sumac)	1	1	.0003	50.0	50.0	50.0	50.0
TOTALS	2	2	.0006	100.0	100.0	100.0	100.0

* Two 50-square-meter circular plots were utilized.

TABLE 4-3

FLORISTIC LIST OF PLANT SPECIES OBSERVED IN THE SHORTLEAF PINE PLANTATION (1976) - AUGUST 28, 1980

Species Sampled	Common Name	Scientific Name
	OVERSTORY TREES	
	Red maple	Acer rubrum
	Mockernut hickory	Carya tomentosa
*	Biltmore ash	Fraxinus americana var. biltmoreana
*	Sweetgum	Liquidambar styraciflua
*	Tulip poplar	Liriodendron tulipifera
*	Shortleaf pine	Pinus echinata
	Black cherry	Prunus serotina
	White oak	Quercus alba
	Black oak	Quercus velutina
	Sassafras	Sassafras albidum
	SMALL TREES	
	Flowering dogwood	Cornus florida
	Blackjack oak	Quercus marilandica
	SHRUBS AND VINES	
*	Japanese honeysuckle	Lonicera japonica
*	Carolina buckthorn	Rhamnus caroliniana
*	Winged sumac	Rhus copallina
*	Poison ivy	Rhus radicans
*	Birch-leaved blackberry	Rubus betulifolius
*	Groundberry	Rubus hispidus
*	Glaucous greenbrier	Smilax glauca
	Rusty blackhaw	Viburnum rufidulum
*	Summer grape	Vitis aestivalis
	COMPOSITE FAMILY	ASTERACEAE
	Common ragweed	Ambrosia artemisiifolia
	White-heath aster	Aster ericoides
*	Horseweed	Conyza canadensis
*	Hyssop-leaved thoroughwort	Eupatorium hyssopifolium
	Late-flowering thoroughwort	Eupatorium serotinum
*	Sweet everlasting	Gnaphalium obtusifolium
	Hairy golden-aster	Heterotheca pilosa
	Small's ragwort	Senecio smallii
*	Canada goldenrod	Solidago canadensis var. scabra
*	Gray goldenrod	Solidago nemoralis
	Wing-stem	Verbesina alternifolia

(Continued)

TABLE 4-3 (Continued)

Species Sampled	Common Name	Scientific Name
	MUSTARD FAMILY	BRASSICACEAE
	Cow cress	*Lepidium campestre*
	SEDGE FAMILY	CYPERACEAE
*	Sedge	*Carex* sp.
	SPURGE FAMILY	EUPHORBIACEAE
*	Milk-purslane	*Euphorbia supina*
	LEGUME FAMILY	FABACEAE
	Partridge pea	*Cassia fasciculata*
	Wild sensitive plant	*Cassia nictitans*
*	Creeping bush-clover	*Lespedeza repens*
*	Bush-clover	*Lespedeza violacea*
*	Pencil-flower	*Stylosanthes biflora*
	ST. JOHN'S WORT FAMILY	HYPERICACEAE
	Spotted St. John's wort	*Hypericum punctatum*
	MINT FAMILY	LAMIACEAE
	Hoary mountain-mint	*Pycnanthemum incanum*
	EVENING-PRIMROSE FAMILY	ONAGRACEAE
	Evening primrose	*Oenothera biennis*
	POKEWEED FAMILY	PHYTOLACCACEAE
*	Pokeweed	*Phytolacca americana*
	GRASS FAMILY	POACEAE
*	Broomsedge	*Andropogon virginicus*
*	Plume grass	*Erianthus alopecuroides*
*	Decumbent panic grass	*Panicum* sp.
	ROSE FAMILY	ROSACEAE
*	White avens	*Geum canadense*
*	Dwarf cinquefoil	*Potentilla canadensis*
	FIGWORT FAMILY	SCROPHULARIACEAE
*	Mullein	*Verbascum thapsus*

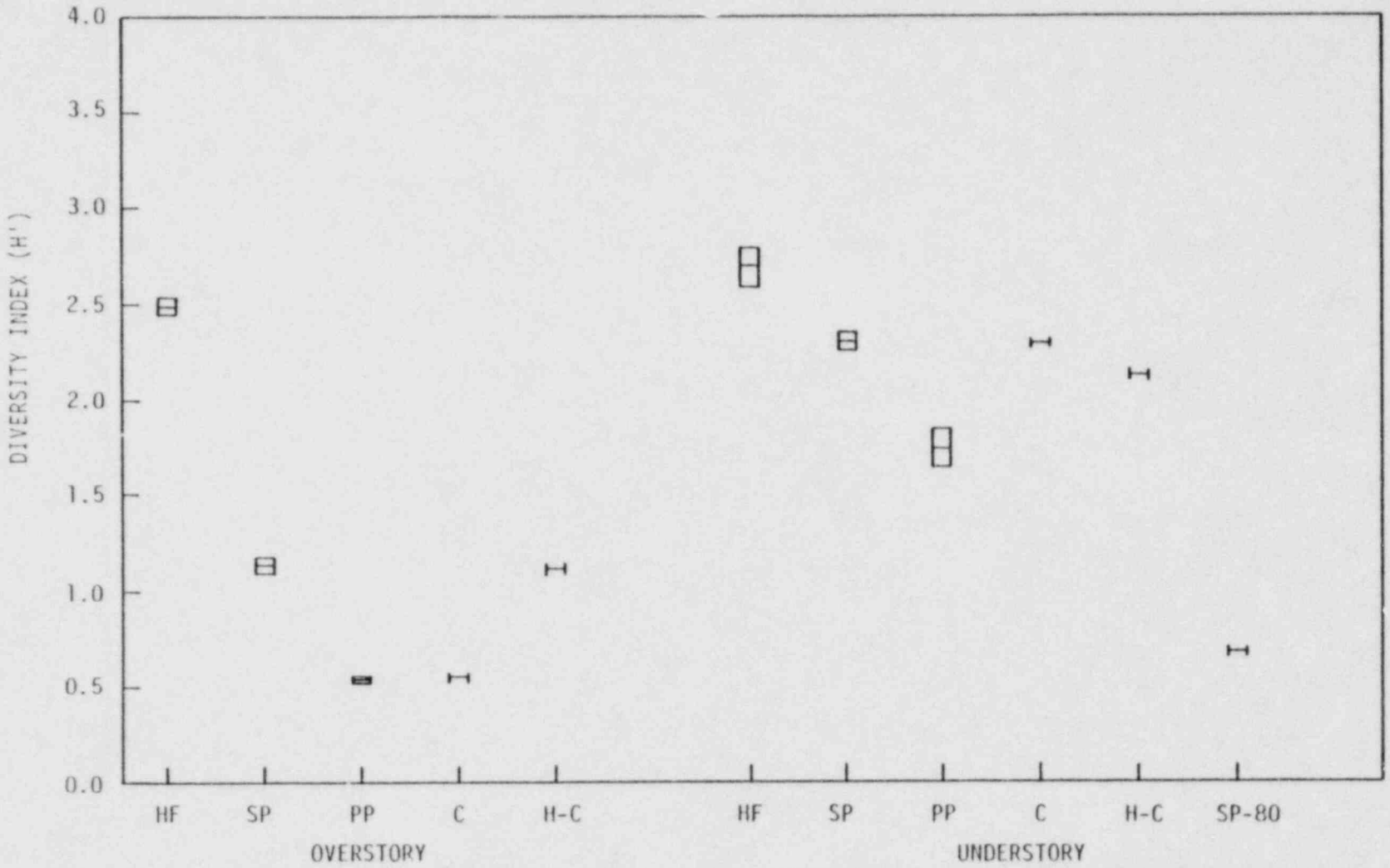


Figure 4-1. Shannon-Weaver Diversity Indices (H') of Overstory and Understory Species Densities for Each Vegetative Community Sampled on the Clinch River Site (The center line ⊢⊣ indicates the mean and the box size indicates one standard error about the mean. The absence of a box indicates that only one datum point is included. HF = Hardwood Forest, SP = Successional Pine, PP = Pine Plantation, C = Cedar, H-C = Hardwood-Cedar and SP-80 = Successional Pine Sampled in 1980.)

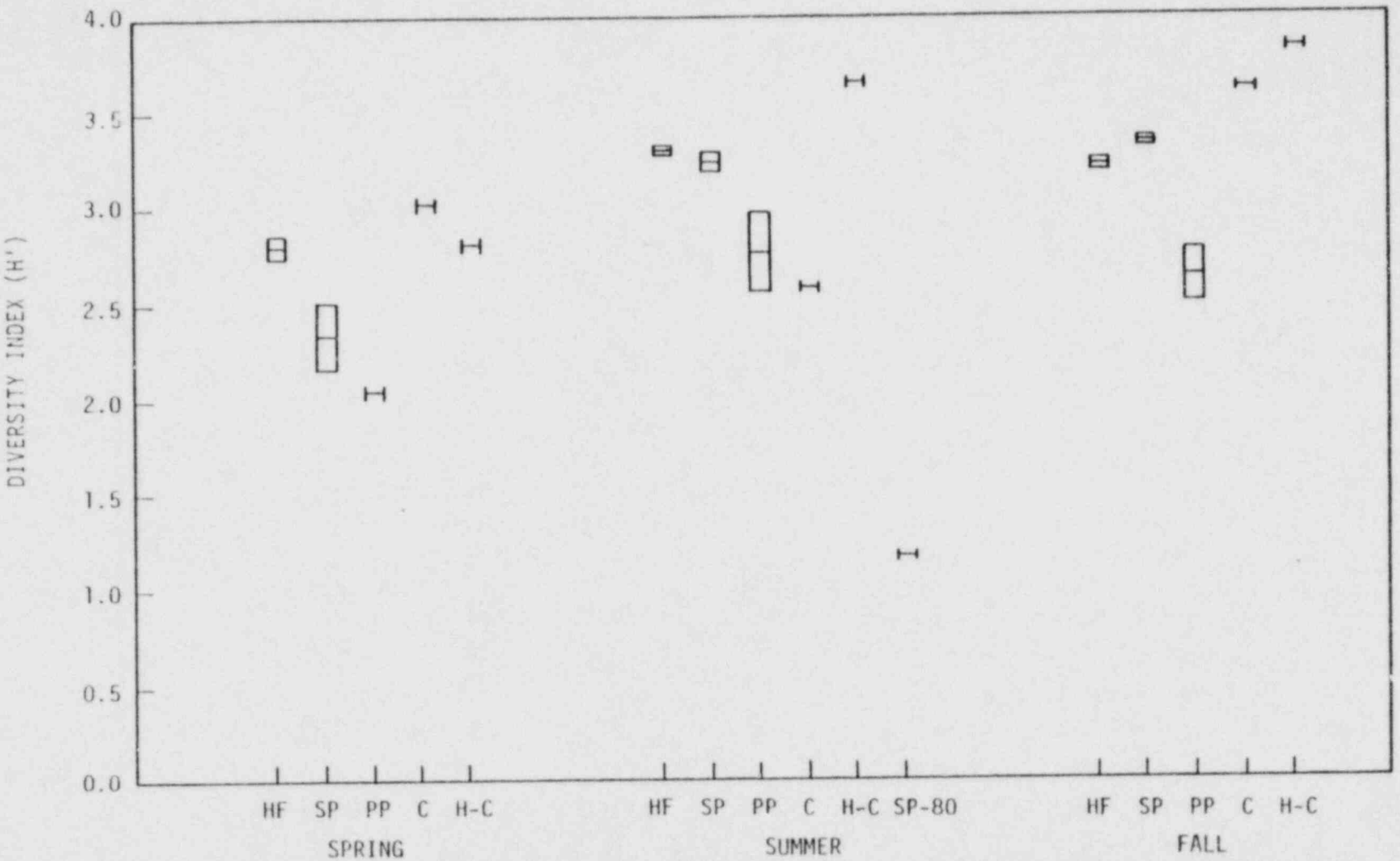


Figure 4-2. Shannon-Weaver Diversity Indices (H') of Ground Cover Species Densities for Each Vegetative Community Sampled on the Clinch River Site (The center line ⊢⊣ indicates the mean and the box size indicates one standard error about the mean. The absence of a box indicates that only one datum point is included. HF = Hardwood Forest, SP = Successional Pine, PP = Pine Plantation, C = Cedar, H-C = Hardwood-Cedar and SP-80 = Successional Pine Sampled in 1980.)

small box, as for pine plantation overstory trees (Figure 4-1), indicates low variation between the loblolly and white pine forests (SE = 0.011), whereas a large box, as for successional pine ground cover in the spring (Figure 4-2), indicates greater variability (SE = 0.174). Individual forest stands as the cedar forest, hardwood-cedar forest and shortleaf pine plantation (1976) have no SE estimate.

Diversity indices of pine plantation (PP) overstory trees, cedar forest (C) overstory trees and shortleaf pine plantation (1976) understory saplings sampled in 1980 (SP-80) have approximately equal means (0.537, 0.534 and 0.693, respectively). Diversity of successional pine (SP) forest overstory trees and hardwood-cedar (H-C) forest overstory trees are approximately equal (1.166 and 1.112, respectively). Diversity of hardwood (H) forest overstory trees is moderately high (2.500). Diversity of understory stems in the hardwood forest, successional pine forest, pine plantation, cedar forest and hardwood-cedar forest are higher than the corresponding values for overstory trees. This indicates that these forests are in transition to more diverse types as abundant, single dominant species are replaced with multiple dominants. These same trends were discussed in the ER in Section 2.7.1.3(1) based on species presence and Importance Value trends for overstory and understory species.

Ground cover diversity indices are uniformly higher than indices of overstory and understory strata within the same forest type. For example, hardwood forest overstory, understory and ground cover (spring, summer and fall) diversity indices are 2.500, 2.691, 2.810, 3.301 and 3.228, respectively, indicating a progression from a moderately high index for overstory trees to a slightly higher index for understory stems and higher indices for ground cover. Within the ground cover vegetative stratum, diversity tends to increase from spring to fall.

However, summer ground cover diversity of the shortleaf pine plantation planted in 1976 (SP-80) was only 1.178, approximately equal to diversity of overstory trees in successional pine and hardwood-cedar forests and considerably lower than indices for all other ground cover samples and for all understory stem samples. This low diversity for a young forest stand is expected.

4.2.3 WILDLIFE OBSERVATIONS

Wildlife observations are summarized in Table 4-4. Cleared lands were extensively utilized as wildlife travel routes and feeding habitat. Deer sightings and tracks were frequently observed in open, disturbed habitat throughout the site. ORNL personnel (Dr. Fred Taylor) reported during the survey that wild turkey were first observed on the Oak Ridge Reservation in 1975 and have been increasing in abundance. Insects, acorns, tree buds, seeds and other foods consumed by turkeys are abundant on the Reservation. Other wildlife observations are summarized in Table 4-4.

ORNL personnel (Dr. Tom Kitchings) reported during the survey that osprey and bald eagle individuals did not nest on or near the Reservation as determined by a low-level aerial search. Both species are listed by the state of Tennessee as endangered.[6] Dr. Kitchings also reported that eastern cougar sightings, especially southeast of ORNL (Figure 2-1) continue to be frequent; these sightings suggest the presence of several animals on the Reservation. The cougar is listed as endangered by the U.S. Department of Interior and State of Tennessee.[5,6] Considering that cougars primarily hunt whitetail deer and that deer are abundant and protected on the Reservation, their presence is not unexpected.

Cooper's hawk, a bird species listed as threatened by the state of Tennessee,[6] was observed near the proposed quarry along the Clinch River.[4] Habitat utilized by other threatened or endangered species considered in CRBRP-ER Section 2.7.1.4.5[1] had not changed significantly on the site.

4.3 CURRENT INFORMATION

In addition to the results of the terrestrial ecology field reconnaissance survey discussed above, conversations with TVA and ORNL personnel and review of literature provided information in the following sections.

TABLE 4-4

SIGNIFICANT WILDLIFE SPECIES OBSERVATIONS ON THE CLINCH RIVER SITE - AUGUST 27-28, 1980

Location	Common Name	Scientific Name	Notes
Peripheral road, barge unloading area	Whitetail deer	Odocoileus virginiana	Doe and two fawns observed on 8/27; Doe (probably same animal) observed on 8/28
Peripheral road, 3400 feet north of CRBRP	Whitetail deer	Odocoileus virginiana	6-point buck observed crossing road on 8/28
Peripheral road, 2950 feet southeast of CRBRP	Whitetail deer	Odocoileus virginiana	Doe observed crossing road on 8/28
Gas pipeline, bulldozed core drilling trails, logging trails, CRBRP meteorological tower sites, CRBRP preconstruction cleared land and clear-cut forests	Whitetail deer	Odocoileus virginiana	Tracks abundant on 8/27 and 28
150 feet east of CRBRP	Raccoon	Procyon lotor	Scat observed in preconstruction clearing on 8/27
3600 feet northeast of CRBRP	Cooper's hawk	Accipiter cooperii	Observed 8/27 roosting in sycamore tree between Clinch River and peripheral road. Flew east across Clinch River.
Hardwood forest	Turkey	Meleagris gallopavo	Not observed but reported from Oak Ridge Reservation including CRBRP site since 1975.
Peripheral road, 1800 feet south of CRBRP	Great blue heron	Ardea herodias	Observed 8/28 roosting on roadside and in flight southeast and then south crossing Clinch River
Cedar and hardwood forest, 1500 feet southwest of CRBRP	Blue jay	Cyanocitta cristata	One individual heard calling on 8/28
	Carolina chickadee	Parus carolinensis	Three individuals heard calling on 8/28
	Common crow	Corvus brachyrhychos	Two individuals sighted and heard calling on 8/28
	Pileated woodpecker	Dryocopus pileatus	One individual sighted in flight, a second heard calling on 8/28
	Downy woodpecker	Dendrocopos pubescens	One individual sighted at close range on 8/28
	Yellow shafted flicker	Colaptes auratus	Several individuals heard calling on 8/28

4.3.1 OAK RIDGE FOREST MANAGEMENT PLAN AND PLANT SPECIES

The 1975 pulp and timber harvest noted in Section 4.2.1 was a part of Oak Ridge Reservation planned forest management. The 1976-1980 Forest Management Plan continues to upgrade Reservation forests.[3] However, no forest management activities are planned for 1976-80 in forest management compartments 13 and 14, the portion of the Reservation containing the CRBRP site. The 1981-1985 forest management plan is in preparation, but unavailable at this time. No major management activities are anticipated on the CRBRP site based on discussions with ORNL personnel during the reconnaissance field survey.

A list of plant species suggested for classification as threatened or endangered by various authors was published in 1979.[8] The list includes three from the CRBRP site: black snakeroot (Cimicifuga rubifolia), ginseng (Panax quinquefolius) and Carey's saxifrage (Saxifraga careyana). Black snakeroot and ginseng are reported in ER, Section 2.7.1.3.4[1] and the location of Carey's saxifrage is reported above in Section 4.2.1.3. Dr. Leo Collins, a member of the Tennessee Committee for Rare Plants and a participant during the site reconnaissance survey, indicated that none of these species is expected to be listed as threatened or endangered for Tennessee. On December 10, 1979, the U.S. Department of Interior, Fish and Wildlife Service, withdrew a 1976 proposal to list some 1700 plant taxa since the two-year time limit for action had passed.[9] Black snakeroot and Carey's saxifrage were included on that list. These two species and ginseng are included on an unofficial 1978 list of rare plant species.[10]

A revised inventory of vascular plants of the five counties in the Oak Ridge region and their habitats of occurrence was published in 1975.[11] Ninety-three taxa collected or sighted on the CRBRP site in 1974[2] had not previously been reported for Roane County and an additional 55 taxa had not been reported for the 5-county region (Anderson, Knox, Loudon, Morgan and Roane Counties), as shown in Table 4-5.

TABLE 4-5

SUMMARY OF NEW PLANT TAXA COLLECTION AND SIGHTING RECORDS
FOR ROANE COUNTY AND THE FIVE COUNTY REGION
SURROUNDING THE OAK RIDGE RESERVATION

Types of Records*	Roane County	5-County Region**
Genera Collections†	0	7
Species Collections	83	40
Variety Collections	6	4
Genera Sightings	0	1
Species Sightings	4	3
Variety Sightings	0	0
TOTALS	93	55

* The number of new collections or sightings of genera, species and varieties for the CRBRP site that had not previously been reported for either Roane County or the 5-County region surrounding the Oak Ridge Reservation.[11] Taxa recorded in one category are not included in others.

** Anderson, Knox, Loudon, Morgan and Roane Counties.

† Specimens are on deposit in the University of Tennessee Herbarium with duplicate specimens in the Energy Impact Associates herbarium.

4.3.2 WILDLIFE

Two reports of whitetail deer populations of the Oak Ridge Reservation[12,13] indicate that populations increased substantially in the period 1969-1977[12] and much less rapidly in 1978.[13] Protection from hunting and abundant food and cover seem to be the main contributing factors. Road-kills by automobile, illegal hunting near the Clinch River and predation by eastern cougars contribute to deer mortality.

A preliminary study of bobcat (Lynx rufus) activity confirms the presence of this species on the Reservation and use of part of the site (Chestnut Ridge, Figure 2-1) by one male bobcat.[14] Bobcat home range was observed to be 1416 hectares (3500 acres) for a female and 3076 hectares (7600 acres) for a male.[14] Low food availability and the relatively small and widely separated areas of old field habitat where the preferred food (cottontail rabbits and cotton rats) abounds contribute to the large observed home ranges. The bobcat population on the Reservation probably numbers 12 to 15 individuals and appears to be increasing.[15]

The state of Tennessee has updated its 1975 list of endangered and threatened species.[6] Species observed on or potentially present on the CRBRP site[1] were not affected by these updates.

4.4 CONCLUSIONS

Based on a two-day field reconnaissance and review of available literature and personal contacts, it is concluded that:

- Vegetation and wildlife on most of the site remains as during the 1974 baseline studies.

- Oak Ridge Reservation forest management activities that were conducted as previously planned resulted in minor to major disturbances to CRBRP site forests. However, major management

activities on the site are not expected again for at least 5 years.

- Weedy plant species and wildlife associated with early successional vegetation have increased in abundance on land disturbed by pre-construction activities. Approximately 25 acres of disturbed land remains sparsely vegetated.

- Whitetail deer and wild turkey populations have increased substantially since 1974.

- Other wildlife populations appear stable over the long-term based on habitat quality. Few species were observed during the survey as a result of drought conditions.

- The bobcat and possibly the eastern cougar apparently reside on the site part of the time. They both have large home ranges on ORR. The eastern cougar is listed as endangered by the state of Tennessee and the U.S. Department of Interior.

- Rare plant species, observed during 1974 surveys, are not expected to be listed as threatened or endangered. Proposals to list two site species as threatened have been withdrawn by the U.S. Fish and Wildlife Service.

- Several wildlife species listed as threatened or endangered by the state of Tennessee occur on the site, as discussed in CRBRP-ER Section 2.7.1.4.5. Populations of these species are unknown, but habitat utilized by them has not changed significantly as a result of site disturbances.

SECTION 5.0
REFERENCES

SECTION 2.0 REFERENCES

1. Project Management Corporation, Clinch River Breeder Reactor Plant Environmental Report, February 1977, 5 vols.

2. Project Management Corporation, Clinch River Breeder Reactor Plant Aquatic Baseline Survey Report, March 1974 - May 1975, March 1976.

3. Project Management Corporation, Clinch River Breeder Reactor Plant Vegetational Data Report, September 1975, 192 pp.

4. Burns and Roe, Inc., Site Plan WP-19, Drawing BC501, Revision 4, Clinch River Breeder Reactor Plant, May 19, 1975.

5. Stone and Webster Engineering Corporation, Burning Limits, Spoil Stockpile, Construction Clearing Limits and Surfacing Requirements, Clinch River Breeder Reactor Plant, Drawing No. 12720-YSK-002-2, October 26, 1977, 1 inch = 400 feet.

SECTION 3.0 REFERENCES

1. Project Management Corporation, Clinch River Breeder Reactor Plant Environmental Report, February 1977, 5 Vols.

2. Project Management Corporation, Clinch River Breeder Reactor Plant Aquatic Baseline Survey Report, March 1974-May 1975, March 1976.

3. Shelton, R., Director of Reservoir Operations, Tennessee Valley Authority, telecon with Wagner, D. J., Energy Impact Associates, September 2, 1980.

4. Mattice, J. S and Bosworth, W., "Modified Venturi Suction Sampler for Collecting Asiatic Clams," The Progressive Fish-Culturist, 41(3):121-123.

5. Mattice, J. S., Oak Ridge National Laboratories, telecon with Wagner, D. J., Energy Impact Associates, August 18, 1980.

6. Fassett, N. C., A Manual of Aquatic Plants, The University of Wisconsin Press, Madison, 1957, 405 p.

7. Wagner, D. J., Energy Impact Associates, Trip Report, August 19-20, 1980.

8. Woosley, L. H., Jr., Taylor, M. P., Toole, T. W. and Wells, S R., Status of the Nonradiological Water Quality and Nonfisheries Biological Communities in the Clinch River Prior to Construction of the Clinch River Breeder Reactor Plant, 1975-1978, Tennessee Valley Authority, Division of Environmental Planning, Water Quality and Ecology Branch, Chattanooga, Tennessee and Muscle Shoals, Alabama, February 1979.

9. Tennessee Valley Authority, unpublished water quality data, Melton Hill Dam tailwater, 1978, 1979.

10. Fletcher, J. W., Assessment of Adult and Larval Fish Populations of the Lower Clinch River Below Melton Hill Dam, M.S. Thesis, Tennessee Technological University, Cookeville, December 1977, 90 pp.

11. Scott, E. M., "Clinch River Sauger Study," unpublished manuscript, Tennessee Valley Authority, 1980, 15 pp.

12. Loar, J., Dr., Oak Ridge National Laboratories, telecon with Wagner, D. J., Energy Impact Associates, August 14, 1980.

13. Tennessee Valley Authority, unpublished rotenone survey data for Watts Bar Reservoir, 1949-1980.

14. Myhr, A., Tennessee Wildlife Resources Agency, telecon with Wagner, D. J., Energy Impact Associates, October 20, 1980.

15. Coutant, C. C., Dr., Oak Ridge National Laboratories, telecon with Wagner, D. J., Energy Impact Associates, October 23, 1980.

16. Cheek, T., Tennessee Technological University, telecon with Wagner, D. J., Energy Impact Associates, October 21, 1980.

17. Van Den Avyle, M., Dr., Tennessee Techological University, telecon with Wagner, D. J., Energy Impact Associates, October 13, 1980.

18. Tennessee Wildlife Resources Commission Proclamation, "Endangered or Threatened Species," Proc. No. 75-15 (June 12, 1975) as amended by Proclamations 77-4 (May 13, 1977), 78-14 (September 22, 1978) and 78-20 (December 8, 1978), Nashville.

19. Tennessee Valley Authority, unpublished gill net data, Kingston Steam Plant, 1975.

20. Heitman, F., Lake Eufalla Fishery Management Unit, Lake Eufalla, OK, two telecons with Wagner, D. J., Energy Impact Associates, October 15, 1980.

21. Smith, P. W., The Fishes of Illinois, University of Illinois Press, Urbana, 1975, 314 pp.

22. Pflieger, W. L., The Fishes of Missouri, Missouri Department of Conservation, 1975, 343 pp.

SECTION 4.0 REFERENCES

1. Project Management Corporation, Clinch River Breeder Reactor Plant, Environmental Report, February 1977, 5 Vols.

2. Project Management Corporation, Clinch River Breeder Reactor Plant, Vegetational Data Report, September 1975, 192 pp.

3. Bradburn, D. M., "Forest Management Plan, ERDA Oak Ridge Reservation: 1976-1980," Oak Ridge National Laboratory, Environmental Sciences Division Publication No. 1056, June 1977 (ORNL/TM-5833), 58 pp.

4. Beimborn, W. A., Dr., Energy Impact Associates, Trip Report, August 27-28, 1980.

5. Pielou, E. C. An Introduction to Mathematical Ecology, Wiley-Interscience, New York, 1969, p. 229.

6. Tennessee Wildlife Resources Commission, Endangered or Threatened Species, Proclamation Number 75-15 (June 12, 1975) as amended by Proclamations 77-4 (May 13, 1977), 78-14 (September 22, 1978) and 78-20 (December 8, 1978), Nashville.

7. U.S. Department of Interior, Fish and Wildlife Service, "Republication of List of Endangered and Threatened Species and Correction of Technical Errors in Final Rules," Federal Register Volume 45, Number 99, May 20, 1980, pp. 33767-33781.

8. Parr, P. D. and Taylor, F. G., Jr., "Plant Species on the Department of Energy - Oak Ridge Reservation that are Rare, Threatened or of Special Concern," Journal of the Tennessee Academy of Science, Volume 54, Number 3, July 1979, pp. 100-102.

9. Endangered Species Program, U. S. Fish and Wildlife Service, "Service withdraws Proposals to List 1,876 Species," Endangered Species Technical Journal, Department of Interior, Fish and Wildlife Service, Volume 5, January 1980, pp. 1, 3 and 4.

10. Ayensu, E. S. and DeFilipps, R. A., Endangered and Threatened Plants of the United States, Smithsonian Institution and World Wildlife Fund, Inc., Washington, D.C., 1978, pp. 180-182.

11. Mann, L. K. and Bierner, M. W., "Oak Ridge, Tennessee, Flora: Habitats of the Vascular Plants - Revised Inventory," Oak Ridge National Laboratory, Environmental Sciences Division Publication 775, October 1975, ORNL-TM-5056, 141 pp.

12. Story, J. D. and Kitchings, J. T., "White-Tailed Deer (Odocoileus virginianus) on the Department of Energy's Oak Ridge Reservation: Data on Road-killed Animals, 1969-1977," Oak Ridge National Laboratory, Environmental Sciences Division, Publication 1320, July, 1979, 26 pp., ORNL/TM-6803.

13. Kitchings, J. T. and Story, J. D., "White-Tailed Deer (Odocoileus virginianus) on the Department of Energy's Oak Ridge Reservation Supplement 1: 1978 Status Report," Oak Ridge National Laboratory, Environmental Sciences Division, Publication No. 1398, September 1979, ORNL/TM-6803/S1, 25 pp.

14. Kitchings, J. T. and Story, J. D., "Preliminary Studies of Bobcat Activity Patterns," Proceedings of the Thirty-Second Annual Conference, Southeastern Association of Fish and Wildlife Agencies, Volume 32, pp. 53-59, 1979.

15. Kitchings, J. T., ORNL, personal communication to Beimborn, W. A., Energy Impact Associates, 1980.

APPENDIX A

VEGETATION MAP AND LEGEND FROM THE
CRBRP ENVIRONMENTAL REPORT, FIGURE 2.7-6

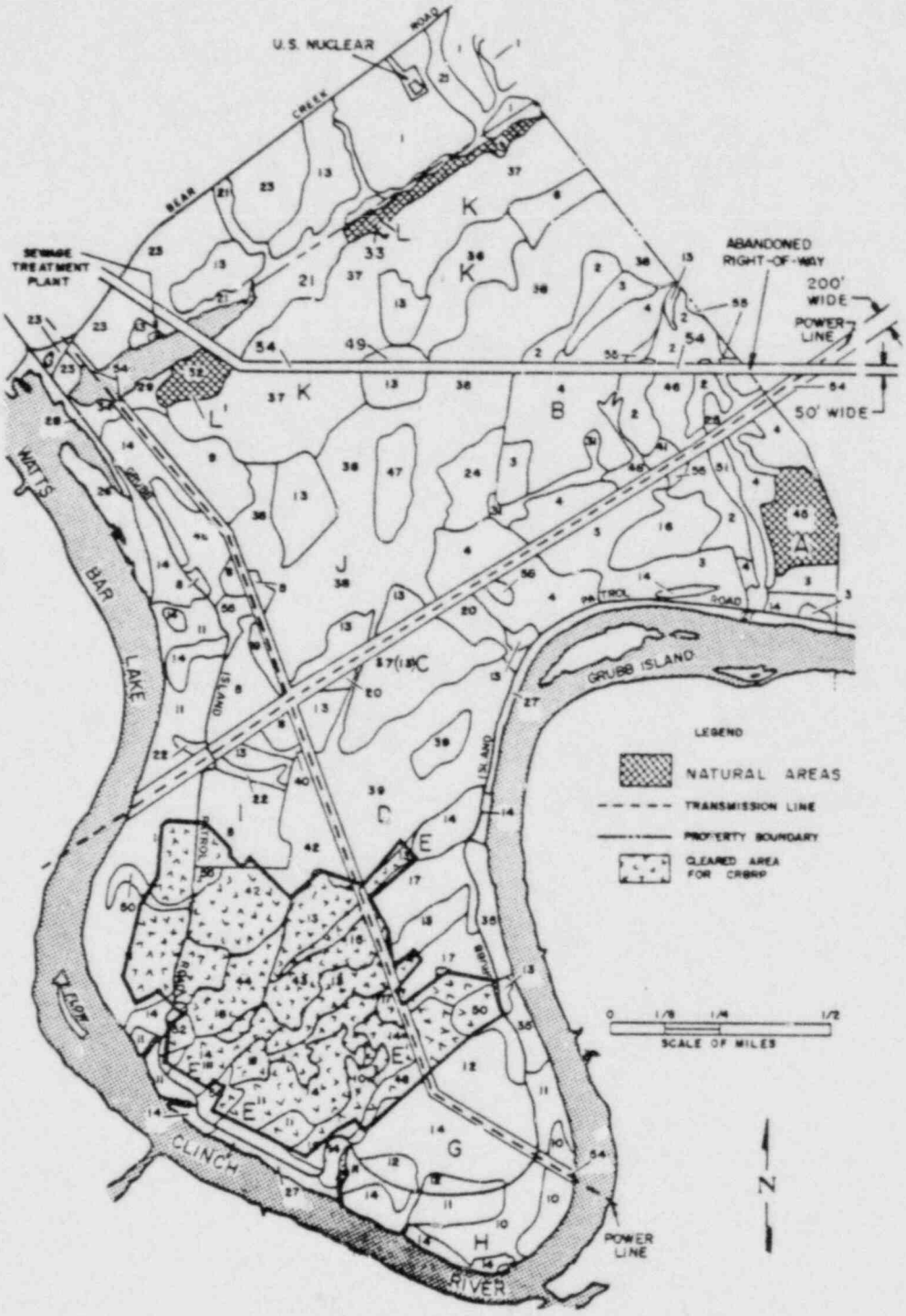


Figure 2.7-6. SITE STUDY AREAS AND OVERSTORY VEGETATION
(Legend on Pages 2.7-507, 2.7-508 and 2.7-509.
Alphabetic letters designate study areas.)

LEGEND FOR FIGURE 2.7-6

Cover Type Number	Forest Cover Type	Acreage
1	Loblolly pine plantation, 1948	48
2	Shortleaf pine plantation, 1951	35
3	White pine plantation, 1951	39
4	Loblolly pine plantation, 1951	86
5	Loblolly, shortleaf pine plantation, 1951	2
6	Loblolly, white pine plantation, 1952	7
7	Shortleaf pine plantation, 1952	6
8	White pine plantation, 1952	37
9	Virginia pine plantation, 1952	13
10	Loblolly pine plantation, 1954	29
11	Shortleaf pine plantation, 1954	87
12	Virginia pine plantation, 1954	28
13	Natural-pine (VP, SLP, VP-SLP, SLP-VP, SLP-MIXED HARDWOODS)	95
14	*Eastern red cedar-pine (CED-SLP, CED-SLP-VP, CED-FIELD, CED-PINE FIELD)	107
15	Eastern red cedar-scarlet oak	2
16	Eastern red cedar, scarlet oak, ash, northern red oak	14
17	Eastern red cedar, white oak, northern red oak	31
18	Eastern red cedar, sweetgum, tulip poplar	11
19	Tulip poplar, white oak	2
20	Tulip poplar, northern red oak	6
21	Tulip opolar, northern red oak, sugar maple, ash	33
22	Sweetgum	4
23	Sweetgum, pine (Virginia, Virginia-shortleaf)	42
24	Shortleaf pine, tulip poplar, southern red oak, hickory	11
25	Sycamore, ash, eastern red cedar	4
26	*Sycamore, American elm, boxelder, black willow	9
27	Sycamore, American elm, boxelder, sugar maple	13

LEGEND FOR FIGURE 2.7-6 (Continued)

Cover Type Number	Forest Cover Type	Acreage
28	Sycamore, tulip poplar, American elm, black walnut	2
29	Boxelder, hackberry, American elm	2
30	American elm, boxelder	3
31	Ash, hackberry, black walnut	5
32	*Beech, white oak, northern red oak, eastern red cedar	7
33	*Beech, northern red oak, tulip poplar, sugar maple	8
34	Sugar maple, American elm	2
35	Sugar maple, white oak, tulip poplar, hickory	10
36	Chestnut oak, black oak	17
37	White oak (Chestnut oak), northern red oak, tulip poplar, sugar maple, hickory	91
38	White oak, hickory, black (sour) gum, northern red oak, tulip poplar	129
39	White oak, tulip poplar, hickory (white oak, hickory, tulip poplar, northern red oak)	55
40	Northern red oak (southern red oak), white oak	2
41	Northern red oak, ash, shortleaf pine	2
42	Northern red oak (Black oak), tulip poplar, white oak, hickory	30
43	Northern red oak, white oak, tulip poplar, pine, eastern red cedar	11
44	Northern red oak, white oak, sweetgum, eastern red cedar	14
45	*Northern red oak, tulip poplar, white oak (northern red oak, white oak, tulip poplar)	28
46	Northern red oak, hickory, pine (northern red oak, hickory, eastern red cedar	11
47	Northern red oak, white oak, pine, tulip poplar	10
48	Northern red oak, eastern red cedar	4
49	Black oak, hickory, tulip poplar	2
50	Southern red oak, shortleaf pine, white oak	7

LEGEND FOR FIGURE 2.7-6 (Continued)

Cover Type Number	Forest Cover Type	Acreage
51	Sycamore, tulip poplar, sweetgum	7
52	Building and Construction sites	3
53	Roads	13
54	Powerline right-of-ways	58
55	Cutover and abandoned fields	7
56	White oak, black oak, hickory, sweetgum	4
57	Shortleaf pine plantation, 1976	25
	Total Acreages	1,364

*Unusual vegetation areas

GRAY'S
Manual of Botany

EIGHTH (*CENTENNIAL*) EDITION—ILLUSTRATED

A HANDBOOK OF THE FLOWERING PLANTS AND FERNS OF THE CENTRAL AND NORTHEASTERN UNITED STATES AND ADJACENT CANADA

Largely rewritten and expanded by

Merritt Lyndon Fernald

FISHER PROFESSOR OF NATURAL HISTORY, EMERITUS,
AND FORMER DIRECTOR OF THE GRAY HERBARIUM, HARVARD UNIVERSITY

WITH ASSISTANCE OF SPECIALISTS IN SOME GROUPS

Corrected Printing, 1970

CORRECTIONS SUPPLIED BY R. C. ROLLINS

D. Van Nostrand Company

New York *Cincinnati* *Toronto* *London* *Melbourne*

6. L. Smállii Wieg. (for its discoverer, JOHN KUNKEL SMALL, 1869–1938), SMALL'S T. — Habitally suggesting nos. 1 and 2, *very slender*, 1–3 dm. high; *stem glandular above; leaves firm*, deep green, *reniform-ovate*, 1.5–3 *cm. long, many times shorter than the slender peduncle; raceme* very loose and open, 2–10 cm. long, *its rachis glandular; the short bracts and elongate* (up to 1 *cm. long*) *filiform pedicels glabrous;* sepals lanceolate; petals lance-linear, a third as long as lip, spreading or reflexed; *lip broadly obovate, eciliate*, 6–9 *mm. long*, the dilated *summit with an open sinus, there bearing a broad oblong to obovate tooth* 1 *mm. long, base of lip sessile* with a tooth on each side; column thick, 1.5 mm. long. (*L. reniformis* Small, not D. Don: *Ophrys Smallii* (Wieg.) House) — Humus of damp woods and thickets, or in bogs of mountain-reg., Pa. and W.Va., s. to Ga. and e. Tenn. July, Aug.

Tribe IV. EPIDÉNDREAE Lindl.

15. CORALLORHÌZA Chatelain CORAL-ROOT

Perianth somewhat ringent, gibbous or obscurely spurred at base. Sepals and petals narrow, nearly alike, 1–3-nerved; lateral sepals ascending, forming with the lip the gibbosity or short spur which is mostly adnate to the ovary. Lip slightly adherent to the base of the compressed column. Anther terminal; pollen-masses 4, soft-waxy, free. — Brownish, purplish or yellowish herbs destitute of green foliage, with branched and toothed coral-like underground rhizomes sending up a simple scape which has sheaths in place of leaves and a raceme of colored flowers. Fruit reflexed. Small genus of N. Hemisph. (Name from the Greek *corallion, coral*, and *rhiza, root.*) CORALLORRHIZA R. Br.

a. Lip 3-lobed or with a prominent lateral tooth on each margin.
  Plant greenish, greenish-yellow or rarely brownish; flowers yellowish-green to slightly brown-tinged; lip notched on each side toward base, with low sub truncate basal lobes, white and unspotted or rarely dotted with red or purple; capsules greenish; chiefly flowering in spring. . . . . 1. *C. trifida.*
  Plant madder-purple, brown or warm-yellowish; flowers usually spotted with purple or red; lip auricled and with prolonged basal lobes; capsules brown or fulvous; flowering in summer. . . . . 2. *C. maculata.*
a. Lip unlobed, entire or merely denticulate. . . *b.*
  b. Perianth 3–7 mm. long, not obviously striped; lip broadly oval to roundish; capsule 5–12 mm. long. . . *c.*
    c. Perianth about 7 mm. long; sepals and petals somewhat spreading; lip about 5 mm. long; flowering in spring. . . . . 3. *C. Wisteriana.*
    c. Perianth 3–4 mm. long; sepals and petals nearly connivent as a hood; lip 2.5–3 mm. long; autumnal. . . . . 4. *C. odontorhiza.*
  b. Perianth 0.8–2 cm. long; sepals and petals conspicuously purple-veined; lip tongue-shaped; capsule 1.5–2 cm. long. . . . . 5. *C. striata.*

1. C. trifida Chatelain (3-parted; from the 3-lobed lip), EARLY or PALE C. — *Rhizome whitish*, with somewhat intricate branching, forming flattened platforms; *scape* erect, 0.8–3 dm. high, with 3 or 4 close sheaths toward base, 2–4 *mm. thick at base;* raceme 2–10-flowered, up to 8 cm. long; pedicels very short, at first ascending, later reflexed; *sepals* narrowly oblong to ligulate, bluntish, 4.5–6 *mm. long, greenish-yellow, often brown-tinged*, the lateral oblique; *petals* similar, *often red-dotted; lip* nearly equaling petals, *oblong, subtruncate or broadly rounded and notched at tip, with low basal lobes, whitish, with many red or purplish ... s.* — Dryish tundra, thickets, bogs and woods, Greenl. and Lab. to Alaska, s. to n. Nfld., Côte Nord, Que., Ung., n. Ont., and mts. to Wyo. and Oreg. (Eurasia) — With us mostly as

Var. **vérna** (Nutt.) Fern. (vernal). — *Plant pale yellow or yellowish-green; sepals yellow-green*, at most brownish-tipped, *these and the similar petals linear-lanceolate, unspotted; lip white, unspotted or with very few basal reddish dots*, 3–4 *mm. long, with an abruptly narrowed recurved tip; capsules greenish, becoming drab*, 6–10 *mm. long.* (*C. trifida* of ed. 7) — Damp woods, thickets and swamps, Nfld. to B.C., s. to N.S., N.E., N.J., Pa., mts. to Ga. and Tenn., O., n. Ind., Wisc., Mo., S.D., Colo. and Oreg. May–July. — Scapes solitary to densely clustered.

2. C. maculàta Raf. (mottled or spotted), SPOTTED C. — Usually *coarser* than no. 1; *rhizome brownish; scape* (with raceme) *up to* 6 dm. high and 1 *cm. thick at base, yellow to warm brown, fuscous or purple-brown*, the similarly colored sheaths extending well above the middle; *raceme* few–35- or more-flowered, 0.4–2 *dm. long; perianth* whitish, *usually spotted with red or purple*, 5–10 *mm. long; lip with* 2 *basal auricles and* 2 *prolonged basal lobes; capsules brown or fulvous*, 1–2 *cm. long.* — Dry woods, Nfld. to B.C., s. to N.S., N.E., L.I., Va., upland of N.C. and Tenn., O., Ind., Wisc., Minn., S.D., Colo. and Calif. Late June–Aug. — Fresh plants occur

in the following color-forms (until dry): typical plant with scapes, sheaths and perianth yellow, the lip spotted; forma **flávida** (Peck) Farw. (yellowish) similar but lip unspotted; forma **intermèdia** Farw. (intermediate) with scape and sheaths dull brown or fuscous, perianth yellow-brown, lip spotted; forma **punícea** (Bartlett) Weath. & Adams (reddish-purple) the scape, sheaths and perianths reddish-purple, lip spotted.

3. C. Wisteriàna Conrad (for its discoverer, CHARLES JONES WISTER, 1782–1863), WISTER'S C. — Coarser than no. 1, 1–4.5 dm. high; *scape* somewhat bulbous at base, from a small coralloid rhizome, *tinged with red or purple*, commonly flexuous toward summit, with paler striate sheaths below; *raceme lax and open*, 2–13 cm. long; *flowers soon nearly horizontal*, finally somewhat reflexed; *perianth 6–8 mm. long, the reddish- or purplish-backed* linear *sepals somewhat spreading, their paler inner faces flecked with purple lines;* petals pale, slightly shorter and broader, purple-flecked; *lip 5 mm. long, deflexed, roundish, with basal claw, unlobed, white, with purplish dots, emarginate; capsule 8–12 mm. long.* — Rich, chiefly deciduous woodland, Fla. to e. Tex., n. (becoming very local) to N.J., Pa., W.Va., O., s. Ind., s. Ill., Mo. and S.D. Late March–May.

4. C. odontorhiza (Willd.) Nutt. (tooth-rooted), LATE or AUTUMN C. — Similar to no. 3; smaller throughout, 1–3 dm. high; scape often greener, slender; *raceme* 3–20-flowered, 1.5–7 *cm. long; perianth* 3–4 *mm. long; sepals and petals approximate as a hood, subequal; lip* white, 2.5–3 *mm. long, crinkly- or erose-margined,* purple-rimmed and -dotted; *capsules* slender-pedicelled, pendulous, 5–8 *mm. long.* — Dry woodlands, sw. Me. to Minn., s. to Ga., Ala., Miss. and Mo. Aug.–early Oct. — Forma **flávida** Wherry (yellowish) has scape, sheaths and perianth yellow (without the usual purple tones) and the lip unspotted.

5. C. striàta Lindl. (striped), STRIPED C. — As coarse as no. 2, 1.5–3 dm. high; stoutish scape and sheaths madder-purple, or in forma **fúlva** Fern. (yellowish-brown) yellowish to orange-brown as also the perianths; *raceme* 0.3–2 *dm. long;* flowers subapproximate, often very numerous: *perianth usually purplish, 0.8–2 cm. long, the lance-ovate translucent conspicuously purple-veined sepals and petals loosely approximate and forming a broad arching hood; lip tongue-shaped, usually madder-purple* (yellow-brown in forma *fulva*), striped only at base, *about as long as other petals,* abruptly drooping; *capsules* strongly reflexed, 1.5–2 *cm. long.* — Calcareous or rich woods, Gaspé Pen., Que.; sw. Que. to w. Ont., s. to nw. N.Y., s. Ont., Mich., ne. and n. Wisc. and ne. Minn.; s. Alta. and s. B.C., s. to Wyo., Ida., and Calif. Late May–Aug.

16. MALÁXIS Sw. MALAXIS. ADDER'S-MOUTH

Sepals lanceolate, oblong or ovate, spreading. Petals lanceolate, filiform or linear, spreading. Lip auricled at base, narrowing toward the summit, entire or cleft. Column very small, terete, with 2 teeth or auricles at the summit and the erect anther between them; pollen-masses 4, in one row (2 in each anther-locule), cohering in pairs, waxy, without stalks, filaments, or gland. — Low herbs of Am. and Eurasia from solid tubers producing simple stems which bear 1 or few leaves and a raceme of tiny mostly greenish flowers. (*Malaxis, weak* or *delicate,* from the frail character of no. 1.) Including MICROSTYLIS (Nutt.) Eat.

a. Leaves 2–5, alternate, basal, subtending axillary new tubers; sepals narrowly ovate, 2 of them erect, the 3rd drooping; petals half as long, lance-ovate, blunt; lip ovate, conspicuously green-nerved, erect, much shorter than lateral sepals; capsule crowned by the persistent porrect perianth. . . . 1. *M. paludosa.*

a. Leaves solitary or 2(–3), subbasal or high on stem, without axillary tubers; sepals lanceolate to ovate; petals linear to thread-like; lip not conspicuously veined, with entire tip or 2-cleft. . . *b.*

b. Leaf 1 (rarely 2); flower greenish to yellowish. . . *c.*

c. Lip drooping, entire, abruptly long-pointed. . . . . 2. *M. brachypoda.*

c. Lip finally ascending, 2-lobed at summit, with a median tooth.

Raceme oblong-cylindric, in anthesis 1.3–2.5 cm. thick; pedicels 4–10 mm. long; lip oblong-oval, shallowly cordate at base, the 2 lateral apical lanceolate lobes much prolonged, the central tooth minute. . 3. *M. unifolia.*

Raceme slenderly cylindric, in anthesis 5–10 mm. thick; pedicels 2–4.5 mm. long; lip broadly cordate-deltoid, the 2 lateral apical lobes deltoid and shorter than the broad basal ones, the median tooth triangular. . . . . 4. *M. Bayardi.*

b. Leaves 2 (rarely 3); lip orange to vermilion, erect, entire, cordate-ovate, the basal auricles broadly rounded, the tip not prolonged. . . . . 5. *M. floridana.*

1. M. paludòsa (L.) Sw. (boggy), BOG-M. or A. — Plant very slender, 0.4–2.5 dm. high; *slender rhizome surmounted by* 2–5 *alternate* oblanceolate or narrowly obovate *leaves* 0.5–3 cm. long, *these eventually subtending* small *tubers;* scape filiform; *raceme very slender,* 1–13 cm. long,

with short-pedicelled as
the 3rd drooping; petals
lateral sepals, conspicu
In wet sphagnum, n. M

2. M. brachýpoda
corm, 0.5–2.5 dm. high
oval, 1.7–9 cm. long,
below the usual one;
before expansion ovate,
pointed perianth yello
lar to axis of ovary, fi
slender pointed tip
phyllos ot
s. Lab. Pen. to Man.
Ind., Wisc., Minn., a

3. M. unifòlia Mi
high
Mo
cyli
une
mm
obl
bu
at
br
bo
Fl

856. M. unifolia.

4. M. Bayárdi
smaller throughou
1.5–12 cm. long an
long; flowers gree
deltoid, 2.5 *mm. lon*
and 1–1.4 *mm. lon*
mm. long, with th
woods and clearin

5. M. floridàna
(rarely 1 or 3)-le
high; *leaves* subo
the lower (usually
scale prolonged;
2 lateral oblong
petals filiform, g
prolonged, the na
milion, the marg
M. spicata Sw.,
marly woods, sl

Sepals oblong
stout at base,
each anther-loc
of trop. and te
few-flowered r
lustrous leaves.

1. L. lilifòli
Convallaria), l
green, lustrous
flòra Wadmon
fruit ascendin
lanceolate but

curved; petals pendent, usually madder-purple; *lip broadly cuneate-obovate, translucent, usually madder-purple, 7–10 mm. long,* with clasping auricles at base; *capsules* clavate, erect *on long pedicels.* (*L. lilifolia* (Sw.) Lindl.) — Loamy or sandy woods and clearings, s. N.H. to s. Minn., s. to s. N.E., Ga., Ala., Tenn. and Mo. May–early July.

2. **L. Loeselii** (L.) Richard (for JOHANN LOESEL, 1607–1655). LOESEL'S, BOG- or YELLOW T. — Smaller than no. 1, with lanceolate to lance-ovate *yellow-green* strongly keeled *leaves;* flowering stem (and raceme) 0.5–3 dm. high; *flowers* 2–25, *about 5 mm. broad, yellowish-green, on short ascending pedicels; lip concave, oblong- to obovate-spatulate, about 5 mm. long,* arching; *capsules longer than their pedicels.* — Bogs, peaty meadows and damp thickets, Gaspé Pen., Que. to Sask., s. to N.S., N.E., N.J., Pa., Md., upland to Ala., O., n. Ind., n. Ill., e. Mo. and N.D. June, July. (Eu.)

18. APLÉCTRUM (Nutt.) Torr. PUTTY-ROOT. ADAM-AND-EVE

Perianth neither gibbous nor with any trace of a spur or sac at base. Lip free, 3-lobed, with three longitudinal crests. Column compressed; pollen-masses 4. — Scape from near the summit of a globular corm-like tuber. Leaf solitary; petiole distinct. The slender naked rootstock producing each year a globular solid tuber or corm, often 2.5 cm. in diameter (filled with exceedingly glutinous matter), which sends up late in summer a large oval many-nerved plaited leaf lasting through the winter; early in the succeeding summer the scape appears, terminated by a loose raceme of lurid flowers. A single species. (Name from *a-privative, without,* and the Greek *plectron, spur.*)

1. **A. hyemàle** (Muhl.) Torr. (of winter; from the conspicuous evergreen leaf). — Rootstock like a coarse chain of 2–4 large biennial corm-like tubers separated by intermediate slender strands; leaf firm, blue-green, corrugate-striate, the blade 0.7–2 dm. long; scape stout, 3–4.5 dm. high, with remote sheathing bracts, the leaf often shriveled at flowering time; flowers 8–20, about 1 cm. long, divergent, purplish-green or madder-purple, or in forma **pállidum** House (pale) pale yellowish throughout; sepals long, greenish or yellowish, tinged with madder-purple; petals shorter, arching over the column, oblong, obtuse, yellowish, tinged with madder-purple above; lip white or nearly so, sparingly marked with magenta; plump capsules reflexed. — Rich woods, now becoming rare, sw. Que. and Vt. to Sask., s. to s. N.E., Ga., Tenn. and Ark. May, June.

19. CALÝPSO Salisb.

Sepals and petals similar, ascending, spreading, oblong-lanceolate, acute, magenta-crimson, rarely white. Lip larger than the rest of the flower, saccate, with three longitudinal rows of yellow (or white) glass-like hairs in front and with a translucent apron-like appendage (formed by the overlapping of the lip) spotted with madder-purple, the sac (bearing two conspicuous horns at its base) whitish, with irregular usually purple-madder markings. Column winged, having the operculate anther just below the apex; pollen-masses waxy, 2, each 2-parted, all sessile on a square gland. — A single circumboreal species with solitary basal leaf and a 1-flowered scape; sometimes with a coralline rhizome below the tuber. (Named for the goddess *Calypso.*)

1. **C. bulbòsa** (L.) Oakes (with a bulb). — Plant 0.5–2 dm. high; tuber superficial; leaf oval to round-ovate, veiny, bluish-green, with undulate margin, 2–6 cm. long, developing in autumn, overwintering, and shriveling soon after flowering season, the slender petiole 3-angled; scape smooth, with membranous sheathing bracts, it and the leaf from separate buds; pedicel of flower subtended by a petaloid bract; lip resembling a sugar-scoop, 2–2.5 cm. long, marked with purple-madder, or white in forma **cándida** Hylander (white); erect capsule tipped by the marrescent perianth. (*C. borealis* Salisb.; *Cytherea bulbosa* House) — Cool, mossy woods, chiefly calcareous, often about bases of *Thuja*, Lab. to Alaska, s. (now very locally) to w. Nfld., N.S., n. N.E., n. N.Y., Mich., Wisc., Minn., Ariz. and Calif. Mid-May–early July. (Eurasia)

20. TIPULÀRIA Nutt. CRANEFLY ORCHIS

Flowers greenish, tinged with madder-purple, numerous in an elongated loose bractless raceme. Sepals oblong-oval, obtuse, upper sepal narrower. Petals oblong, obtuse. Lip with a slender spur, 3-lobed; lateral lobes obtuse, obscurely toothed; apical lobes broad at base, margin deflexed at the middle, apex expanded. Column wingless; anther operculate, terminal; pollen-masses 2, waxy, each 2-parted, connected by a linear stalk with the transverse small gland. — Tubers connected in a horizontal series, producing in autumn a single ovate slender-

2-25

Section 2.7.1
Reference T12

Re REFERENCE 2-25

Federal Register

Tuesday
May 20, 1980

Part II

Department of the Interior

Fish and Wildlife Service

Republication of Lists of Endangered and Threatened Species and Correction of Technical Errors in Final Rules

DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

Republication of the Lists of Endangered and Threatened Species and Correction of Technical Errors in Final Rules

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule; republication of the U.S. Lists of Endangered and Threatened Wildlife and Plants and correction of technical errors.

SUMMARY: The Service hereby issues a republication of the lists of Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 and 17.12. The last republication was January 17, 1979 (44 FR 3636–3654). Technical errors are also corrected.

DATE: These lists include all species listed as of May 10, 1980, and are effective May 20, 1980, except the bonytail chub (final rule effective May 23, 1980) and the Goodenough gambusia (final rule effective May 30, 1980). The texts of 50 CFR 17.11 and 17.12 are also effective May 20, 1980 (*see* 45 FR 13010, February 27, 1980).

ADDRESSES: Comments concerning this republication should be sent to the Director (OES), U.S. Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C. 20240.

FOR FURTHER INFORMATION CONTACT: Mr. John L. Spinks, Jr., Chief, Office of Endangered Species, Washington, D.C. 20240, (703) 235–2771.

SUPPLEMENTARY INFORMATION: The lists incorporate species officially listed as Endangered or Threatened under the Endangered Species Act of 1973, as amended, and 50 CFR Part 424. The previous republication was January 17, 1979 (44 FR 3636–3654). The animal species added to § 17.11 since that publication are Caribbean monk seal, Ryukyu rabbit, Simien fox, Malabar large spotted civet, Iriomote cat, Fea's muntjac, Formosan sika, Ryukyu sika, North China sika, Shansi sika, South China sika, Corsican red deer, Barbary deer, Yarkand deer, Bactrian deer, western giant eland, Jentink's duiker, Tora hartebeest, Swayne's hartebeest, Zanzibar suni, sand gazelle, Saudi Arabian gazelle, Pelzeln's gazelle, Arabian gazelle, Arabian tahr, West African manatee, Grevy's zebra, Hartmann's zebra, Virginia big-eared bat, Ozark big-eared bat, red-necked parrot, saltwater crocodile, two unnamed boas from Mauritius, Virgin Islands tree boa, San Esteban Island chuckwalla, Fiji banded and Fiji crested iguanas, Bolson tortoise, Plymouth red-bellied turtle, totoaba, bonytail chub, Goodenough gambusia, and Kern primrose sphinx moth. Plant species added to §17.12 are bunched arrowhead, Tennessee purple coneflower, *Lipochaeta venosa*, Truckee barberry, Chapman rhododendron, green pitcher plant, Harper's beauty, purple-spined hedgehog cactus, Wright fishhook cactus, Uinta Basin hookless cactus, Lee pincushion cactus, Arizona hedgehog cactus, Brady pincushion cactus, Siler pincushion cactus, Raven's mazanita, MacFarlane's four-o'clock, Lloyd's hedgehog cactus, black lace cactus, Peebles Navajo cactus, Kuenzler hedgehog cactus, Nicoll's Turk's head cactus, Knowlton cactus, *Stenogyne angustifolia* var. *angustifolia*, *Haplostachys haplostachya* var. *angustifolia*, Cooke's kokio, Mesa Verde cactus, bunched cory cactus, Lloyd's Mariposa cactus, dwarf bear-poppy, Chilean false larch or alerce, *Ancistrocactus tobuschii*, Davis' green pitaya, Nellie cory cactus, Sneed pincushion cactus, spineless hedgehog cactus, Guatemalan fir or pinabete. Some populations of the American alligator have been reclassified and all the non-U.S. populations of the American crocodile were added to the previously listed U.S. population. The following captive self-sustaining populations of species have been removed from the list (*see* the September 17, 1979, Federal Register [44 FR 54007]): jaguar, black lemur, ring-tailed lemur, leopard, tiger, brown eared pheasant, Edward's pheasant, bar-tailed pheasant, Mikado pheasant, Palawan peacock pheasant, Swinhoe's pheasant.

Since the republication of the lists is a consolidation of previous rules, and the technical changes are purely to aid the reader, this document is not a rule as contemplated under Executive Order 12044 and 43 CFR 14.2(e). Therefore, the provisions of that rule do not apply, and a determination of significance is not required. In addition, the Service finds for good cause that this document shall be effective as indicated above and that notice and public comment are unnecessary. Technical errors detected in previous lists and the Federal Register of February 27, 1980 (45 FR 13010–13026, to be codified at 50 CFR §§ 17.11 and 17.12), have been corrected. Some scientific names have been changed to reflect current usage. Synonyms or alternative names are indicated by (=). Readers are requested to advise the Service of any errors, particularly with regard to the historic ranges of the listed taxa.

Dated: May 14, 1980.

Lynn A. Greenwalt,

Director, Fish and Wildlife Service.

Regulations Promulgation

Accordingly, §§ 17.11 and 17.12 are revised and republished to Title 50 of the Code of Federal Regulations as set forth below:

PART 17—ENDANGERED AND THREATENED WILDLIFE AND PLANTS

1. 50 CFR 17.11 and 17.12 are revised to read as follows:

§ 17.11 Endangered and threatened wildlife.

(a) The list in this section contains the names of all species of wildlife which have been determined by the Director to be Endangered or Threatened. It also contains the names of species of wildlife treated as Endangered or Threatened because they are sufficiently similar in appearance to Endangered or Threatened species (see § 17.50 *et seq.*).

(b) The columns entitled "Common Name", "Scientific Name", and "Vertebrate Population where Endangered or Threatened" define the species of wildlife within the meaning of the Act. Thus, differently classified geographic populations of the same vertebrate subspecies or species shall be identified by their differing geographic boundaries, even though the other two columns are identical. The term "Entire" means that all populations throughout the present range of a vertebrate species are listed. Although common names are included, they cannot be relied upon for identification of any specimen, since they may vary greatly in local usage. The Director shall use the most recently accepted scientific name. In cases in which confusion might arise, a synonym will be provided in parentheses. The Services shall rely to the extent practicable on the *International Code of Zoological Nomenclature*.

(c) In the "Status" column the following symbols are used: "E" for Endangered, "T" for Threatened, and "E [or T] (S/A)" for similarity of appearance species.

(d) For information purposes only, the "Historic Range" indicates the general known distribution of the species or subspecies as reported in the scientific literature. The present distribution may be greatly reduced from this historic range. This column does not imply any limitation on the application of the prohibitions in the Act or implementing rules. Such prohibitions apply to all

individuals of the species, wherever found. When the list is updated annually any change in the range will be added.

(e) For informational purposes only, a footnote to the Federal Register publication(s) originally listing a species is provided under the column "When Listed." Footnote numbers to §§ 17.11 and 17.12 are in the same numerical sequence, since plants and animals may be listed in the same Federal Register document. That document includes a statement indicating the basis for the listing.

(i) The "Special Rules" and "Critical Habitat" columns provide a cross-reference to other sections in Part 17 or Parts 222, 226 or 227. The term "N/A" (not applicable) appearing in either of these two columns indicates that there are no special rules and/or Critical Habitat for that particular species. However, all other appropriate rules in Part 17 and Parts 217–227 and 402 still apply to that species. In addition, there may be other rules in this Title 50 that relate to such wildlife, e.g., port-of-entry requirements. It is not intended that the references in the "Special Rules" column list all the regulations of the two Services which might apply to the species or to the regulations of other Federal agencies or State or local governments.

(g) The listing of a particular taxon includes all lower taxonomic units. For example, the genus *Hylobates* (gibbons) is listed as Endangered throughout its entire range (China, India, and SE Asia); consequently, all species, subspecies, and populations of that genus are considered listed as Endangered for the purposes of the Act. In 1978 (43 FR 6230–6233) the species *Haliaeetus leucocephalus* (bald eagle) was listed as Threatened in "USA (WA, OR, MN, WI, MI)" rather than its entire population; thus, all individuals of the bald eagle found in those five States are considered listed as Threatened for the purposes of the Act.

(h) The "List of Endangered and Threatened Wildlife" is provided below:

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
MAMMALS							
Anoa	*Bubalus anoa depressicornis*	Indonesia	Entire	E	3	NA	NA
Anoa	*Bubalus anoa quarlesi*	Indonesia	Entire	E	15	NA	NA
Antelope, scaly	*Manis temminckii*	Africa	Entire	E	15	NA	NA
Antelope, bontebok	*Damaliscus dorcas dorcas*	South Africa	Entire	E	15	NA	NA
Antelope, giant sable	*Hippotragus niger variani*	Angola	Entire	E	15	NA	NA
Antelope, Mongolian saiga	*Saiga tatarica mongolica*	Mongolia	Entire	E	15	NA	NA
Argali	*Ovis ammon hodgsoni*	China (Tibet)	Entire	E	15	NA	NA
Armadillo, giant	*Priodontes giganteus*	Venezuela and Guyana to Argentina.	Entire	E	15	NA	NA
Armadillo, pink fairy	*Chlamyphorus truncatus*	Argentina	Entire	E	3	NA	NA
Ass, African wild	*Equus asinus*	Somalia, Sudan, Ethiopia	Entire	E	3	NA	NA
Ass, Asian wild	*Equus hemionus*	Southwestern and Central Asia	Entire	E	3	NA	NA
Avahis	*Avahi* spp. (all species)	Malagasy Republic (= Madagascar).	Entire	E	3	NA	NA
Aye-Aye	*Daubentonia*	Malagasy Republic (= Madagascar).	Entire	E	3	NA	NA
Babirousa	*Babyrousa babyrussa*	Indonesia	Entire	E	15	NA	NA
Bandicoot, barred	*Perameles bougainville*	Australia	Entire	E	4	NA	NA
Bandicoot, desert	*Perameles eremiana*	Australia	Entire	E	6	NA	NA
Bandicoot, lesser rabbit	*Macrotis leucura*	Australia	Entire	E	4	NA	NA
Bandicoot, pig-footed	*Chaeropus ecaudatus*	Australia	Entire	E	4	NA	NA
Bandicoot, rabbit	*Macrotis lagotis*	Australia	Entire	E	4	NA	NA
Banteng	*Bos banteng*	Southeast Asia	Entire	E	3	NA	NA
Bat, gray	*Myotis grisescens*	Central and Southeast U.S.A.	Entire	E	13	NA	NA
Bat, Hawaiian hoary	*Lasiurus cinereus semotus*	U.S.A. (Hawaii)	Entire	E	2	NA	NA
Bat, Indiana	*Myotis sodalis*	East and Midwestern U.S.A.	Entire	E	1	17.95(a)	NA
Bat, Ozark big-eared	*Plecotus townsendii ingens*	U.S.A. (MO, OK, AR)	Entire	E	85	NA	NA
Bat, Virginia big-eared	*Plecotus townsendii virginianus*	U.S.A. (KY, WV, VA, IN, IL, OH)	Entire	E	85	17.95(a)	NA
Bear, brown	*Ursus arctos pruinosus*	China (Tibet)	Entire	E	15	NA	NA
Bear, brown	*Ursus arctos arctos*	Palearctic	Italy	E	15	NA	NA
Bear, brown or grizzly	*Ursus arctos horribilis*	Canada, Western U.S.A.	U.S.A.—48 conterminous States	T	1, 2#, 9	NA	17.40(i)
Bear, Mexican grizzly	*Ursus arctos nelsoni*	Mexico	Entire	E	3	NA	NA
Beaver	*Castor fiber birulai*	Mongolia	Entire	E	15	NA	NA
Bison, wood	*Bison bison athabascae*	Canada, Northwest U.S.A.	Canada	E	3	NA	NA
Bobcat	*Felis rufus escuinape*	Central Mexico	Entire	E	15	NA	NA
Camel, Bactrian	*Camelus bactrianus*	Mongolia, China	Entire	E	15	NA	NA
Cat, Andean	*Felis jacobita*	Chile, Peru, Bolivia, Argentina	Entire	E	15	NA	NA
Cat, black-footed	*Felis nigripes*	Southern Africa	Entire	E	15	NA	NA
Cat, flat-headed	*Felis planiceps*	Malaysia	Entire	E	15	NA	NA
Cat, Iriomote	*Mayailurus iriomotensis*	Japan (Iriomote Island, Ryukyu Islands).	Entire	E	50	NA	NA
Cat, leopard	*Felis bengalensis bengalensis*	Eastern Asia	Entire	E	15	NA	NA
Cat, marbled	*Felis marmorata*	Nepal, Malaysia, Burma, Indochina.	Entire	E	15	NA	NA
Cat, Temminck's	*Felis temminckii*	China (Tibet), Malaysia, Indonesia (Sumatra).	Entire	E	15	NA	NA
Cat, tiger	*Felis tigrina*	Costa Rica to Northern South America.	Entire	E	3	NA	NA
Chamois, Apennine	*Rupicapra rupicapra ornata*	Italy	Entire	E	15	NA	NA
Cheetah	*Acinonyx jubatus*	Africa to India	Entire	E	3, 5	NA	NA
Chimpanzee	*Pan troglodytes*	West and Central Africa	Entire	T	16	NA	17.40(b)
Chimpanzee, pygmy	*Pan paniscus*	Zaire	Entire	T	16	NA	17.40(b)
Chinchilla	*Chinchilla brevicaudata boliviana*	Bolivia	Entire	E	15	NA	NA
Civet, Malabar large-spotted	*Viverra megaspila civettina*	India	Entire	E	50	NA	NA
Colobus, black	*Colobus satanas*	Equatorial Guinea, People's Republic of Congo, Cameroon, Gabon.	Entire	E	16	NA	NA
Colobus, Tana River red	*Colobus badius rufomitratus*	Kenya	Entire	E	3, 16	NA	NA
Colobus, Zanzibar red	*Colobus kirkii*	Tanzania	Entire	E	3	NA	NA
Cougar, eastern	*Felis concolor cougar*	Eastern North America	Entire	E	6	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Deer, Bactrian	*Cervus elaphus bactrianus*	U.S.S.R., Afghanistan	Entire	E	50	NA	NA
Deer, Bawean	*Axis porcinus kuhli*	Indonesia	Entire	E	3	NA	NA
Deer, Barbary	*Cervus elaphus barbarus*	Morocco, Tunisia, Algeria	Entire	E	50	NA	NA
Deer, Cedros Island mule	*Odocoileus hemionus cedrosensis.*	Mexico (Cedros Island)	Entire	E	10	NA	NA
Deer, Columbian white-tailed	*Odocoileus virginianus leucurus*	U.S.A. (WA, OR)	Entire	E	1	NA	NA
Deer, Corsican red	*Cervus elaphus corsicanus*	Corsica, Sardinia	Entire	E	50	NA	NA
Deer, Eld's brown-antlered	*Cervus eldi*	India to Southeast Asia	Entire	E	3	NA	NA
Deer, hog	*Axis (=Cervus) porcinus annamiticus.*	Thailand, Indochina	Entire	E	18	NA	NA
Deer, key	*Odocoileus virginianus clavium*	U.S.A. (southern FL)	Entire	E	1	NA	NA
Deer, marsh	*Blastocerus dichotomus*	Argentina, Uruguay, Paraguay, Brazil.	Entire	E	3	NA	NA
Deer, McNeill's	*Cervus eld[illegible]tus macneilli*	China (Sinkiang, Tibet)	Entire	E	3	NA	NA
Deer, musk	*Moschus moschiferus moschiferus.*	South-central Asia	Entire	E	15	NA	NA
Deer, pampas	*Ozotoceros bezoarticus*	Brazil, Argentina, Uruguay, Paraguay.	Entire	E	15	NA	NA
Deer, Persian fallow	*Dama dama mesopotamica*	Iraq, Iran	Entire	E	3	NA	NA
Deer, Philippine	*Axis calamianensis*	Philippines (Calamian Islands)	Entire	E	15	NA	NA
Deer, swamp	*Cervus duvaucelli*	India, Nepal	Entire	E	3	NA	NA
Deer, Yarkand	*Cervus elaphus yarkandensis*	China (Sinkiang)	Entire	E	50	NA	NA
Dibbler	*Antechinus apicalis*	Australia	Entire	E	4	NA	NA
Dog, Asiatic wild (=Dhole)	*Cuon, alpinus*	U.S.S.R., Korea, China, India, Southeast Asia.	Entire	E	3	NA	NA
Drill	*Papio leucophaeus*	Equatorial West Africa	Entire	E	16	NA	NA
Dugong	*Dugong dugon*	East Africa to southern Japan, including U.S.A. (Trust Territories)	Entire	E	4	NA	NA
Duiker, Jentink's	*Cephalophus jentinki*	Sierra Leone, Liberia, Ivory Coast.	Entire	E	50	NA	NA
Eland, Western giant	*Taurotragus derbianus derbianus*	Senegal to Ivory Coast	Entire	E	50	NA	NA
Elephant, African	*Loxodonta africana*	Africa	Entire	T	40	NA	17.40(e)
Elephant, Asian	*Elephas maximus*	South-central and Southeast Asia	Entire	E	15	NA	NA
Ferret, black-footed	*Mustela nigripes*	Western U.S.A., Western Canada.	Entire	E	1, 3	NA	NA
Forester, Tasmanian (kangaroo)	*Macropus giganteus tasmaniensis*	Australia (Tasmania)	Entire	E	6	NA	NA
Fox, Northern swift	*Vulpes velox hebes*	U.S.A. (northern plains), Canada.	Canada	E	3	NA	NA
Fox, San Joaquin kit	*Vulpes macrotis mutica*	U.S.A. (California)	Entire	E	1	NA	NA
Fox, Simien	*Simia simensis*	Ethiopia	Entire	E	50	NA	NA
Gazelle, Clark's (=Dibatag)	*Ammodorcas clarkei*	Somalia, Ethiopia	Entire	E	3	NA	NA
Gazelle, Cuvier's	*Gazella cuvieri*	Morocco, Tunisia	Entire	E	3	NA	NA
Gazelle, Mhorr	*Gazella dama mhorr*	Morocco	Entire	E	3	NA	NA
Gazelle, Moroccan (=Dorcas)	*Gazella dorcas massaesyla*	Morocco, Algeria	Entire	E	3	NA	NA
Gazelle, Rio de Oro Dama	*Gazella dama lozanoi*	Spanish Sahara	Entire	E	3	NA	NA
Gazelle, Arabian	*Gazella gazella*	Arabian Peninsula including Israel	Entire	E	3	NA	NA
Gazelle, Sand	*Gazella subgutterosa marica*	Jordan, Arabian Peninsula	Entire	E	50	NA	NA
Gazelle, Saudi Arabian	*Gazella dorcas saudiya*	Israel, Iraq, Jordan, Syria, Saudi Arabia, Kuwait.	Entire	E	50	NA	NA
Gazelle, Petzein's	*Gazella dorcas petzeini*	Somalia	Entire	E	50	NA	NA
Gazelle, slender-horned (=Rhim)	*Gazella leptoceros*	Sudan, Egypt, Algeria, Libya	Entire	E	3	NA	NA
Gelada (baboon)	*Theropithecus gelada*	Northern Ethiopia	Entire	T	16	NA	17.40(c)
Gibbons	*Hylobates* spp. (including *Nomascus*).	China, India, southeastern Asia	Entire	E	3, 15	NA	NA
Goral	*Nemorhaedus goral*	East Asia	Entire	E	15	NA	NA
Gorilla	*Gorilla gorilla*	Central and Western Africa	Entire	E	3	NA	NA
Hare, hispid	*Caprolagus hispidus*	India, Nepal	Entire	E	15	NA	NA
Hartebeest, Swayne's	*Alcelaphus buselaphus swaynei*	Ethiopia, Somalia	Entire	E	3, 50	NA	NA
Hartebeest, Tora	*Alcelaphus buselaphus tora*	Ethiopia, Sudan, Egypt	Entire	E	50	NA	NA
Hog, pygmy	*Sus salvanius*	India, Nepal, Bhutan, Sikkim	Entire	E	3	NA	NA
Horse, Przewalski's	*Equus przewalskii*	Mongolia	Entire	E	15	NA	NA
Huemul, North Andean	*Hippocamelus antisensis*	Ecuador, Peru, Chile, Bolivia, Argentina.	Entire	E	15	NA	NA
Huemul, South Andean	*Hippocamelus bisulcus*	Chile, Argentina	Entire	E	15	NA	NA
Hyena, Barbary	*Hyaena hyaena barbara*	Morocco	Entire	E	3	NA	NA
Hyena, brown	*Hyaena brunnea*	Southern Africa	Entire	E	3	NA	NA
Ibex, Pyrenean	*Capra pyrenaica pyrenaica*	Spain	Entire	E	3	NA	NA
Ibex, Walia	*Capra walie*	Ethiopia	Entire	E	3	NA	NA
Impala, black-faced	*Aepyceros melampus petersi*	Southwest Africa, Namibia, Angola.	Entire	E	3	NA	NA
Indris	*Indris* spp. (all species)	Malagasy Republic (=Madagascar) Comoro Island.	Entire	E	3	NA	NA
Jaguar	*Panthera onca*	U.S.A. (TX, NM, AZ), Central and South America.	Mexico southward.	E	5	NA	NA
Jaguarundi	*Felis yagouaroundi cacomitli*	U.S.A. (TX), Mexico	Entire	E	15	NA	NA
Jaguarundi	*Felis yagouaroundi fossata*	Mexico, Nicaragua	Entire	E	15	NA	NA
Jaguarundi	*Felis yagouaroundi panamensis*	Nicaragua, Costa Rica, Panama	Entire	E	15	NA	NA
Jaguarundi	*Felis yagouaroundi tolteca*	U.S.A. (AZ), Mexico	Entire	E	15	NA	NA
Kangaroo, eastern gray (see also Forester, Tasmanian).	*Macropus giganteus* (all subspecies except *tasmaniensis*).	Australia	Entire	T	7	NA	17.40(a)
Kangaroo, red	*Megaleia rufa*	Australia	Entire	T	7	NA	17.40(a)
Kangaroo, western gray	*Macropus fuliginosus*	Australia	Entire	T	7	NA	17.40(a)
Kouprey	*Bos sauveli*	Vietnam, Laos, Cambodia, Thailand.	Entire	E	3	NA	NA
Langur, capped	*Presbytis pileatus*	India, Burma	Entire	E	15	NA	NA
Langur, entellus	*Presbytis entellus*	China (Tibet), India, Pakistan, Kashmir, Sri Lanka, Sikkim, Bangladesh.	Entire	E	15	NA	NA
Langur, Douc	*Pygathrix nemaeus*	Cambodia, Laos, China, Vietnam	Entire	E	3	NA	NA
Langur, golden	*Presbytis geei*	India (Assam), Bhutan	Entire	E	15	NA	NA
Langur, long-tailed	*Presbytis potenziani*	Indonesia	Entire	T	16	NA	17.40(c)
Langur, Pagi Island	*Simias concolor*	Indonesia	Entire	E	3	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Langur, purple-faced	*Presbytis senex*	Sri Lanka (= Ceylon)	Entire	T	16	NA	17.40(c)
Lechwe, red	*Kobus leche*	Southern Africa	Entire	E	2, 15	NA	NA
Lemurs	*Lemuridae* (incl. Cheirogaleidae, Lepilemuridae); all members of genera *Lemur, Phaner, Hapalemur, Lepilemur, Microcebus, Allocebus, Cheirogaleus, Varecia*	Malagasy Republic (= Madagascar).	Entire	E	2, 15	NA	NA
Leopard	*Panthera pardus*	Africa, India, Southeast Asia	Entire	E	2, 5	NA	NA
Leopard, clouded	*Neofelis nebulosa*	Southeast and South-central Asia, Taiwan.	Entire	E	2, 15	NA	NA
Leopard, snow	*Panthera uncia*	Central Asia	Entire	E	5	NA	NA
Linsang, spotted	*Prionodon pardicolor*	Nepal, Assam, Vietnam, Cambodia, Laos, Burma.	Entire	E	15	NA	NA
Lion, Asiatic	*Panthera leo persica*	Western Iran to India	Entire	E	3	NA	NA
Loris, lesser slow	*Nycticebus pygmaeus*	Indochina	Entire	T	16	NA	17.40(c)
Lynx, Spanish	*Felis lynx pardina*	Spain	Entire	E	3	NA	NA
Macaque, Formosan rock	*Macaca cyclopis*	Taiwan	Entire	T	16	NA	17.40(c)
Macaque, Japanese	*Macaca fuscata*	Japan (Shikoku, Kyushu and Honshu island).	Entire	T	16	NA	17.40(c)
Macaque, lion-tailed	*Macaca silenus*	India	Entire	E	3	NA	NA
Macaque, stump-tailed	*Macaca arctoides*	India (Assam) to southern China	Entire	T	16	NA	17.40(c)
Macaque, Toque	*Macaca sinica*	Sri Lanka (= Ceylon)	Entire	T	16	NA	17.40(c)
Manatee, Amazonian	*Trichechus inunguis*	South America; Amazon River basin.	Entire	E	3	NA	NA
Manatee, West African	*Trichechus senegalensis*	West Coast of Africa from Senegal River Cuanza River.	Entire	T	52	NA	NA
Manatee, West Indian (Florida)	*Trichechus manatus*	U.S.A. (southeastern), Caribbean Ocean, South America.	Entire	E	1, 3	17.95(a)	NA
Mandrill	*Papio sphinx*	Equatorial West Africa	Entire	E	16	NA	NA
Mangabey, Tana River	*Cercocebus galeritus*	Kenya	Entire	E	3	NA	NA
Mangabey, white-collared	*Cercocebus torquatus*	Senegal to Ghana; Nigeria to Gabon.	Entire	E	16	NA	NA
Margay	*Felis wiedii*	U.S.A. (NM, AZ); Central and South America.	Mexico southward.	E	5	NA	NA
Markhor, Chiltan	*Capra falconeri chiltanensis*	Pakistan	Entire	E	15	NA	NA
Markhor, Kabal	*Capra falconeri megaceros*	Afghanistan, Pakistan	Entire	E	15	NA	NA
Markhor, straight-horned	*Capra falconeri jerdoni*	Pakistan, Afghanistan	Entire	E	16	NA	NA
Marmoset, cotton-top	*Saguinus oedipus*	Panama, Costa Rica, Colombia	Entire	E	16	NA	NA
Marmoset, Goeldi's	*Callimico goeldi*	Brazil, Colombia, Ecuador, Peru	Entire	E	3	NA	NA
Marsupial, eastern jerboa	*Antechinomys laniger*	Australia	Entire	E	4	NA	NA
Marsupial-mouse large desert	*Sminthopsis psammophila*	Australia	Entire	E	4	NA	NA
Marsupial-mouse, long-tailed	*Sminthopsis longicaudata*	Australia	Entire	E	4	NA	NA
Marten, Formosan yellow-throated	*Martes flavigula chrysospila*	Taiwan	Entire	E	3	NA	NA
Monkey, black howler	*Alouatta pigra*	Mexico, Guatemala, Belize	Entire	T	16	NA	17.40(c)
Monkey, Diana	*Cercopithecus diana*	Coastal West Africa	Entire	E	16	NA	NA
Monkey, Francois' leaf	*Presbytis francoisi*	China (Kwangsi, Indochina	Entire	E	16	NA	NA
Monkey, howler	*Alouatta villosa*	Mexico to South America	Entire	E	16	NA	NA
Monkey, L'hoest's	*Cercopithecus lhoesti*	Upper Eastern Congo Basin, Cameroon.	Entire	E	16	NA	NA
Monkey, proboscis	*Nasalis larvatus*	Borneo	Entire	E	3	NA	NA
Monkey, red-backed squirrel	*Samiri oerstedi*	Costa Rica, Panama	Entire	E	16	NA	NA
Monkey, red-bellied	*Cercopithecus erythrogaster*	Western Nigeria	Entire	E	16	NA	NA
Monkey, red-eared nose-spotted	*Cercopithecus erythrotis*	Nigeria, Cameroon, Fernando Po.	Entire	E	3	NA	NA
Monkey, spider	*Ateles geoffroyi frontatus*	Costa Rica, Nicaragua	Entire	E	3	NA	NA
Monkey, spider	*Ateles geoffroyi panamensis*	Costa Rica, Panama	Entire	T	16	NA	17.40(c)
Monkey, Tonkin snub-nosed	*Rhinopithecus avunculus*	Vietnam	Entire	E	3	NA	NA
Monkey, woolly spider	*Brachyteles arachnoides*	Brazil	Entire	E	16	NA	NA
Monkey, yellow-tailed woolly	*Lagothrix flavicauda*	Andes of northern Peru	Entire	E	15	NA	NA
Mouse, Australian native	*Notomys pedunculatus*	Australia	Entire	E	15	NA	NA
Mouse, Australian native	*Notomys aquilo*	Australia	Entire	E	4	NA	NA
Mouse, Field's	*Pseudomys fieldi*	Australia	Entire	E	6	NA	NA
Mouse, Gould's	*Pseudomys gouldi*	Australia	Entire	E	4	NA	NA
Mouse, New Holland	*Pseudomys novaehollandiae*	Australia	Entire	E	2	NA	NA
Mouse, salt marsh harvest	*Reithrodontomys raviventris*	U.S.A. (California)	Entire	E	4	NA	NA
Mouse, Shark Bay	*Pseudomys praeconis*	Australia	Entire	E	4	NA	NA
Mouse, Shortridge's	*Pseudomys shortridgei*	Australia	Entire	E	4	NA	NA
Mouse, Smoky	*Pseudomys fumeus*	Australia	Entire	E	4	NA	NA
Mouse, western	*Pseudomys occidentalis*	Australia	Entire	E	50	NA	NA
Munjac, Fea's	*Muntiacus feae*	Northern Thailand, Burma	Entire	E	6	NA	NA
Native-cat, eastern	*Dasyurus viverrinus*	Australia	Entire	E	4, 6	NA	NA
Numbat	*Myrmecobius fasciatus*	Australia	Entire	E	5	NA	NA
Ocelot	*Felis pardalis*	Southwest U.S.A., Central and South America.	Mexico southward.	E	3	NA	NA
Orangutan	*Pongo pygmaeus*	Borneo, Sumatra	Entire	E	3	NA	NA
Oryx, Arabian	*Oryx leucoryx*	Arabian Peninsula	Entire	E	3	NA	NA
Otter, Cameroon clawless	*Paraonyx microdon*	Cameroon	Entire	E	3	NA	NA
Otter, giant	*Pteronura brasiliensis*	South America	Entire	E	3	NA	NA
Otter, La Plata	*Lutra platensis*	Argentina, Bolivia, Uruguay, Brazil	Entire	E	16	NA	NA
Otter, long tailed	*Lutra longicaudis*	South America	Entire	E	15	NA	NA
Otter, marine	*Lutra felina*	Peru, south to Straits of Magellan	Entire	E	15	NA	NA
Otter, southern river	*Lutra provocax*	Chile, Argentina	Entire	T	21	NA	NA
Otter, southern sea	*Enhydra lutris nereis*	West coast U.S.A. (WA) south to Mexico (Baja California).	Entire	E	1	NA	NA
Panther, Florida	*Felis concolor coryi*	U.S.A. (LA and AR east to SC and FL).	Entire	E	4	NA	NA
Planigale, little	*Planigale subtilissima*	Australia	Entire	E	4	NA	NA
Planigale, southern	*Planigale tenuirostris*	Australia	Entire	E	3	NA	NA
Porcupine, thin-spined	*Chaetomys subspinosus*	Brazil	Entire	E			

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Possum, mountain pygmy	*Burramys parvus*	Australia	Entire	E	4	NA	NA
Possum, scaly-tailed	*Wyulda squamicaudata*	Australia	Entire	E	4	NA	NA
Prairie dog, Mexican	*Cynomys mexicanus*	Mexico	Entire	E	3	NA	NA
Prairie dog, Utah	*Cynomys parvidens*	U.S.A. (Utah)	Entire	E	6	NA	NA
Pronghorn, peninsular	*Antilocapra americana peninsularis.*	Mexico (Baja California)	Entire	E	10	NA	NA
Pronghorn, Sonoran	*Antilocapra americana sonoriensis.*	U.S.A. (AZ), Mexico	Entire	E	1, 3	NA	NA
Pudu	*Pudu pudu*	Southern South America	Entire	E	15	NA	NA
Puma, Costa Rican	*Felis concolor costaricensis*	Nicaragua, Panama, Costa Rica	Entire	E	15	NA	NA
Quokka	*Setonix brachyurus*	Australia	Entire	E	8	NA	NA
Rabbit, Ryukyu	*Pentalagus furnessi*	Japan (Ryukyu Island)	Entire	E	50	NA	NA
Rabbit, volcano	*Romerolagus diazi*	Mexico	Entire	E	3	NA	NA
Rat, false water	*Xeromys myoides*	Australia	Entire	E	4	NA	NA
Rat, Key-nest	*Leporillus conditor*	Australia	Entire	E	6	NA	NA
Rat, Morro Bay kangaroo	*Dipodomys heermanni*	U.S.A. (California)	Entire	E	2	17.95(a)	NA
Rat—kangaroo, brush-tailed	*Bettongia penicillata*	Australia	Entire	E	4	NA	NA
Rat—kangaroo, Gaimard's	*Bettongia gaimardi*	Australia	Entire	E	6	NA	NA
Rat—kangaroo, Lesuer's	*Bettongia lesueur*	Australia	Entire	E	4	NA	NA
Rat—kangaroo, plain	*Caloprymnus campestris*	Australia	Entire	E	4	NA	NA
Rat—kangaroo, Queensland	*Bettongia tropica*	Australia	Entire	E	4	NA	NA
Rhinoceros, great Indian	*Rhinoceros unicornis*	India, Nepal	Entire	E	4	NA	NA
Rhinoceros, Javan	*Rhinoceros sondaicus*	Indonesia, Indochina, Burma,	Entire	E	3	NA	NA
Rhinoceros, northern white	*Ceratotherium simum cottoni*	Zaire, Sudan, Uganda, Central African Republic.	Entire	E	3	NA	NA
Rhinoceros, Sumatran	*Dicerorhinus sumatrensis*	Bangladesh to Vietnam to Indonesia (Borneo).	Entire	E	3	NA	NA
Saki, white-nosed	*Chiropotes albinasus*	Brazil	Entire	E	3	NA	NA
Seal, Caribbean monk	*Monachus tropicalis*	Caribbean Sea, Gulf of Mexico	Entire	E	1, 2, 15	NA	NA
Seal, Hawaiian monk	*Monachus schauinslandi*	Hawaiian Archipelago	Entire	E	18	NA	NA
Seal, Mediterranean monk	*Monachus monachus*	Mediterranean, Northwest African Coast and Black Sea.	Entire	E	3	NA	NA
Seladang (=Guar)	*Bos gaurus*	Bangladesh, Southeast Asia, India.	Entire	E	3	NA	NA
Serow, Sumatran	*Capricornis sumatraensis*	Sumatra	Entire	E	15	NA	NA
Serval, Barbary	*Felis serval constantina*	Algeria	Entire	E	3	NA	NA
Shapo	*Ovis vignei*	Kashmir	Entire	E	15	NA	NA
Shou	*Cervus elaphus wallichi*	Tibet, Bhutan	Entire	E	3	NA	NA
Siamang	*Symphalangus syndactylus*	Malaysia, Indonesia	Entire	E	15	NA	NA
Sifakas	*Propithecus* spp. (all species)	Malagasy Republic (=Madagascar).	Entire	E	4	NA	NA
Sika (deer), Formosan	*Cervus nippon taiouanus*	Taiwan	Entire	E	50	NA	NA
Sika (deer), North China	*Cervus nippon mandarinus*	China (Shantung and Chihli Provinces).	Entire	E	50	NA	NA
Sika (deer), Ryukyu	*Cervus nippon keramae*	Japan (Ryukyu Island)	Entire	E	50	NA	NA
Sika (deer), Shansi	*Cervus nippon grassianus*	China (Shansi Province)	Entire	E	50	NA	NA
Sika (deer), South China	*Cervus nippon kopschi*	Southern China	Entire	E	50	NA	NA
Sloth, Brazilian three-toed	*Bradypus torquatus*	Brazil	Entire	E	3, 4	NA	NA
Solenodon, Cuban	*Atopogale cubana*	Cuba	Entire	E	3	NA	NA
Solenodon, Haitian	*Solenodon paradoxus*	Dominican Republic, Haiti	Entire	E	3	NA	NA
Squirrel, Delmarva Peninsula fox	*Sciurus niger cinereus*	U.S.A. (DelMarVa Peninsula to Southeast PA).	Entire	E	1	NA	NA
Stag, Barbary	*Cervus elephus barbarus*	Tunisia, Algeria	Entire	E	3	NA	NA
Stag, Kashmir	*Cervus elephus hanglu*	Kashmir	Entire	E	3	NA	NA
Suni, Zanzibar	*Nesotragus moschatus moschatus.*	Zanzibar (and neighboring states)	Entire	E	50	NA	NA
Tahr, Arabian	*Hemitragus jayakari*	Oman	Entire	E	50	NA	NA
Tamaraw	*Bubalus mindorensis*	Philippines	Entire	E	4	NA	NA
Tamarin, golden-rumped (=golden-headed Tamarin; =golden-lion Marmoset).	*Leontideus* spp. (all species)	Brazil	Entire	E	3	NA	NA
Tamarin, pied	*Saguinus bicolor*	Northern Brazil	Entire	E	16	NA	NA
Tamarin, white-footed	*Saguinus leucopus*	Northern Colombia	Entire	T	16	NA	17.40(c)
Tapir, Asian	*Tapirus indicus*	Burma, Laos, Cambodia, Vietnam, Malaysia, Indonesia, Thailand.	Entire	E	15	NA	NA
Tapir, Brazilian	*Tapirus terrestris*	Colombia and Venezuela south to Paraguay and Argentina.	Entire	E	3	NA	NA
Tapir, Central American	*Tapirus bairdi*	Southern Mexico to Colombia and Ecuador.	Entire	E	3	NA	NA
Tapir, mountain	*Tapirus pinchaque*	Colombia, Ecuador and possibly Peru and Venezuela.	Entire	E	3	NA	NA
Tarsier, Philippine	*Tarsius syrichta*	Philippines	Entire	T	16	NA	17.40(c)
Tiger	*Panthera tigris*	Temperate and Tropical Asia	Entire	E	3, 5	NA	NA
Tiger, Tasmanian (=Thylacine)	*Thylacinus cynocephalus*	Australia	Entire	E	3	NA	NA
Uakari (all species)	*Cacajao* spp. (all species)	Peru, Brazil, Ecuador, Columbia, Venezuela.	Entire	E	3	NA	NA
Urial	*Ovis orientalis ophion*	Cyprus	Entire	E	15	NA	NA
Vicuna	*Vicugna vicugna*	South American Andes	Entire	E	3	NA	NA
Wallaby, banded hare	*Lagostrophus fasciatus*	Australia	Entire	E	4	NA	NA
Wallaby, brindled nail-tailed	*Onychogalea frenata*	Australia	Entire	E	4	NA	NA
Wallaby, crescent nail-tailed	*Onychogalea lunata*	Australia	Entire	E	4	NA	NA
Wallaby, Parma	*Macropus parma*	Australia	Entire	E	4	NA	NA
Wallaby, Western hare	*Lagorchestes hirsutus*	Australia	Entire	E	4	NA	NA
Wallaby, yellow-footed rock	*Petrogale xanthopus*	Australia	Entire	E	4	NA	NA
Whale, blue	*Balaenoptera musculus*	Oceanic	Entire	E	6	NA	NA
Whale, bowhead	*Balaena mysticetus*	Oceanic (north latitudes only)	Entire	E	3	NA	NA
Whale, finback	*Balaenoptera physalus*	Oceanic	Entire	E	3	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Whale, gray	*Eschrichtius robustus*	North Pacific Ocean; coastal and Bering Sea.	Entire	E	3	NA	NA
Whale, humpback	*Megaptera novaeangliae*	Oceanic	Entire	E	3	NA	NA
Whale, right	*Balaena glacialis*	Oceanic	Entire	E	3	NA	NA
Whale, Sei	*Balaenoptera borealis*	Oceanic	Entire	E	3	NA	NA
Whale, sperm	*Physeter catodon*	Oceanic	Entire	E	3	NA	NA
Wolf, gray	*Canis lupus*	Holarctic	U.S.A. (48 conterminous States other than MN), Mexico.	E	1, 6, 13, 15, 35	17.95(b)	NA
Wolf, gray	*Canis lupus*	Holarctic	U.S.A. (MN)	T	35	17.95(a)	17.40(d)
Wolf, maned	*Chrysocyon brachyurus*	Argentina, Bolivia, Brazil, Paraguay, Uruguay.	Entire	E	4	NA	NA
Wolf, red	*Canis rufus*	U.S.A. (southeast U.S.A. west to central TX).	Entire	E	1	NA	NA
Wombat, Barnard's	*Lasiorhinus barnardi*	Australia	Entire	E	4	NA	NA
Wombat, Queensland hairy-nosed	*Lasiorhinus gillespiei*	Australia	Entire	E	6	NA	NA
Yak, wild	*Bos grunniens mutus*	China (Tibet), India	Entire	E	3	NA	NA
Zebra, Grevy's	*Equus grevyi*	Kenya, Ethiopia, Sudan	Entire	T	54	NA	NA
Zebra, mountain	*Equus zebra*	South Africa	Entire	E	15, 54	NA	NA
Birds							
Akepa, Hawaii (honeycreeper)	*Loxops coccineus coccineus*	U.S.A. (Hawaii)	Entire	E	2	NA	NA
Akepa, Maui (honeycreeper)	*Loxops coccineus ochraceus*	U.S.A. (Hawaii)	Entire	E	2	NA	NA
Akialoa, Kauai (honeycreeper)	*Hemignathus procerus*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Akiapolaau (honeycreeper)	*Hemignathus wilsoni*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Albatross, short-tailed	*Diomedea albatrus*	North Pacific Ocean; Japan, U.S.S.R., U.S.A. (AK, CA, HA, OR, WA).	Entire, except U.S.A.	E	3	NA	NA
Blackbird, yellow-shouldered	*Agelaius xanthomus*	U.S.A. (Puerto Rico)	Entire	E	17	17.95(b)	NA
Bobwhite, masked (quail)	*Colinus virginianus ridgwayi*	U.S.A. (Arizona), Mexico (Sonora)	Entire	E	1, 3	NA	NA
Booby, Abbott's	*Sula abbotti*	Indian Ocean; Christmas Island	Entire	E	15	NA	NA
Brissebird, western	*Dasyornis brachypterus longirostris.*	Australia	Entire	E	3	NA	NA
Brissebird, western rufous	*Dasyornis broadbenti litoralis*	Australia	Entire	E	15	NA	NA
Bulbul, Mauritius olivaceous	*Hypsipetes borbonicus olivaceus*	Mauritius	Entire	E	3	NA	NA
Bullfinch, Sao Miguel (finch)	*Pyrrhula pyrrhula murina*	Eastern Atlantic Ocean; Azores	Entire	E	3	NA	NA
Bushwren, New Zealand	*Xenicus longipes*	New Zealand	Entire	E	3	NA	NA
Bustard, great Indian	*Choriotis nigriceps*	India, Pakistan	Entire	E	3	NA	NA
Cahow (= Bermuda Petrel)	*Pterodroma cahow*	North Atlantic Ocean; Bermuda	Entire	E	3	NA	NA
Condor, Andean	*Vultur gryphus*	Colombia to Chile and Argentina	Entire	E	4	NA	NA
Condor, California	*Gymnogyps californianus*	U.S.A. (OR, CA), Mexico (Baja California).	Entire	E	1	17.95(a)	NA
Coot, Hawaiian	*Fulica americana alai*	U.S.A. (Hawaii)	Entire	E	2	NA	NA
Cotinga, banded	*Cotinga maculata*	Brazil	Entire	E	15	NA	NA
Cotinga, white-winged	*Xipholena atropurpurea*	Brazil	Entire	E	15	NA	NA
Crane, black-necked	*Grus nigricollis*	China (Tibet)	Entire	E	15	NA	NA
Crane, Cuba sandhill	*Grus canadensis nesiotes*	West Indies; Cuba	Entire	E	15	NA	NA
Crane, hooded	*Grus monacha*	Japan, U.S.S.R.	Entire	E	4	NA	NA
Crane, Japanese	*Grus japonensis*	China, Japan, Korea, U.S.S.R.	Entire	E	3	NA	NA
Crane, Mississippi sandhill	*Grus canadensis pulla*	U.S.A. (Mississippi)	Entire	E	6	(17.95(b))	NA
Crane, Siberian white	*Grus leucogeranus*	U.S.S.R. (Siberia) to India, including Iran and China.	Entire	E	4	NA	NA
Crane, white-naped	*Grus vipio*	Mongolia	Entire	E	15	NA	NA
Crane, whooping	*Grus americana*	Canada, U.S.A. (Rocky Mountains east to Carolinas), Mexico.	Entire	E	1, 3	17.95(b)	NA
Creeper, Hawaiian	*Loxops maculata mana*	U.S.A. (Hawaii)	Entire	E	10	NA	NA
Creeper, Molokai (= Kakawahie)	*Loxops maculata flammea*	U.S.A. (Hawaii)	Entire	E	2	NA	NA
Creeper, Oahu (= alauwahio)	*Loxops maculata maculata*	U.S.A. (Hawaii)	Entire	E	2	NA	NA
Crow, Hawaiian (= alala)	*Corvus tropicus*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Cuckoo-shrike, Mauritius	*Coracina (= Coracina) typica*	Indian Ocean; Mauritius	Entire	E	3	NA	NA
Cuckoo-shrike, Reunion	*Coracina (= Coracina) newtoni*	Indian Ocean; Reunion	Entire	E	3	NA	NA
Curassow, razor-billed	*Mitu (= Crax) mitu mitu*	Brazil (Eastern)	Entire	E	15	NA	NA
Curassow, red-billed	*Crax blumenbachii*	Brazil	Entire	E	4	NA	NA
Curassow, Trinidad, white-headed	*Pipile pipile pipile*	West Indies; Trinidad	Entire	E	3	NA	NA
Curlew, Eskimo	*Numenius borealis*	Alaska and northern Canada to Argentina.	Entire	E	1, 3	NA	NA
Dove, cloven-feathered	*Drepanoptila holosericea*	Southwest Pacific Ocean; New Caledonia.	Entire	E	3	NA	NA
Dove, Grenada	*Leptotila wellsi*	West Indies; Grenada	Entire	E	3	NA	NA
Dove, Palau ground	*Gallicolumba canifrons*	West Pacific Ocean; U.S.A. (Palau Islands).	Entire	E	3	NA	NA
Duck, Hawaiian (= koloa)	*Anas wyvilliana*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Duck, Laysan	*Anas laysanensis*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Duck, pink-headed	*Rhodonessa caryophyllacea*	India	Entire	E	15	NA	NA
Duck, white-winged wood	*Cairina scutulata*	India, Malaysia, Indonesia, Thailand.	Entire	E	3	NA	NA
Eagle, Greenland white-tailed	*Haliaeetus albicilla groenlandicus*	Greenland and adjacent Atlantic islands.	Entire	E	15	NA	NA
Eagle, harpy	*Harpia harpyja*	Mexico south to Argentina	Entire	E	15	NA	NA
Eagle, Philippine (= monkey-eating)	*Pithecophaga jefferyi*	Philippines	Entire	E	3	NA	NA
Eagle, bald	*Haliaeetus leucocephalus*	North America south to northern Mexico.	U.S.A. (conterminous States, except WA, OR, MN, WI, MI).	E	1, 24	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Eagle, bald	*Haliaeetus leucocephalus*	North America south to northern Mexico.	U.S.A. (WA, OR, MN, WI, MI).	T	34	NA	17.41(a)
Eagle, Spanish imperial	*Aquila heliaca adalberti*	Spain, Morocco, Algeria	Entire	E	3	NA	NA
Egret, Chinese	*Egretta eulophotes*	China, Korea	Entire	E	3	NA	NA
Falcon, American peregrine	*Falco peregrinus anatum*	Canada, U.S.A., Mexico	Entire	E	2, 3	17.95(a)	NA
Falcon, Arctic peregrine	*Falco peregrinus tundrius*	Alaska to Greenland, south to Argentina.	Entire	E	2, 3	NA	NA
Falcon, Eurasian peregrine	*Falco peregrinus peregrinus*	Europe, Eurasia south to Africa and Mideast.	Entire	E	15	NA	NA
Finch, Laysan (Honeycreeper)	*Telespyza (=Psittirostra) cantans*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Finch, Nihoa (honeycreeper)	*Telespyza (=Psittirostra) ultima*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Flycatcher, Euler's	*Empidonax euleri johnstonei*	West Indies: Grenada	Entire	E	3	NA	NA
Flycatcher, Palau fantail	*Rhipidura lepida*	West Pacific Ocean: U.S.A. (Palau Islands).	Entire	E	3	NA	NA
Flycatcher, Seychelles paradise	*Terpsiphone corvina*	Indian Ocean: Seychelles	Entire	E	3	NA	NA
Flycatcher, Tahiti	*Pomarea nigra*	South Pacific Ocean: Tahiti	Entire	E	3	NA	NA
Flycatcher, Tinian monarch	*Monarcha takatsukasae*	Western Pacific Ocean: U.S.A. (Marianas islands).	Entire	E	3	NA	NA
Fody, Seychelles (weaver-finch)	*Foudia sechellarum*	Indian Ocean: Seychelles	Entire	E	3	NA	NA
Frigatebird, Andrew's	*Fregata andrewsi*	East Indian Ocean	Entire	E	15	NA	NA
Gallinule, Hawaiian	*Gallinula chloropus sandvicensis*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Goose, Aleutian Canada	*Branta canadensis leucopareia*	Western U.S.A. (AK, CA, OR, WA), Japan.	Entire	E	1, 3	NA	NA
Goose, Hawaiian (=Nene)	*Branta sandvicensis*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Goshawk, Christmas Island	*Accipiter fasciatus natalis*	Indian Ocean: Christmas Island	Entire	E	3	NA	NA
Grackle, slender-billed	*Cassidix palustris*	Mexico	Entire	E	3	NA	NA
Grasswren, Eyrean (flycatcher)	*Amytornis goyderi*	Australia	Entire	E	3	NA	NA
Grebe, Atitlan	*Podilymbus gigas*	Guatemala	Entire	E	3	NA	NA
Greenshank, Nordmann's	*Tringa guttifer*	U.S.S.R., Japan, south to Malaya, Borneo.	Entire	E	15	NA	NA
Guan, highland	*Oreophasis derbianus*	Guatemala, Mexico	Entire	E	3	NA	NA
Gull, Audouin's	*Larus audouini*	Mediterranean Sea	Entire	E	3	NA	NA
Gull, relict	*Larus relictus*	India, China	Entire	E	15	NA	NA
Hawk, Anjouan Island sparrow	*Accipiter francesi pusillus*	Indian Ocean: Comoro Islands	Entire	E	3	NA	NA
Hawk, Galapagos	*Buteo galapagoensis*	Ecuador (Galapagos island)	Entire	E	3	NA	NA
Hawk, Hawaiian (=io)	*Buteo solitarius*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Hermit, hook-billed (hummingbird)	*Glaucis (=Ramphodon) dohrnii*	Brazil	Entire	E	15	NA	NA
Honeycreeper, crested (=akohekohe).	*Palmeria dolei*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Hornbill, helmeted	*Rhinoplax vigil*	Thailand, Malaysia	Entire	E	15	NA	NA
Ibis, Japanese crested	*Nipponia nippon*	China, Japan, U.S.S.R., Korea	Entire	E	3	NA	NA
Kagu	*Rhynochetos jubatus*	Southwestern Pacific Ocean: New Caledonia.	Entire	E	3	NA	NA
Kakapo (=owl-parrot)	*Strigops habroptilus*	New Zealand	Entire	E	3	NA	NA
Kestrel, Mauritius	*Falco punctatus*	Indian Ocean: Mauritius	Entire	E	3	NA	NA
Kestrel, Seychelles	*Falco araea*	Indian Ocean: Seychelles Islands	Entire	E	3	NA	NA
Kite, Cuba hook-billed	*Chondrohierax uncinatus wilsonii*	West Indies: Cuba	Entire	E	3	NA	NA
Kite, Grenada hook-billed	*Chondrohierax uncinatus mirus*	West Indies: Grenada	Entire	E	3	NA	NA
Kite, Everglade (snail kite)	*Rostrhamus sonabilis plumbeus*	U.S.A. (Florida)	Entire	E	1	17.95(b)	NA
Kokako (wattlebird)	*Callaeas cinerea*	New Zealand	Entire	E	3	NA	NA
Macaw, glaucous	*Anodorhynchus glaucus*	Paraguay, Uruguay, Brazil	Entire	E	15	NA	NA
Macaw, indigo	*Anodorhynchus leari*	Brazil	Entire	E	15	NA	NA
Macaw, little blue	*Cyanopsitta spixii*	Brazil	Entire	E	15	NA	NA
Magpie-robin, Seychelles (thrush)	*Copsychus sechellarum*	Indian Ocean: Seychelles Islands	Entire	E	3	NA	NA
Malkoha, red-faced (cuckoo)	*Phaenicophaeus pyrrhocephalus*	Sri Lanka (=Ceylon)	Entire	E	3	NA	NA
Mallard, Marianas	*Anas oustaleti*	West Pacific Ocean: (Guam, Marianas island).	Entire	E	23	NA	NA
Megapode, La Perouse's	*Megapodius laperouse*	West Pacific Ocean: U.S.A. (Palau Island, Marianas Island).	Entire	E	3	NA	NA
Megapode, Maleo	*Macrocephalon maleo*	Indonesia (Celebes)	Entire	E	3	NA	NA
Millerbird, Nihoa (willow warbler)	*Acrocephalus familiaris kingi*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Nukupuu (honeycreeper)	*Hemignathus lucidus*	U.S.A. (Hawaii)	Entire	E	1, 2	NA	NA
Oo, Kauai (=Oo Aa) (honeyeater)	*Moho braccatus*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Ostrich, Arabian	*Struthio camelus syriacus*	Jordan, Saudi Arabia	Entire	E	3	NA	NA
Ostrich, West African	*Struthio camelus spatzi*	Spanish Sahara	Entire	E	3	NA	NA
Ou (honeycreeper)	*Psittirostra psittacea*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Owl, Anjouan scops	*Otus rutilus capnodes*	Indian Ocean: Comoro Island	Entire	E	3	NA	NA
Owl, giant scops	*Otus gurneyi*	Philippines: Mindoro and Mindanao Island.	Entire	E	15	NA	NA
Owl, Palau	*Otus podargina*	West Pacific Ocean: U.S.A. (Palau Islands).	Entire	E	3	NA	NA
Owl, Seychelles	*Otus insularis*	Indian Ocean: Seychelles Island	Entire	E	3	NA	NA
Owlet, Mr. Morden's	*Otus senegalensis*	Kenya	Entire	E	3	NA	NA
Palila (honeycreeper)	*Psittirostra bailleui*	U.S.A. (Hawaii)	Entire	E	1	17.95(b)	NA
Parakeet, Forbes'	*Cyanoramphus auriceps forbesi*	New Zealand	Entire	E	3, 15	NA	NA
Parakeet, golden	*Aratinga guarouba*	Brazil	Entire	E	4	NA	NA
Parakeet, golden-shouldered (=hooded)	*Psephotus chrysopterygius*	Australia	Entire	E	3	NA	NA
Parakeet, Mauritius	*Psittacula echo*	Indian Ocean: Mauritius	Entire	E	3	NA	NA
Parakeet, ochre-marked	*Pyrrhura cruentata*	Brazil	Entire	E	3	NA	NA
Parakeet, orange-bellied	*Neophema chrysogaster*	Australia	Entire	E	4	NA	NA
Parakeet, paradise	*Psephotus pulchrimmus*	Australia	Entire	E	4	NA	NA
Parakeet, scarlet-chested	*Neophema splendida*	Australia	Entire	E	4	NA	NA
Parakeet, turquoise [illegible]	*Neophema pulchella*	Australia	Entire	E	3	NA	NA
Parrot, Australian	*Geopsittacus occidentalis*	Australia	Entire	E	3	NA	NA
Parrot, Bahaman or Cuban	*Amazona leucocephala*	West Indies: Cuba, Bahamas, Caymans.	Entire	E	3, 15	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Parrot, ground	*Pezoporus wallicus*	Australia	Entire	E	6	NA	NA
Parrot, imperial	*Amazona imperialis*	West Indies: Dominica	Entire	E	3	NA	NA
Parrot, Puerto Rican	*Amazona vittata*	U.S.A. (Puerto Rico)	Entire	E	1	NA	NA
Parrot, red-browed	*Amazona rhodocorytha*	Brazil	Entire	E	3	NA	NA
Parrot, red-capped	*Pionopsitta pileata*	Brazil	Entire	E	15	NA	NA
Parrot, red-necked	*Amazona arausiaca*	West Indies: Dominica	Entire	E	50	NA	NA
Parrot, red-spectacled	*Amazona pretrei pretrei*	Brazil, Argentina	Entire	E	15	NA	NA
Parrot, St. Lucia	*Amazona versicolor*	West Indies: St. Lucia	Entire	E	3	NA	NA
Parrot, St. Vincent	*Amazona guildingii*	West Indies: St. Vincent	Entire	E	3	NA	NA
Parrot, thick-billed	*Rhynchopsitta pachyrhyncha*	Mexico, U.S.A. (AZ, NM)	Mexico	E	3	NA	NA
Parrot, vinaceous-breasted	*Amazona vinacea*	Brazil	Entire	E	15	NA	NA
Parrotbill, Maui (honeycreeper)	*Pseudonestor xanthophrys*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Pelican, brown	*Pelecanus occidentalis*	U.S.A (Carolinas to Texas, CA), West Indies, Central and South America: Coastal.	Entire	E	2, 3	NA	NA
Penguin, Galapagos	*Spheniscus mendiculus*	Ecuador (Galapagos Island)	Entire	E	3	NA	NA
Petrel, Hawaiian dark-rumped	*Pterodroma phaeopygia sandwichensis*	U.S.A. (Hawaii)	Entire	E	2, 4, 1	NA	NA
Pheasant, bar tailed	*Syrmaticus humiae*	Burma, China	Entire	E	3	NA	NA
Pheasant, Blyth's tragopan	*Tragopan blythii*	Burma, China, India	Entire	E	3	NA	NA
Pheasant, brown eared	*Crossoptilon mantchuricum*	China	Entire	E	3	NA	NA
Pheasant, Cabot's tragopan	*Tragopan caboti*	China	Entire	E	3	NA	NA
Pheasant, Chinese monal	*Lophophorus lhuysii*	China	Entire	E	3	NA	NA
Pheasant, Edward's	*Lophura edwardsi*	Vietnam	Entire	E	3	NA	NA
Pheasant, Elliot's	*Syrmaticus ellioti*	China	Entire	E	15	NA	NA
Pheasant, imperial	*Lophura imperialis*	Vietnam	Entire	E	3	NA	NA
Pheasant, Mikado	*Syrmaticus mikado*	Taiwan	Entire	E	3	NA	NA
Pheasant, Palawan peacock	*Polyplectron emphanum*	Philippines	Entire	E	3	NA	NA
Pheasant, Sclater's monal	*Lophophorus sclateri*	Burma, China, India	Entire	E	3	NA	NA
Pheasant, Swinhoe's	*Lophura swinhoii*	Taiwan	Entire	E	3	NA	NA
Pheasant, western tragopan	*Tragopan melanocephalus*	India, Pakistan	Entire	E	4	NA	NA
Pheasant, white eared	*Crossoptilon crossoptilon*	China (Tibet), India	Entire	E	3	NA	NA
Pigeon, Azores wood	*Columba palumbus azorica*	East Atlantic Ocean: Azores	Entire	E	3	NA	NA
Pigeon, Chatham Island	*Hemiphaga novaeseelandiae chathamensis*	New Zealand	Entire	E	15	NA	NA
Pigeon, Mindoro zone-tailed	*Ducula mindorensis*	Philippines	Entire	E	2	NA	NA
Pigeon, Puerto Rican plain	*Columba inornata wetmorei*	U.S.A. (Puerto Rico)	Entire	E	15	NA	NA
Piping-guan, black-fronted	*Pipile jacutinga*	Argentina	Entire	E	15	NA	NA
Pitta, Koch's	*Pitta kochi*	Philippines	Entire	E	3	NA	NA
Plover, New Zealand shore	*Thinornis novaeseelandiae*	New Zealand	Entire	E	10	NA	NA
Poo-uli	*Melamprosops phaeosoma*	U.S.A. (Hawaii)	Entire	E	1	NA	NA
Prairie chicken, Attwater's greater	*Tympanuchus cupido attwateri*	U.S.A. (Texas)	Entire	E	15	NA	NA
Quail, Merriam's Montezuma	*Cyrtonyx montezumae merriami*	Mexico (Vera Cruz)	Entire	R	15	NA	NA
Quetzal, resplendent	*Pharomachrus mocinno*	Mexico to Panama	Entire	E	3	NA	NA
Rail, Auckland Island	*Rallus pectoralis muelleri*	New Zealand	Entire	E	2	NA	NA
Rail, California clapper	*Rallus longirostris obsoletus*	U.S.A. (California)	Entire	E	2	NA	NA
Rail, light-footed clapper	*Rallus longirostris levipes*	U.S.A. (California), Mexico (Baja California)	Entire	E	15	NA	NA
Rail, Lord Howe wood	*Tricholimnas sylvestris*	Australia (Lord Howe Island)	Entire	E	1	NA	NA
Rail, Yuma clapper	*Rallus longirostris yumanensis*	Mexico, U.S.A. (AZ, CA)	Entire	E	3	NA	NA
Rhea, Darwin's	*Pterocnemia pennata*	Argentina, Bolivia, Peru, Uruguay	Entire	E	3	NA	NA
Robin, Chatham Island	*Petroica traversi*	New Zealand	Entire	E	3	NA	NA
Robin, scarlet-breasted (flycatcher)	*Petroica multicolor multicolor*	Australia (Norfolk Island)	Entire	E	3	NA	NA
Rockfowl, grey-necked	*Picathartes oreas*	Cameron	Entire	E	3	NA	NA
Rockfowl, white-necked	*Picathartes gymnocephalus*	Africa: Togo to Sierra Leone	Entire	E	3	NA	NA
Roller, long-tailed ground	*Uratelornis chimaera*	Malagasy Republic (=Madagascar)	Entire	E	3	NA	NA
Scrub-bird, noisy	*Atrichornis clamosus*	Australia	Entire	E	3	NA	NA
Shama, Cebu black (thrush)	*Copsychus niger cebuensis*	Philippines	Entire	E	10	NA	NA
Shearwater, Newell's Manx	*Puffinus puffinus newelli*	U.S.A. (Hawaii)	Entire	T	26	NA	NA
Shrike, San Clemente loggerhead	*Lanius ludovicianus mearnsi*	U.S.A. (California)	Entire	E	15	NA	NA
Siskin, red	*Carduelis (=Spinus) cucullatus*	South America	Entire	E	1	17.95(b)	NA
Sparrow, Cape Sable seaside	*Ammospiza maritima mirabilis*	U.S.A. (Florida)	Entire	E	1	17.95(b)	NA
Sparrow, dusky seaside	*Ammospiza maritima nigrescens*	U.S.A. (Florida)	Entire	T	26	NA	NA
Sparrow, San Clemente sage	*Amphispiza belli clementeae*	U.S.A. (California)	Entire	E	6	NA	NA
Sparrow, Santa Barbara song	*Melospiza melodia graminea*	U.S.A. (California)	Entire	E	3	NA	NA
Starling, Polynesian mountain	*Aplonis pelzelni*	West Pacific Ocean: U.S.A. (Caroline Island)	Entire	E	3	NA	NA
Starling, Rothschild's (myna)	*Leucopsar rothschildi*	Indonesia (Bali)	Entire	E	2	NA	NA
Stilt, Hawaiian	*Himantopus himantopus knudseni*	U.S.A. (Hawaii)	Entire	E	3	NA	NA
Stork, oriental white	*Ciconia ciconia boyciana*	China, Japan, Korea, U.S.S.R.	Entire	E	15	NA	NA
Teal, Campbell Island flightless	*Anas aucklandica nesiotis*	New Zeland (Campbell Island)	Entire	E	2, 3	NA	NA
Tern, California least	*Sterna albifrons browni*	Mexico, U.S.A. (CA)	Entire	E	3	NA	NA
Thrasher, white-breasted	*Ramphocinclus brachyurus*	West Indies: St. Lucia, Martinique	Entire	E	2	NA	NA
Thrush, large Kauai	*Phaeornis obscurus myadestina*	U.S.A. (Hawaii)	Entire	E	2	NA	NA
Thrush, Molokai (=olomao)	*Phaeornis obscurus rutha*	U.S.A. (Hawaii)	Entire	E	3	NA	NA
Thrush, New Zealand (wattlebird)	*Turnagra capensis*	New Zealand	Entire	E	1	NA	NA
Thrush, small Kauai (=puaiohi)	*Phaeornis palmeri*	U.S.A. (Hawaii)	Entire	E	15	NA	NA
Tinamou, solitary	*Tinamus solitarius*	Brazil, Paraguay, Argentina	Entire	E	3	NA	NA
Trembler, Martinique brown (thrasher)	*Cinclocerthia ruficauda gutturalis*	West Indies: Martinique	Entire	E	6	NA	NA
Wanderer, plain	*Pedionomous torquatus*	Australia	Entire	E	1, 3	NA	NA
Warbler (wood), Bachman's	*Vermivora bachmanii*	Cuba, U.S.A. (Southeastern)	Entire	E	3	NA	NA
Warbler (wood), Barbados yellow	*Dendroica petechia petechia*	West Indies: Barbados	Entire	E	1, 3	NA	NA
Warbler (wood), Kirtland's	*Dendroica kirtlandi*	U.S.A. (principally MI), Canada, West Indies: Bahama Islands	Entire	E			

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Warbler (willow), reed	*Acrocephalus luscinia*	Western Pacific Ocean: Marianas Islands	Entire	E	3	NA	NA
Warbler (willow), Rodrigues	*Bebrornis rodericanus*	Mauritius (Rodrigues Islands)	Entire	E	3	NA	NA
Warbler (wood), Semper's	*Leucopeza semperi*	West Indies: St. Lucia	Entire	E	3	NA	NA
Warbler (willow), Seychelles	*Bebrornis sechellensis*	Indian Ocean: Seychelles Islands	Entire	E	3	NA	NA
Whipbird, Western	*Psophodes nigrogularis*	Australia	Entire	E	3	NA	NA
Whip-poor-will, Puerto Rican	*Caprimulgus noctitherus*	U.S.A. (Puerto Rico)	Entire	E	3	NA	NA
White-eye, Norfolk Island	*Zosterops albogularis*	Indian Ocean: Norfolk Islands	Entire	E	9	NA	NA
White-eye, Ponape great	*Rukia longirostra* (= *sanfordi*)	West Pacific Ocean: U.S.A. (Caroline Islands).	Entire	E	15	NA	NA
White-eye, Seychelles	*Zosterops modesta*	Indian Ocean: Seychelles	Entire	E	1	NA	NA
Woodpecker, imperial	*Campephilus imperialis*	Mexico	Entire	E	3	NA	NA
Woodpecker, ivory-billed	*Campephilus principalis*	U.S.A. (southcentral and southeastern), Cuba.	Entire	E	3	NA	NA
Woodpecker, red-cockaded	*Picoides* (= *Dendrocopos*) *borealis*	U.S.A. (southcentral and southeastern).	Entire	E	1, 3	NA	NA
Woodpecker, Tristam's	*Dryocopus javensis richardsi*	Korea	Entire	E	2	NA	NA
Wren, Guadeloupe house	*Troglodytes aedon guadeloupensis*	West Indies: Guadeloupe	Entire	E	3	NA	NA
Wren, St. Lucia house	*Troglodytes aedon mesoleucus*	West Indies: St. Lucia	Entire	E	3	NA	NA
REPTILES							
Alligator, American	*Alligator mississippiensis*	Southeastern U.S.A.	Wherever found in wild except those areas where listed as threatened as set forth below	E	1, 11, 51, 60	NA	NA
Alligator, American	*Alligator mississippiensis*	Southeastern U.S.A.	U.S.A. (FL and certain areas of GA, LA [except in those parishes listed as T(S/A)], SC, TX).	T	20, 47, 51, 60	NA	17.42(a)
Alligator, American	*Alligator mississippiensis*	Southeastern U.S.A.	U.S.A. (in wild in LA [Cameron, St. Mary, Vermilion, Iberia, Terrebonne, St. Charles, LaFourche, St. Bernard, St. Tammany, Jefferson, Calcasieu, and Plaquemines Parishes].)	T(S/A)	11, 47, 51, 60	NA	17.42(a)
Alligator, American	*Alligator mississippiensis*	Southeastern U.S.A.	In captivity wherever found.	T(S/A)	11, 47, 51	NA	17.42(a)
Alligator, Chinese	*Alligator sinensis*	China	Entire	E	15	NA	NA
Anole, Culebra giant	*Anolis roosevelti*	U.S.A. (Puerto Rico: Culebra Island).	Entire	E	25	17.95(c)	NA
Boa, Jamaican	*Epicrates subflavus*	Jamaica	Entire	E	3	NA	NA
Boa, Mona	*Epicrates monensis monensis*	U.S.A. (Puerto Rico)	Entire	T	33	17.95(c)	NA
Boa, Puerto Rico	*Epicrates inornatus*	U.S.A. (Puerto Rico)	Entire	E	2	NA	NA
Boa, Round Island [no common name].	*Casarea dussumieri*	Indian Ocean: Mauritius	Entire	E	88	NA	NA
Boa, Round Island [no common name].	*Bolyeria multocarinata*	Indian Ocean: Mauritius	Entire	E	88	NA	NA
Boa, Virgin Islands tree	*Epicrates monensis granti*	U.S. and British Virgin Islands	Entire	E	86	NA	NA
Caiman, Apaporis River	*Caiman crocodilus apaporiensis*	Colombia	Entire	E	15	NA	NA
Caiman, black	*Melanosuchus niger*	Amazon basin	Entire	E	15	NA	NA
Caiman, broad-snouted	*Caiman latirostris*	Brazil, Argentina, Paraguay, Uruguay	Entire	E	15	NA	NA
Caiman, Yacare	*Caiman crocodilus yacare*	Bolivia, Argentina, Peru, Brazil	Entire	E	3	NA	NA
Chuckwalla, San Esteban Island	*Sauromalus varius*	Mexico	Entire	E	88	NA	NA
Crocodile, African dwarf	*Osteolaemus tetraspis tetraspis*	West Africa	Entire	E	15	NA	NA
Crocodile, African slender-snouted	*Crocodylus cataphractus*	Western and central Africa	Entire	E	5	NA	NA
Crocodile, American	*Crocodylus acutus*	U.S.A. (FL), Mexico, South America, Central America, Caribbean.	Entire	E	10, 87	17.95(c)	NA
Crocodile, Ceylon mugger	*Crocodylus palustris kimbula*	Sri Lanka	Entire	E	15	NA	NA
Crocodile, Congo dwarf	*Osteolaemus tetraspis osborni*	Congo River drainage	Entire	E	15	NA	NA
Crocodile, Cuban	*Crocodylus rhombifer*	Cuba	Entire	E	3	NA	NA
Crocodile, Morelet's	*Crocodylus moreletii*	Mexico, Belize, Guatemala	Entire	E	3	NA	NA
Crocodile, mugger	*Crocodylus palustris palustris*	India, Pakistan, Iran, Bangladesh	Entire	E	15	NA	NA
Crocodile, Nile	*Crocodylus niloticus*	Africa	Entire	E	3	NA	NA
Crocodile, Orinoco	*Crocodylus intermedius*	South America: Orinoco River Basin.	Entire	E	3	NA	NA
Crocodile, Philippine	*Crocodylus novaeguineae mindorensis.*	Philippine Islands	Entire	E	15	NA	NA
Crocodile, saltwater (= estuarine)	*Crocodylus porosus*	Southeast Asia, Australia, Papua-New Guinea, Pacific Islands	Entire, except Papua-New Guinea	E	87	NA	NA
Crocodile, Siamese	*Crocodylus siamensis*	Southeast Asia, Malay Peninsula	Entire	E	15	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Gavial (= ghenal)	*Gavialis gangeticus*	Pakistan, Burma, Bangladesh, India.	Entire	E	3, 15	NA	NA
Gecko, day	*Phelsuma newtoni*	Indian Ocean: Mauritius	Entire	E	3	NA	NA
Gecko, Round Island day	*Phelsuma guentheri*	Indian Ocean: Mauritius	Entire	E	3	NA	NA
Iguana, Anegada ground	*Cyclura pinguis*	West Indies: British Virgin Islands (Anegada Island).	Entire	E	3	NA	NA
Iguana, Barrington land	*Conolophus pallidus*	Ecuador (Galapagos Island)	Entire	E	3	NA	NA
Iguana, Fiy banded	*Brachylophus fasciatus*	Fiji, Tonga	Entire	E	88	NA	NA
Iguana, Fiy crested	*Brachylophus sp.*	Fiji	Entire	E	88	NA	NA
Iguana, Mona ground	*Cyclura stejnegeri*	U.S.A. (Puerto Rico: Mona Island)	Entire	T	33	17.95(c)	NA
Lizard, blunt-nosed leopard	*Crotaphytus silus*	U.S.A. (California)	Entire	E	1	NA	NA
Lizard, Island night	*Klauberina riversiana*	U.S.A. (California)	Entire	T	26	NA	NA
Lizard, St. Croix ground	*Ameiva polops*	U.S.A. (Virgin Island: Green Cay, Protestant Cay).	Entire	E	24	17.95(c)	NA
Monitor, Bengal	*Varanus bengalensis*	Iran, Iraq, India, Sri Lanka, Malaysia, Afghanistan, Burma, Vietnam, Thailand.	Entire	E	15	NA	NA
Monitor, desert	*Varanus griseus*	North Africa to Nearest, Caspian Sea through U.S.S.R. to Pakistan, Northwest India.	Entire	E	15	NA	NA
Monitor, Komodo Island	*Varanus komodensis*	Indonesia (Komodo, Rintja, Padar, and western Flores Island.	Entire	E	15	NA	NA
Monitor, yellow	*Varanus flavescens*	West Pakistan through India to Bangladesh.	Entire	E	15	NA	NA
Python, Indian	*Python molurus molurus*	Sri Lanka and India	Entire	E	15	NA	NA
Rattlesnake, New Mexican ridge-nosed.	*Crotalus willardi obscurus*	U.S.A. (NM), Mexico	Entire	T	43	17.95(c)	NA
Snake, Atlantic salt marsh	*Nerodia fasciata taeniata*	U.S.A. (Florida)	Entire	T	30	NA	NA
Snake, eastern indigo	*Drymarchon corais couperi*	U.S.A. (AL, FL, GA, MS, SC)	Entire	T	32	NA	NA
Snake, San Francisco garter	*Thamnophis sirtalis tetrataenia*	U.S.A. (California)	Entire	E	1	NA	NA
Terrapin, river (= Tuntong)	*Batagur baska*	Malaysia, Bangladesh, Burma, India, Indonesia.	Entire	E	3	NA	NA
Tomistoma	*Tomistoma schlegelii*	Malaysia, Indonesia	Entire	E	15	NA	NA
Tortoise, angulated	*Geochelone yniphora*	Malagasy Republic (= Madagascar).	Entire	E	15	NA	NA
Tortoise, Bolson	*Gopherus flavomarginatus*	Mexico	Entire	E	46	NA	NA
Tortoise, Galapagos	*Geochelone elephantopus*	Ecuador (Galapagos Islands)	Entire	E	3	NA	NA
Tortoise, Indian flap-shell	*Lissemys punctata punctata*	India, Pakistan, Bangladesh	Entire	E	15	NA	NA
Tortoise, radiated	*Geochelone (= Testudo) radiata*	Malagasy Republic (= Madagascar).	Entire	E	3	NA	NA
Tuatara	*Sphenodon punctatus*	New Zealand	Entire	E	3	NA	NA
Turtle, aquatic box	*Terrapene coahuila*	Mexico	Entire	E	6	NA	NA
Turtle, black softshell	*Trionyx nigricans*	Bangladesh	Entire	E	15	NA	NA
Turtle, Burmese peacock	*Morenia ocellata*	Burma	Entire	E	15	NA	NA
Turtle, Cuatro Cienegas softshell	*Trionyx ater*	Mexico	Entire	E	15	NA	NA
Turtle, geometric	*Geochelone geometrica*	Union of South Africa	Entire	E	15	NA	NA
Turtle, green sea	*Chelonia mydas*	Circumglobal in tropical and temperate seas and oceans.	Wherever found except where listed as endangered below.	T	42	NA	17.42(b) and Parts 220 and 227.
Turtle, green sea	*Chelonia mydas*	Circumglobal in tropical and temperate seas and oceans.	Breeding colony populations in FL and on Pacific coast of Mexico.	E	42	NA	NA
Turtle, hawksbill sea (= carey)	*Eretmochelys imbricata*	Tropical seas	Entire	E	3	NA	NA
Turtle, Indian sawback	*Kachuga tecta tecta*	India	Entire	E	15	NA	NA
Turtle, Indian softshell	*Trionyx gangeticus*	Pakistan, India	Entire	E	15	NA	NA
Turtle, Kemp's (= Atlantic) Ridley sea.	*Lepidochelys kempi*	Tropical and temperate seas	Entire	E	4	NA	NA
Turtle, leatherback sea	*Dermochelys coriacea*	Tropical, temperate, and subpolar seas.	Entire	E	3	17.95(c)	NA
Turtle, loggerhead sea	*Caretta caretta*	Circumglobal in tropical and temperate seas and oceans.	Entire	T	42	NA	17.42(b) and Parts 220 and 227.
Turtle, Olive (Pacific) Ridley sea	*Lepidochelys olivacea*	Circumglobal in tropical and temperate seas and oceans.	Wherever found except where listed as endangered below.	T	42	NA	17.42(b) and Parts 220 and 227.
Turtle, Olive (Pacific) Ridley sea	*Lepidochelys olivacea*	Circumglobal in tropical and temperate seas and oceans.	Breeding colony populations on Pacific coast of Mexico.	E	42	NA	NA
Turtle, peacock softshell	*Trionyx hurum*	India, Bangladesh	Entire	E	15	NA	NA
Turtle, Plymouth red-bellied	*Chrysemys (= Pseudemys) nelsoni/rubriventris bangsi*	U.S.A. (Massachusetts)	Entire	E	90	17.95(c)	NA
Turtle, short-necked or western swamp.	*Pseudemydura umbrina*	Australia	Entire	E	3	NA	NA
Turtle, South American river (no common name).	*Podocnemis expansa*	South America: Orinoco and Amazon River basins.	Entire	E	3	NA	NA
Turtle, South American river (no common name).	*Podocnemis unifilis*	South America: Orinoco and Amazon River basins.	Entire	E	3	NA	NA
Turtle, spotted pond	*Geoclemmys (= Damonia) hamiltonii*	North India, Pakistan	Entire	E	15	NA	NA
Turtle, three-keeled Asian	*Geoemyda (= Nicoria) tricarinata*	Central India to Bangladesh and Burma.	Entire	E	15	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
AMPHIBIANS							
Coqui, golden	*Eleutherodactylus jasperi*	U.S.A. (Puerto Rico)	Entire	T	29	17.95(d)	NA
Frog, Israel painted	*Discoglossus nigriventer*	Israel	Entire	E	9	NA	NA
Frog, Panamanian golden	*Atelopus varius zeteki*	Panama	Entire	E	15	NA	NA
Frog, Stephen Island	*Leiopelma hamiltoni*	New Zealand	Entire	E	9	NA	NA
Salamander, Chinese giant	*Andrias davidianus davidianus*	Western China	Entire	E	15	NA	NA
Salamander, desert slender	*Batrachoseps aridus*	U.S.A. (California)	Entire	E	6	NA	NA
Salamander, Japanese giant	*Andrias davidianus japonicus*	Japan	Entire	E	15	NA	NA
Salamander, Red Hills	*Phaeognathus hubrichti*	U.S.A. (Alabama)	Entire	T	19	NA	NA
Salamander, Santa Cruz long-toed	*Ambystoma macrodactylum croceum.*	U.S.A. (California)	Entire	E	1	NA	NA
Salamander, Texas blind	*Typhlomolge rathbuni*	U.S.A. (Texas)	Entire	E	1	NA	NA
Toad, African viviparous	*Nectophrynoides spp.*	Tanzania, Guinea	Entire	E	15	NA	NA
Toad, Cameroon	*Bufo superciliaris*	Equatorial Africa	Entire	E	15	NA	NA
Toad, Houston	*Bufo houstonensis*	U.S.A. (Texas)	Entire	E	2	17.95(d)	NA
Toad, Monte Verde	*Bufo pangleniei*	Costa Rica	Entire	E	15	NA	NA
Treefrog, pine barrens	*Hyla andersonii*	U.S.A. (FL, AL, NC, SC, NJ)	Florida	E	29	17.95(d)	NA
FISHES							
Ala Balik (trout)	*Salmo platycephalus*	Turkey	Entire	E	3	NA	NA
Ayumodoki (loach)	*Hyasenophysa (= Bota) curta*	Japan	Entire	E	3	NA	NA
Bándcat, Mexican	*Prietella phreatophila*	Mexico	Entire	E	3	NA	NA
Bonytail, Pahranagat	*Gila robusta jordani*	U.S.A. (Nevada)	Entire	E	2	NA	NA
Bonytongue, Asian	*Scleropages formosus*	Thailand, Indonesia, Malaysia	Entire	E	15	NA	NA
Catfish [no common name]	*Pangasius sanitwongsei*	Thailand	Entire	E	3	NA	NA
Catfish, giant	*Pangasianodon gigas*	Thailand	Entire	E	3	NA	NA
Cavefish, Alabama	*Speoplatyrhinus poulsoni*	U.S.A. (Alabama)	Entire	T	25	17.95(e)	NA
Chub, bonytail	*Gila elegans*	U.S.A. (AZ, CA, CO, NV, UT, WY)	Entire	E	82	NA	NA
Chub, humpback	*Gila cypha*	U.S.A. (AZ, CO, UT, WY)	Entire	E	1	NA	NA
Chub, Mohave	*Gila mohavensis*	U.S.A. (California)	Entire	E	2	NA	NA
Chub, slender	*Hybopsis cahni*	U.S.A. (TN, VA)	Entire	T	26	17.95(e)	17.44(c)
Chub, spotfin	*Hybopsis monacha*	U.S.A. (AL, GA, NC, TN, VA)	Entire	T	29	17.95(e)	17.44(c)
Cicek (minnow)	*Acanthorutilus handlirschi*	Turkey	Entire	E	3	NA	NA
Cisco, longjaw	*Coregonus alpenae*	U.S.A. and Canada (Lakes Michigan, Huron, Erie).	Entire	E	1, 4	NA	NA
Cui-ui	*Chasmistes cujus*	U.S.A. (Nevada)	Entire	E	1	NA	NA
Dace, Kendall Warm Springs	*Rhinichthys osculus thermalis*	U.S.A. (Wyoming)	Entire	E	2	NA	NA
Dace, Moapa	*Moapa coriacea*	U.S.A. (Nevada)	Entire	E	1	NA	NA
Darter, bayou	*Etheostoma rubrum*	U.S.A. (Mississippi)	Entire	T	10	NA	17.44(b)
Darter, fountain	*Etheostoma fontiola*	U.S.A. (Texas)	Entire	E	2	NA	NA
Darter, leopard	*Percina pantherina*	U.S.A. (AR, OK)	Entire	T	31	17.95(e)	17.44(d)
Darter, Maryland	*Etheostoma sellare*	U.S.A. (Maryland)	Entire	E	1	NA	NA
Darter, Okaloosa	*Etheostoma okaloosae*	U.S.A. (Florida)	Entire	E	6	NA	NA
Darter, slackwater	*Etheostoma boschungi*	U.S.A. (AL, TN)	Entire	T	29	NA	17.44(c)
Darter, snail	*Percina tanasi*	U.S.A. (Tennessee)	Entire	E	12	NA	NA
Darter, watercress	*Etheostoma nuchale*	U.S.A. (Alabama)	Entire	E	2	NA	NA
Gambusia, Big Bend	*Gambusia gaigei*	U.S.A. (Texas)	Entire	E	1	NA	NA
Gambusia, Clear Creek	*Gambusia heterochir*	U.S.A. (Texas)	Entire	E	1	NA	NA
Gambusia, Goodenough	*Gambusia amistadensis*	U.S.A. (Texas)	Entire	E	93	NA	NA
Gambusia, Pecos	*Gambusia nobilis*	U.S.A. (NM, TX)	Entire	E	2	NA	NA
Killifish, Pahrump	*Empetrichthys latos*	U.S.A. (Nevada)	Entire	E	1	NA	NA
Madtom, Scioto	*Noturus trautmani*	U.S.A. (Ohio)	Entire	E	10	NA	NA
Madtom, yellowfin	*Noturus flavipinnis*	U.S.A. (GA, TN, VA)	Entire	T	29	NA	17.44(c)
Nekogigi	*Coreoleuciscus ichikawai*	Japan	Entire	E	3	NA	NA
Pike, blue	*Stizostedion vitreum glaucum*	U.S.A. and Canada (Lakes Erie, Ontario).	Entire	E	1	NA	NA
Pupfish, Comanche Springs	*Cyprinodon elegans*	U.S.A. (Texas)	Entire	E	1	NA	NA
Pupfish, Devil's Hole	*Cyprinodon diabolis*	U.S.A. (Nevada)	Entire	E	1	NA	NA
Pupfish, Owens River	*Cyprinodon radiosus*	U.S.A. (California)	Entire	E	1	NA	NA
Pupfish, Tecopa	*Cyprinodon nevadensis calidae*	U.S.A. (California)	Entire	E	2	NA	NA
Pupfish, Warm Springs	*Cyprinodon nevadensis pectoralis*	U.S.A. (Nevada)	Entire	E	2	NA	NA
Squawfish, Colorado River	*Ptychocheilus lucius*	U.S.A. (AZ, CA, CO, NM, NV, UT, WY).	Entire	E	1	NA	NA
Stickleback, unarmored threespine	*Gasterosteus aculeatus williamsoni.*	U.S.A. (California)	Entire	E	2	NA	NA
Sturgeon, shortnose	*Acipenser brevirostrum*	U.S.A. and Canada (Atlantic Coast).	Entire	E	1	NA	NA
Tango, Miyako (Tokyo bitterling)	*Tanakia tanago*	Japan	Entire	E	3	NA	NA
Temoleh, Ikan (minnow)	*Probarbus jullieni*	Thailand, Cambodia, Vietnam, Malaysia, Laos.	Entire	E	15	NA	NA
Topminnow, Gila	*Poeciliopsis occidentalis*	U.S.A. (AZ, NM), Mexico	Entire	E	1	NA	NA
Totoaba (seatrout or weakfish)	*Cynoscion macdonaldi*	Mexico (Gulf of California)	Entire	E	45	NA	NA
Trout, Arizona	*Salmo apache*	U.S.A. (Arizona)	Entire	T	1, 8	NA	17.44(a)
Trout, Gila	*Salmo gilae*	U.S.A. (New Mexico)	Entire	E	1	NA	NA
Trout, greenback cutthroat	*Salmo clarki stomias*	U.S.A. (Colorado)	Entire	T	1, 38	NA	17.44(f)
Trout, Lahontan cutthroat	*Salmo clarki henshawi*	U.S.A. (CA, NV)	Entire	T	2, 8	NA	17.44(a)
Trout, Little Kern golden	*Salmo aguabonita whitei*	U.S.A. (California)	Entire	T	37	17.95(e)	17.44(e)
Trout, Paiute cutthroat	*Salmo clarki seleneris*	U.S.A. (California)	Entire	T	1, 8	NA	17.44(a)
Woundfin	*Plagopterus argentissimus*	U.S.A. (AZ, NV, UT)	Entire	E	2	NA	NA
SNAILS							
Snail, Chittenango ovate amber	*Succinea chittenangoensis*	U.S.A. (New York)	NA	T	41	NA	NA
Snail, flat-spired three-toothed	*Triodopsis platysayoides*	U.S.A. (West Virginia)	NA	T	41	NA	NA
Snail, Iowa Pleistocene	*Discus macclintocki*	U.S.A. (Iowa)	NA	E	41	NA	NA
Snail, Manus Island tree	*Papustyla pulcherrima*	Admiralty Islands (Manus Islands)	NA	E	3	NA	NA
Snail, noonday	*Mesodon clarki nantahala*	U.S.A. (North Carolina)	NA	T	41	NA	NA
Snail, painted snake coiled forest	*Anguispira picta*	U.S.A. (Tennessee)	NA	T	41	NA	NA
Snail, Block Island	*Orthalicus reses*	U.S.A. (Florida)	NA	T	41	NA	NA
Snail, Virginia fringed mountain	*Polygyriscus virginianus*	U.S.A. (Virginia)	NA	E	41	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
CLAMS							
Pearly mussel, Alabama lamp	*Lampsilis virescens*	U.S.A. (AL, TN)	NA	E	15	NA	NA
Pearly mussel, Appalachian monkeyface	*Quadrula sparsa*	U.S.A. (TN, VA)	NA	E	15	NA	NA
Pearly mussel, birdwing	*Conradilla caelata*	U.S.A. (TN, VA)	NA	E	15	NA	NA
Pearly mussel, Cumberland bean	*Villosa* (= *Micromya*) *trabalis*	U.S.A. (Kentucky)	NA	E	15	NA	NA
Pearly mussel, Cumberland monkeyface	*Quadrula intermedia*	U.S.A. (AL, TN, VA)	NA	E	15	NA	NA
Pearly mussel, Curtis'	*Epioblasma* (= *Dysnomia*) *florentina curtisi*	U.S.A. (Missouri)	NA	E	15	NA	NA
Pearly mussel, dromedary	*Dromus dromas*	U.S.A. (TN, VA)	NA	E	15	NA	NA
Pearly mussel, green-blossom	*Epioblasma* (= *Dysnomia*) *torulosa gubernaculum*	U.S.A. (TN, VA)	NA	E	15	NA	NA
Pearly mussel, Higgin's eye	*Lampsilis higginsi*	U.S.A. (IL, IA, MN, MO, NE, WI)	NA	E	15	NA	NA
Pearly mussel, Hubbin's	*Megalonaias nickliniana*	Mexico	NA	E	15	NA	NA
Pearly mussel, orange-footed	*Plethobasis cooperianus*	U.S.A. (AL, IN, IA, KY, OH, PA, TN).	NA	E	15	NA	NA
Pearly mussel, pale lilliput	*Toxolasma* (= *Carunculina*) *cylindrella*	U.S.A. (AL, MO, TN, WV)	NA	E	15	NA	NA
Pearly mussel, pink mucket	*Lampsilis orbiculata*	U.S.A. (AL, IL, IN, KY, MO, OH, PA, TN, WV).	NA	E	15	NA	NA
Pearly mussel, Sampson's	*Epioblasma* (= *Dysnomia*) *sampsoni*	U.S.A. (IL, IN)	NA	E	15	NA	NA
Pearly mussel, Tampico	*Cyprogenia tampicoensis tecomatensis*	Mexico	NA	E	15	NA	NA
Pearly mussel, tubercled-blossom	*Epioblasma* (= *Dysnomia*) *torulosa torulosa*	U.S.A. (IL, KY, TN, WV)	NA	E	15	NA	NA
Pearly mussel, turgid-blossom	*Epioblasma* (= *Dysnomia*) *turgidula*	U.S.A. (AL, AR, MO, TN)	NA	E	15	NA	NA
Pearly mussel, white cat's eye	*Epioblasma* (= *Dysnomia*) *sulcata delicata*	U.S.A. (IN, MI, OH)	NA	E	15	NA	NA
Pearly mussel, white wartyback	*Plethobasis arcaincosus*	U.S.A. (AL, TN)	NA	E	15	NA	NA
Pearly mussel, yellow-blossom	*Epioblasma* (= *Dysnomia*—*florentina florentina*	U.S.A. (AL, TN)	NA	E	15	NA	NA
Pigtoe, fine-rayed	*Fusconaia cuneolus*	U.S.A. (AL, TN, VA)	NA	E	15	NA	NA
Pigtoe, rough	*Pleurobema plenum*	U.S.A. (KY, TN, VA)	NA	E	15	NA	NA
Pigtoe, shiny	*Fusconaia edgariana*	U.S.A. (AL, TN, VA)	NA	E	15	NA	NA
Pocketbook, fat	*Potamilus* (= *Proptera*) *capax*	U.S.A. (AR, IN, MO, OH)	NA	E	27	NA	NA
Riffle shell clam, tan	*Epioblasma walkeri*	U.S.A. (KY, TN, VA)	NA	E			
CRUSTACEANS							
Isopod, Socorro	*Exosphaeroma thermophilus*	U.S.A. (New Mexico)	NA	E	36	NA	NA
INSECTS							
Butterfly, Bahama swallowtail	*Papilio andraemon bonhotei*	U.S.A. (FL), Bahamas	NA	T	13	NA	17.47(b)
Butterfly, El Segundo blue	*Euphilotes* (= *Shijimaeoides*) *battoides allyni*	U.S.A. (California)	NA	E	14	NA	NA
Butterfly, Lange's metalmark		U.S.A. (California)	NA	E	14	*Apodemia mormo langei* NA	NA
Butterfly, Lotis blue		U.S.A. (California)	NA	E	14	*Lycaeides argyrognomon lotis* NA	NA
Butterfly, mission blue		U.S.A. (California)	NA	E	14	*Icaricia icaroides missionensis* NA	NA
Butterfly, San Bruno elfin		U.S.A. (California)	NA	E	14	*Callophrys mossii bayensis* NA	NA
Butterfly, Schaus swallowtail		U.S.A. (Florida)	NA	T	13	*Papilio aristodemus ponceanus* NA	17.47(a)
Butterfly, Smith's blue		U.S.A. (California)	NA	E	14	*Euphilotes* (= *Shijimaeoides*) *enoptes smithi* NA	NA
Moth, Kern primrose sphinx		U.S.A. (California)	NA	T	91	*Euproserpinus euterpe* NA	NA

1—32 FR 4001; March 11, 1967.
2—35 FR 16047; October 13, 1970.
3—35 FR 8495; June 2, 1970.
4—36 FR 18320; December 2, 1970.
5—37 FR 6476; March 30, 1972.
6—38 FR 14878; June 4, 1973.
7—39 FR 44991; December 30, 1974.
8—40 FR 29864; July 16, 1975.
9—40 FR 31736; July 28, 1975.
10—40 FR 44151; September 25, 1975.
11—40 FR 44419; September 26, 1975.
12—40 FR 47506; October 9, 1975.
13—41 FR 17427; April 28, 1976.
14—41 FR 22044; June 1, 1976.
15—41 FR 24064; June 14, 1976.
16—41 FR 45993; October 19, 1976.
17—41 FR 51027; November 19, 1976.
18—41 FR 51812; November 23, 1976.
19—41 FR 53033; December 3, 1976.
20—42 FR 2076; January 10, 1977.
21—42 FR 2968; January 14, 1977.
22—42 FR 28056; June 1, 1977.
23—42 FR 28137; June 2, 1977.
24—42 FR 28545; June 3, 1977.
25—42 FR 37373; July 21, 1977.
26—42 FR 40685; August 11, 1977.
27—42 FR 42353; August 23, 1977.
28—42 FR 45528; September 9, 1977.
29—42 FR 58755; November 11, 1977.
30—42 FR 60745; November 29, 1977.
31—43 FR 3715; January 27, 1978.
32—43 FR 4028; January 31, 1978.
33—43 FR 4821; February 3, 1978.
34—43 FR 8233; February 14, 1978.
35—43 FR 9612; March 9, 1978.
36—43 FR 12691; March 27, 1978.
37—43 FR 15429; April 13, 1978.
38—43 FR 16345; April 18, 1978.
40—43 FR 20504; May 12, 1978.
41—43 FR 28932; July 3, 1978.
42—43 FR 32806; July 28, 1978.
43—43 FR 34479; August 4, 1978.
44—43 FR 44812; September 26, 1978.
45—44 FR 21289; April 10, 1979.
46—44 FR 23084; April 17, 1979.
48—44 FR 29480; May 21, 1979.
50—44 FR 37126; June 25, 1979.
51—44 FR 37132; June 25, 1979.
52—44 FR 42911; July 20, 1979.
54—44 FR 49220; August 21, 1979.
55—44 FR 54007; September 17, 1979.
60—44 FR 59084; October 12, 1979.
85—44 FR 69208; November 30, 1979.
86—44 FR 70677; December 7, 1979.
87—44 FR 75076; December 18, 1979.
88—45 FR 18010; March 20, 1980.
90—45 FR 21833; April 2, 1980.
91—45 FR 24090; April 8, 1980.
92—45 FR 27713; April 23, 1980.
93—45 FR 28722; April 30, 1980.

#—Indicates FR where species was deleted; relisting of the species is indicated by subsequent number(s).
E—Indicates Emergency rule publication (see FR document for effective dates); subsequent number(s) indicate FR final rule, # appearance.

§ 17.12 Endangered and threatened plants.

(a) The list in this section contains all species of plants which are determined by the Director to be Endangered or Threatened. It also contains species of plants treated as Endangered or Threatened because they are similar in appearance to an Endangered or Threatened species (see § 17.50 *et seq.*)

(b) The columns entitled "Scientific Name" and "Common Name" define a species of plant within the meaning of the Act. Although common names are usually included, they cannot be relied upon for identification of any specimen, since they may vary greatly with local usage. The Director will use the most recently accepted scientific name. In cases in which confusion might arise, a synonym will be provided in parentheses. The Services shall rely to the extent practical on the *International Code of Botanical Nomenclature.*

(c) In the "Status" column the following symbols are used: "E" for Endangered, "T" for Threatened, and "E (or T) (S/A)" for similarity of appearance species.

(d) For information purposes only, the "Historic Range" indicates the general known distribution of the species or subspecies as reported in the scientific literature. The present distribution may be greatly reduced from this historic range. This column does not imply any limitation on the application of the prohibitions in the Act or implementing rules. Such prohibitions apply to all individuals of the species, wherever found. When the list is updated annually any change in the range will be added.

(e) For informational purposes only, a footnote to the Federal Register publication which originally listed the species is provided under the column "When Listed." Footnote numbers to § 17.12 and § 17.11 are in same numerical sequence since plants and animals may be listed in the Federal Register document. That document includes a statement indicating the basis for listing.

(f) The "Special Rules" and "Critical Habitat" columns provide a cross-reference to other sections in this Part 17 or Parts 222 or 227. The term "N/A" (not applicable) appearing in either of these two columns indicates that there are no special rules and/or Critical Habitat for that particular species. However, all other appropriate rules in this Part 17 still apply to that species. In addition, there may be other rules in this Title that relate to such plants, e.g., port-of-entry requirements. It is not intended that the references in the "Special Rules" column list all the regulations of the two Services which might apply to the plants in question or to the regulations of other Federal agencies or State or local governments.

(g) The listing of a particular taxonomic group includes all its lower taxonomic units [see § 17.11(g) for examples].

(h) The "List of Endangered and Threatened Plants" is provided below:

Species						
Scientific name	Common name	Historic range	Status	When listed	Critical habitat	Special rules
Plants:						
Alismataceae—Water plantain family:						
Sagittaria fasciculata	Bunched arrowhead	U.S.A. (NC, SC)	E	53	NA	NA
Asteraceae—Aster family:						
Echinacea tennesseensis	Tennessee purple coneflower	U.S.A. (TN)	E	49	NA	NA
Lipochaeta venosa	None	U.S.A. (HI)	E	73	NA	NA
Berberidaceae—Barberry family:						
Berberis sonnei	Truckee barberry	U.S.A. (CA)	E	78	NA	NA
Betulaceae—Birch family:						
Betula uber	Virginia round-leaf birch	U.S.A. (VA)	E	39	NA	NA
Brassicaceae—Mustard family:						
Arabis mcdonaldiana	McDonald's rock-cress	U.S.A. (CA)	E	44	NA	NA
Erysimum capitatum var. angustatum	Contra Costa wallflower	U.S.A. (CA)	E	39	17.96(a)	NA
Cactaceae—Cactus family:						
Ancistrocactus tobuschii (= Echinocactus t., Mammillaria t.)	Tobusch fishhook cactus	U.S.A. (TX)	E	50	NA	NA
Coryphantha minima (= C. neliesae, Escobaria n., Mammillaria n.)	Nellie cory cactus	U.S.A. (TX)	E	81	NA	NA
Coryphantha ramillosa	Bunched cory cactus	U.S.A. (TX), Mexico (Coahuila)	T	77	NA	NA
Coryphantha sneedii var. leei (= Escobaria l., Mammillaria l.)	Lee pincushion cactus	U.S.A. (NM)	T	61	NA	NA
Coryphantha sneedii var. sneedii (= Escobaria s., Mammillaria s.)	Sneed pincushion cactus	U.S.A. (TX, NM)	E	82	NA	NA
Echinocactus horizonthalonius var. nicholii	Nichol's Turk's head cactus	U.S.A. (AZ)	E	71	NA	NA
Echinocereus engelmannii var. purpureus	Purple-spined hedgehog cactus	U.S.A. (UT)	E	58	NA	NA
Echinocereus kuenzleri (= E. hempelii of authors, not Fobe)	Kuenzler hedgehog cactus	U.S.A. (NM)	E	70	NA	NA
Echinocereus lloydii (= E. roetteri var. l.)	Lloyd's hedgehog cactus	U.S.A. (TX)	E	67	NA	NA
Echinocereus reichenbachii var. albertii (= E. melanocentrus)	Black lace cactus	U.S.A. (TX)	E	68	NA	NA
Echinocereus triglochidiatus var. arizonicus (= E. arizonicus)	Arizona hedgehog cactus	U.S.A. (AZ)	E	62	NA	NA
Echinocereus triglochidiatus var. inermis (= E. coccineus, var. i., E. phoeniceus var. c.)	Spineless hedgehog cactus	U.S.A. (CO, UT)	E	83	NA	NA
Echinocereus viridiflorus var. davisii (= E. davisii)	Davis' green pitaya	U.S.A. (TX)	E	81	NA	NA
Neolloydia manposensis (= Echinocactus m., Echinomastus m.)	Lloyd's Manposa cactus	U.S.A. (TX)	T	77	NA	NA
Pediocactus bradyi (= Toumeya b.)	Brady pincushion cactus	U.S.A. (AZ)	E	63	NA	NA
Pediocactus knowltonii	Knowlton cactus	U.S.A. (NM)	E	72	NA	NA
Pediocactus peeblesianus var. peeblesianus (= Echinocactus p., Nuvaua p., Toumeya p., Utahia p.)	Peebles Navajo cactus	U.S.A. (AZ)	E	69	NA	NA
Pediocactus sileri (= Echinocactus s., Utahia s.)	Silver pincushion cactus	U.S.A. (AZ, UT)	E	64	NA	NA
Sclerocactus glaucus (= Echinocactus g., E. subglaucus, E. whipplei var. g., Pediocactus g., S. franklinii)	Uinta Basin hookless cactus	U.S.A. (CO, UT)	*	59	NA	NA
Sclerocactus mesae-verdae (= Coloradoa m., Echinocactus m., Pediocactus m.)	Mesa Verde cactus	U.S.A. (CO, NM)	T	75	NA	NA
Sclerocactus wrightiae (= Pediocactus w.)	Wright fishhook cactus	U.S.A. (UT)	E	58	NA	NA
Crassulaceae—Stonecrop family:						
Dudleya traskiae	Santa Barbara Island liveforever	U.S.A. (CA)	E	39	NA	NA
Cupressaceae—Cypress family:						
Fitzroya cupressoides	Chilean false larch (= alerce)	Chile, Argentina	T	79	NA	NA
Ericaceae—Heath family:						
Arctostaphylos hookeri ssp. ravenii	Raven's manzanita	U.S.A. (CA)	E	65	NA	NA
Rhododendron chapmanii	Chapman rhododendron	U.S.A. (FL)	E	47	NA	NA

Species		Historic range	Status	When listed	Critical habitat	Special rules
Scientific name	Common name					
Fabaceae—Pea family:						
Astragalus perianus	Rydberg milk-vetch	U.S.A. (UT)	T	39	NA	NA
Baptisia arachnifera	Hairy rattleweed	U.S.A. (GA)	E	39	NA	NA
Lotus scoparius ssp. *traskiae*	San Clemente broom	U.S.A. (CA)	E	26	NA	NA
Vicia menziesii	Hawaiian wild broad-bean	U.S.A. (HI)	E	39	NA	NA
Hydrophyllaceae—Waterleaf family:						
Phacelia argillacea	None	U.S.A. (UT)	E	44	NA	NA
Lamiaceae—Mint family:						
Haplostachys haplostachya var. *angustifolia*	None	U.S.A. (HI)	E	73	NA	NA
Pogogyne abramsii	San Diego mesa mint	U.S.A. (CA)	E	44	NA	NA
Stenogyne angustifolia var. *angustifolia*	None	U.S.A. (HI)	E	73	NA	NA
Liliaceae—Lily family:						
Harperocallis flava	Harper's beauty	U.S.A. (FL)	E	57	NA	NA
Trillium persistens	Persistent trillium	U.S.A. (GA, SC)	E	39	NA	NA
Malvaceae—Mallow family:						
Kokia cookei	Cooke's kokio	U.S.A. (HI)	E	74	NA	NA
Malacothamnus clementinus	San Clemente island bush-mallow	U.S.A. (CA)	E	24	NA	NA
Nyctaginaceae—Four-o'clock family:						
Mirabilis macfarlanei	MacFarlane's four-o'clock	U.S.A. (ID, OR)	E	66	NA	NA
Onagraceae—Evening-primrose family:						
Oenothera avita ssp. *eurekensis*	Eureka evening-primrose	U.S.A. (CA)	E	39	NA	NA
Oenothera deltoides ssp. *howellii*	Antioch Dunes evening-primrose	U.S.A. (CA)	E	39	17.96(a)	NA
Papaveraceae—Poppy family:						
Arctomecon humilis	Dwarf bear-poppy	U.S.A. (UT)	E	78	NA	NA
Pinaceae—Pine family:						
Abies guatemalensis	Guatemalan fir (= pinabete)	Mexico, Guatemala, Honduras, El Salvador	T	84	NA	NA
Poaceae—Grass family:						
Orcuttia mucronata	Solano (=Crampton's Orcutt) grass	U.S.A. (CA)	E	44	NA	NA
Swallenia alexandrae	Eureka Dune grass	U.S.A. (CA)	E	39	NA	NA
Zizania texana	Texas wild-rice	U.S.A. (TX)	E	39	NA	NA
Ranunculaceae—Buttercup family:						
Aconitum noveboracense	Northern wild monkshood	U.S.A. (IA, NY, OH, WI)	T	39	NA	NA
Delphinium kinkiense	San Clemente Island larkspur	U.S.A. (CA)	E	26	NA	NA
Sarraceniaceae—Pitcherplant family:						
Sarracenia oreophila	Green pitcher plant	U.S.A. (AL, GA)	E	56, 89	NA	NA
Scrophulariaceae—Snapdragon family:						
Castilleja grisea	San Clemente Island Indian paintbrush	U.S.A. (CA)	E	26	NA	NA
Cordylanthus maritimus ssp. *maritimus*	Salt marsh bird's beak	U.S.A. (CA), Mexico (Baja California)	E	44	NA	NA
Pedicularis furbishiae	Furbish lousewort	U.S.A. (ME), Canada (New Brunswick)	E	39	NA	NA

26—42 FR 40685, August 11, 1977.
39—43 FR 17916, April 26, 1978.
44—43 FR 44812, September 28, 1978.
47—44 FR 24250, April 24, 1979.
49—44 FR 32605, June 6, 1979.
53—44 FR 43701, July 25, 1979.
56—44 FR 54923, September 21, 1979.
57—44 FR 58863, October 2, 1979.
58—44 FR 58868, October 11, 1979.
59—44 FR 58870, October 11, 1979.
61—44 FR 61556, October 25, 1979.
62—44 FR 61558, October 25, 1979.
63—44 FR 61786, October 26, 1979.
64—44 FR 61788, October 26, 1979.
65—44 FR 61911, October 26, 1979.
66—44 FR 61913, October 26, 1979.
67—44 FR 61916, October 26, 1979.
68—44 FR 61920, October 26, 1979.
69—44 FR 61924, October 26, 1979.
70—44 FR 61927, October 25, 1979.
71—44 FR 61929, October 26, 1979.
72—44 FR 62246, October 26, 1979.
73—44 FR 62469, October 30, 1979.
74—44 FR 62471, October 30, 1979.
75—44 FR 62474, October 30, 1979.
76—44 FR 64247, November 6, 1979.
77—44 FR 64250, November 6, 1979.
78—44 FR 64252, November 6, 1979.
79—44 FR 64733, November 7, 1979.
80—44 FR 64738, November 7, 1979.
81—44 FR 64740, November 7, 1979.
82—44 FR 64743, November 7, 1979.
83—44 FR 64746, November 7, 1979.
84—44 FR 65005, November 8, 1979.
89—45 FR 18929, March 24, 1980.

[FR Doc. 80-15198 Filed 5-19-80; 8:45 am]

BILLING CODE 4310-55-M

TENNESSEE WILDLIFE RESOURCES COMMISSION
PROCLAMATION
ENDANGERED OR THREATENED SPECIES

Pursuant to the authority granted by Tennessee Code Annotated, Sections 51-905 and 51-907, the Tennessee Wildlife Resources Commission does hereby declare the following species to be endangered or threatened species subject to the regulations as herein provided. Said regulations shall become effective sixty days from this date.

SECTION I. ENDANGERED OR THREATENED SPECIES

MOLLUSCS

ENDANGERED

Birdwing pearly mussel	*Conradilla caelata*
Dromedary pearly mussel	*Dromus dromas*
Yellow-blossom pearly mussel	*Epioblasma (-Dysnomia) florentina florentina*
Green-blossom pearly mussel	*Epioblasma (-Dysnomia) torulosa gubernaculum*
Tuberculed-blossom pearly mussel	*Epioblasma (-Dysnomia) torulosa torulosa*
Turgid-blossom pearly mussel	*Epioblasma (-Dysnomia) turgidula*
Tan riffle shell pearly mussel	*Epioblasma (-Dysnomia) walkeri*
Fine-rayed pigtoe pearly mussel	*Fusconaia cuneolus*
Shiny pigtoe pearly mussel	*Fusconaia edgariana*
Pink mucket pearly mussel	*Lampsilis orbiculata orbiculata*
White warty-back pearly mussel	*Plethobasis cicatricosus*
Orange-footed pimpleback	*Plethobasis cooperianus*
Rough pigtoe pearly mussel	*Pleurobema plenum*
Cumberland monkeyface pearly mussel	*Quadrula intermedia*
Appalachian monkeyface pearly mussel	*Quadrula sparsa*
Pale lilliput pearly mussel	*Toxolasma (-Carunculina) cylindrella*
Painted snake coiled forest snail	*Anguispira picta*

FISH

ENDANGERED

Lake Sturgeon	*Acipenser fulvescens*
Ohio River Muskellunge (in Morgan, Cumberland, Fentress & Scott Counties)	*Esox masquinongy ohioensis*
Barren's Topminnow	*Fundulus sp. (cf. F. albolineatus)*
Spotfin Chub	*Hybopsis monacha*
Yellowfin Madtom	*Noturus flavipinnis*
Snail Darter	*Percina tanasi*

Proc. No. 75-15*

*Section I amended by Proc. No. 77-4 dated May 13, 1977, Proc. No. 78-14 dated Sept. 22, 1978; and, Proc. No. 78-20 dated Dec. 8, 1978.

SECTION I. (Continued)

FISH (Continued)

THREATENED

Silverjaw Minnow	*Ericymba buccatta*
Slender Chub	*Hybopsis cahni*
Blue Sucker	*Cycleptus elongatus*
Pigmy madtom	*Noturus sp. (cf. N. hilderbrandi)*
Frecklebelly Madtom	*N. munitus*
Slackwater Darter	*Etheostoma boschungi*
Coldwater Darter	*E. ditrema*
Tuspot Darter	*E. tuscella*
Duskytail Darter	*E. (Catonotus) sp.*
Coppercheek Darter	*E. sp. (cf. E. maculatum)*
Longhead Darter	*Percina macrocephala*
Amber Darter	*P. (Imostoma) sp.*
Reticulate Longperch	*P. sp. (cf. P. caprodes)*

AMPHIBIANS

TEREATENED

Tennessee Cave Salamander	*Gyrinophilus palleucus*

REPTILES

TEREATENED

Northern Pine Snake	*Pituophis m. melanoleucus*
Western Pigmy Rattlesnake	*Sistrurus miliarius streckeri*

BIRDS

ENDANGERED

Mississippi Kite	*Ictinea mississippiensis*
Golden Eagle	*Aquila chrysaetos*
Bald Eagle	*Haliaeetus leucocephalus*
Osprey	*Pandion haliaetus*
Peregrine falcon	*Falco peregrinus*
Red-cockaded Woodpecker	*Picoides borealis*
Raven	*Corvus corax*
Bachman's Sparrow	*Aimophila aestivalis bachmanii*

THREATENED

Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*A. cooperi*
Marsh Hawk	*Circus cyaneus hudsonius*
Bewick's Wren	*Thyromanes bewickii*
Grasshopper Sparrow	*Ammodramus savannarum*
Black-Crowned Night Heron	*Nycticorax nycticorax*

*Section I amended by Proc. No. 77-4 dated May 13, 1977, Proc. No. 78-14 dated Sept. 22, 1978; and, Proc. No. 78-20 dated Dec. 8. 1978.

SECTION I. (Continued)

MAMMALS

ENDANGERED

Eastern Cougar	*Felix concolor cougar*
Indiana Myotis	*Myotis sodalis*
Gray Myotis	*Myotis grisescens*

THREATENED

River Otter	*Lutra canadensis*

SECTION II. REGULATIONS

Except as provided for in Tennessee Code Annotated, Section 51-906 (d) and (e), it shall be unlawful for any person to take, harass, or destroy wildlife listed as threatened or endangered or otherwise to violate terms of Section 51-905 (c) or to destroy knowingly the habitat of such species without due consideration of alternatives for the welfare of the species listed in (1) of this proclamation, or (2) the United States list of Endangered fauna.

Date: June 12, 1975

Proc. No. 75-15*

*Section I amended by Proc. No. 77-4 dated May 13, 1977, Proc. No. 78-14 dated September 22, 1978; and, Proc. No. 78-20 dated Dec. 8, 1978.

OCCASIONAL PAPERS

of the

MUSEUM OF NATURAL HISTORY
The University of Kansas
Lawrence, Kansas

NUMBER 54, PAGES 1-38 MAY 12, 1976

POPULATION ECOLOGY OF THE GRAY BAT (*MYOTIS GRISESCENS*): PHILOPATRY, TIMING AND PATTERNS OF MOVEMENT, WEIGHT LOSS DURING MIGRATION, AND SEASONAL ADAPTIVE STRATEGIES

By

MERLIN D. TUTTLE[1]

ABSTRACT

An intensive banding and recovery study of *M. grisescens* resulted in 19,691 recoveries at 120 locations. Included were many multiple recaptures and roundtrip recoveries between maternity and hibernating caves. Gray bats demonstrated strong loyalty to a summer home range, often including six or more caves, as well as to their wintering site. Adult females emerged from hiberation first, in early April, followed by yearlings of both sexes and lastly by adult males. Once at the summer home range, adult females congregated in one preferred maternity site to rear young, while adult males and yearlings clustered in smaller groups, usually in caves other than the maternity cave.

After the fledging of young, sex and age segregation weakened, and individuals were more evenly dispersed through the home range. Fall migration took place in approximately the same order as spring emergence, with adult females leaving in early September and juveniles remaining behind with the last males to leave, usually by mid-October. Distances regularly traveled in migration ranged from 17 to 437 km (one way, direct distance), with nearly the entire southeastern population congregating in three major hibernacula. Migratory movements appeared to be direct and rapid for adult females in particular, and weight loss during migration was directly proportional to distance traveled. No significant winter movements were observed after hibernation began.

INTRODUCTION

Much is known about the length and approximate timing of migratory movements of bats. Myers (1964) and Hall and Wilson

[1] Vertebrate Division, Milwaukee Public Museum, Milwaukee, Wisconsin 53233.

(1966) have reported on seasonal movements of gray bats between warm maternity and cool hibernating caves, in Missouri and Kentucky, respectively. However, their studies, like others, provide only a general picture of movement patterns; the extent of loyalty to a given site (philopatry), sex or age differences in behavior, and the rates, energetic cost and adaptive significance of travel are virtually unknown (Griffin, 1970).

In an attempt to obtain such information I conducted an extensive capture-recapture study of *Myotis grisescens*. The study was designed to test the hypothesis that some of the important limiting factors affecting gray bat growth, distribution and population size were (1) cave temperature and colony size (Tuttle, 1975), (2) distance between roost and feeding grounds (Tuttle, 1976), and (3) distance between maternity and hibernating sites. The purpose of this paper is to present my findings on seasonal movements, particularly those pertinent to the presumed importance of distance between maternity and hibernating sites, and to summarize the effects of the three important limiting factors on cave selection and seasonal behavior in the gray bat.

Definition of Terms

The following definitions have been established for this study to provide clarity: *banding site*—one of the eight main study caves where banding took place; *wintering (hibernating) cave*—a place where hibernation occurs from September through April; *maternity cave*—a site where the young are reared in June and July; *bachelor cave*—a cave occupied mostly by adult males and yearlings of both sexes during June and July; *summer cave*—an inclusive term for the previous two classifications; *transitory cave*—one used primarily during fall and spring migration; *colony*—all individuals that were born in a given maternity cave (or group of caves used annually by the same bats); *home range*—the area including caves used interchangeably during the summer by one colony of bats and the adjacent areas in which these bats forage; *population*—a freely interbreeding group that returns annually to a particular wintering cave (may include any number of colonies).

Description of Study Area and Sites

All banding sites were in limestone caves, surrounded by areas of both forest and cultivated fields. These sites were distributed from Jackson Co., Florida, north to Scott Co., Virginia, and west to Stewart Co., Tennessee, and Lauderdale Co., Alabama (Fig. 1). In Alabama and Tennessee most caves used by gray bats are associated with the Tennessee River drainage system, and the caves used in Florida are located near the Chipola River and adjacent swamps.

Banding sites discussed in this paper are located at latitudes

ranging from 30°41′ N in Florida to 36°38′ N in Tennessee, with a corresponding range (19.4-12.3 C) of mean annual temperatures (Climatological Data, Florida, 1970; Climatological Data, Tennessee, 1970). This is roughly reflected in local cave temperatures;

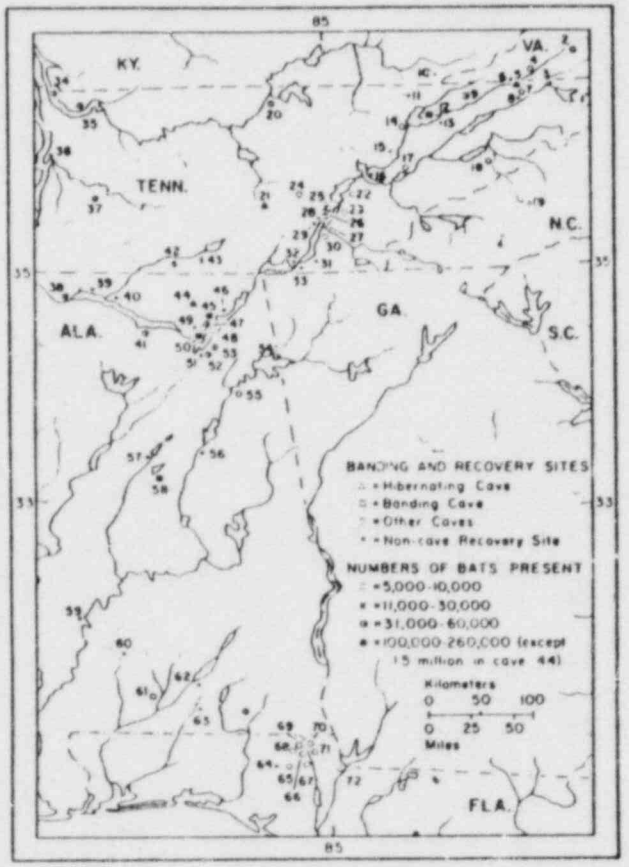


Fig. 1.—Locations of the 8 banding caves and sites where bats from those colonies were recovered (with the exception of two Missouri sites.) Any reference to cave 25 in this paper includes data from both caves 25 and 26, since a single maternity colony used both caves alternately. Localities 65-71 (the home range of a single colony) are represented by one symbol on subsequent maps, and are referred to collectively as colony 69 or the Florida localities.

the highest ambient cave temperatures are most frequently found in southern caves, while the coldest caves are located farther north. A few caves, due to their peculiar qualities, provide mean temperatures at least 5.6 C or more below those expected on the basis of mean annual above-ground temperature. These are characterized by having large volumes and volume to surface area ratios. Also, their main volume is below at least one large sinkhole-type entrance, with one or more smaller entrances higher than the sinkhole. Such characteristics allow denser cold air to flow in and become trapped in successive winters, with minimal gain of heat through surface conductance.

Means and ranges of temperatures occupied by bats (in °C) in major banding caves (for June-August 1970) and hibernating caves (for October-April 1970-71) were as follows: *banding caves*—9 (19.7, 18.3-22.1); 12 (14.6, 13.9-15.8); 25 (16.9, 12.9-20.2); 45 (21.8, 19.9-23.9); 50 (27.1, 25.1-28.6); 58 (15.0, 12.8-16.1); 69 (19.7, 18.4-21.3); *hibernating caves*—5 (6.7, 2.0-10.9); 21 (8.6, 6.4-10.2); 44 (10.0, 7.3-11.9). Approximate colony sizes for the same months are shown in Fig. 1. These are estimates based on the average numbers present over the period of 1968-1971 and in some cases differ from the size estimates given for 1970 in Tuttle (1975, 1976), due to reductions in colony sizes in that year caused by disturbance from my observations.

Materials and Methods

In the periods from 1960-1961 and 1968-1971, 40,182 gray bats were banded from colonies in 50 caves; from these, 19,691 recoveries have been made at 120 locations through the winter of 1973-74. Approximately 94% of the banding was done in summer, largely at maternity caves. Since the data set is so large, certain caves have been chosen as representative of the observed range of variation in any specific aspect under discussion. Of the 50 caves where banding took place, eight are designated as banding caves in Figs. 1-8; banding and recovery data presented in this paper (hereafter, "this study") are from these banding locations only, unless otherwise noted. Approximately half of the bats in this study were banded as newly flying juveniles at maternity caves, before they moved to other locations.

All bands used in this study were supplied by the Bat Banding Office, National Fish and Wildlife Laboratory, National Museum of Natural History, Washington, D.C. Bands used in 1961 were size 0; all others were size 2 lipped bands. All were applied to the right forearm. Only a very few bands were found to be chewed sufficiently by the bats to render them illegible. Approximately 10% of the recovered size 0 bands had become embedded in the flesh of the forearm, but injury from size 2 lipped bands was virtually nonexistent. No bands under roosts or other evidence was found to indicate significant loss of bands.

Most caves were found through personal inquiry at small country stores and service stations, and through conversations with landowners. Members of the Huntsville (Alabama) Grotto of the National Speleological Society provided much valuable information regarding caves of that area, and biologists studying cave faunas were helpful in Florida and Tennessee. In order to ascertain the distribution of colonies, I spent much time checking areas removed from large bodies of water, as well as along river systems. I made a special effort to investigate every known cave within a 70 km radius of colony 25 in order to gain a complete understanding of local nightly and seasonal movements of that colony. I also searched for a possible Florida gray bat hibernaculum one week per month during the winter of 1970-71.

Several capture techniques were used in this study. Most bats caught before 10 May or after 10 July were hand-netted at their roosts. Those caught between these dates (the time when pregnant females or non-volant young might be on the roost) were usually trapped at cave entrances (Tuttle, 1974); limited hand-netting during that period was restricted to bachelor colonies where there would be no danger of abortion or mortality. Although some bats were trapped at entrances to hibernating caves, most winter captures were made by hand; torpid individuals were simply removed from their clusters.

Wintering caves (5, 21 and 44) were visited for the purpose of recovering banded bats from one to three times per winter in 1969-70, 1970-71 and 1972-73. In addition, a trap was set in an entrance to cave 5 at 14-day intervals throughout the winter of 1970-71, regardless of weather conditions. This cave also was visited in the winters of 1961-62, 1962-63, 1967-68, 1968-69 and 1971-72, and in January of 1974. Data from the 1974 visit are used in Fig. 10 but were not processed in time for most other analyses.

Although many banded bats were recovered in the summers of 1968 and 1969, most summer recoveries resulted from my regular visits in 1970. During 1970, Alabama and Tennessee maternity caves (9, 12, 25 and 50) were visited at 10-day intervals from early April until mid-August. Thereafter, until all bats had departed, regular visits were made at 14 to 15-day intervals. All Florida caves were visited one or more times each month from March, 1970, to April, 1971. Many other caves (especially 14, 22, 23, 30, 38, 41, 45, 47, 52 and 58) were visited less frequently. A small proportion (less than 1%) of the recoveries of banded individuals resulted from captures of bats by local citizens who reported them to the Fish and Wildlife Service or to local health departments (Tuttle and Stevenson, 1976).

Bats were sampled for band ratios, sex, age and reproductive

condition, and were weighed to the nearest 0.1 gm on an Ohaus triple beam balance. Ambient cave temperature and humidity were measured with a motor-driven psychrometer (Bendix Psychron), accurate to within 0.5°C. At summer caves these readings were taken 3 cm below the roost after the bats left in the evening, or after daytime hand-netting. In cave 58 the roost was never found, and temperatures given previously were estimated from readings taken 30 m inside the entrance. In winter caves, readings were taken 3 cm from the wall near edges of hibernating clusters of bats.

In summer caves, when bats could be seen roosting, colony size estimates were based on the area of ceiling covered by clusters and the estimated number of per m^2. The estimate of number per m^2 was made by taking two samples with hand nets which covered 0.28 m^2, one from the center and the other from the edge of the cluster, and averaging the two results. When roosting bats could not be observed, colony size estimates were made by calculating the area covered by new guano times 1828 (the average number/m^2) or by entrance count estimates.

Estimates of numbers of bats present in winter caves were extremely difficult to make. Clusters of hibernating bats were highly variable in density, scattered throughout thousands of meters of passages and rooms, and sometimes were 30 meters or more above cave floors. Both cluster size and density were estimated, often from a distance. Additionally, only part of any one winter population could be observed on any given visit, and some bats probably were counted more than once. Consequently, figures for winter populations are only rough approximations.

A number of difficulties were encountered in gathering and interpreting the data. Owing to the wide geographic area covered in this field study, it was impossible to visit different colonies on exactly the same dates, nor was recovery effort equal at all locations. Hibernation cave 5, for example, was visited more frequently and over a longer period of time than the other winter caves. Recovery success was greatly affected by characteristics of the cave and by colony size. For example, cave 44 required vertical roping and dangerous climbing to reach hibernating bats; even after reaching hibernating clusters the probability of recovering banded bats was lessened by the large size of the population and the height of the roost sites above the floor. Summer recoveries in Florida caves were made difficult by the large numbers of *M. austroriparius* also present.

In addition, sex and age segregation often were evident (Tuttle, unpublished data) making it imperative to sample widely throughout the clusters, which sometimes was impossible. Learning by the bats was also a problem. Bats captured in hand nets or traps frequently learned to avoid such devices; older individuals caught repeatedly during hibernation often moved to unknown roosts or to places difficult to reach. When large numbers of bats were being handled in winter caves, weight measurements had to be made as fast as possible in order to reduce the effect of weight loss during handling. The sampling problems discussed here, however, produce serious bias only when absolute values are sought; they do not appear to detract from estimates of relative costs of bat travel and would result in underestimates rather than overestimates of philopatry. Research disturbance appears to have had little effect on normal movement patterns in this study but probably led to slightly earlier timing of some movements. These and other factors were given due consideration in the gathering and analysis of data and, I believe, represent a minimal bias.

Facilities at the University of Kansas Computation Center were used to sort the data and to generate a cross tabulation that printed summaries of locations of all band recoveries made on bats from each banding locality by sex-age and 10-day periods of the annual cycle (excluding November 21-February 23 included in one winter grouping), combining all years of the study. These periods were then grouped in hand tabulations according to the usual activity of the bats at that time of year, as follows: summer period, May 25-August 22; maternity period (a subunit within the summer period), June 4-July 3; migratory (spring/fall) periods, March 26-May 24 and August 23-November 20; hibernation (winter) period, November 21-March 25.

Results

Band Recoveries

From the 19,817 gray bats that were banded at study caves discussed in this paper, 11,133 recoveries were made from 1960 through 1973 at 74 locations. These recoveries include multiple captures (on different dates) of individual bats. Success was greatest at caves 9, 12 and 23 where banded individuals were caught up to five or more times, with some bats being captured as many as 10 times. The probability of recapturing a given bat was high; for example, of juveniles banded in the summer of 1970, 39.3% (405) of those from colony 9 were recovered one or more times. The figure was 52.8% (338) for colony 12, 45.6% (452) for colony 23 and 16.5% (141) for colony 69.

Recovery success for bats banded as adults was even higher. For example, from adults banded in cave 12 in 1969, 77% were recovered at least once (at cave 12 or elsewhere), while 17% were recovered five or more times. Fifty-seven percent were caught at least once while hibernating at cave 5, and numerous other foreign recoveries were made.

Philopatry

Summer philopatry.—Gray bats exhibited strong loyalty to their maternity caves. Recoveries of banded individuals of known age

and origin demonstrated that caves 9, 12, 23 and 69 each were occupied by separate summer colonies. Bats from caves 50 and 45 were found to comprise another colony (colony 50), and cave 58 proved to be an important transitory cave for migrating bats from Florida and other southern localities. In addition, cave 58 sheltered a bachelor segment of a local colony which was not studied in detail.

In at least two cases summer colonies were found to use a number of caves within a clearly defined home range. In Florida, a single colony of gray bats (69) moved among seven caves (Fig. 1) averaging only 5.7 km apart (range 1.6-9.7). Bats in this colony, when undisturbed, preferred to subdivide into three or more smaller groups, roosting among larger numbers of *M. austroriparius* in the maternity period. If these small groups were disturbed, however, they quickly moved to form a single large unit in the least disturbed cave. Subsequent disturbance often led to redivision into smaller subunits. No loyalty to particular subunits was observed; rather, the colony was loyal to the larger home area. To a lesser extent similar movements occurred within colony 23, which used caves 22, 23, 25 26 and 30 as a summer home range (see Tuttle, 1976). All colonies appeared to have particular roosts that were preferred for maternity purposes and served as a focus for summer activity. Since colony 23 was observed extensively in this study, it was selected for a detailed presentation of summer philopatry.

Within the maternity periods of all years combined, 99.3% of the 285 recoveries of adult females banded at cave 23 were made within the home range of that colony (Fig. 2). Two bats were found outside that area: one individual (band number 6-83836) at cave 5, 25 June 1969, and the other (6-8[illegible]7) at cave 41 on 12 June 1970. All maternity period recoveries at cave 23 yearling females (N=37; banded as juveniles) were from caves 23, 26 and 30, within the home area. In all recoveries of females from other caves in the study during maternity periods, only one additional example of apparent disloyalty to the colony home range was found. This bat, a female (6-84407), banded at locality 30 (16 June 1968, pregnant) therefore probably belonging to colony 23, was recaptured at locality 12 on 1 July 1969 (lactating); it was never captured again.

Adult males also demonstrated strong loyalty to the summer home range in which they were born. Fifty-three adult males banded at cave 23 were recovered in the maternity period. Of these, 92.5% were found within the home area. Of the four recovered elsewhere one, banded as an adult 26 June 1968, was recovered 7 June 1970 at cave 12. Three, banded as juveniles 1-8 July 1968, were recovered as adults as follows: one at cave 5 on 26 June 1969 and two at cave 7 on 27 June 1969. None of these were subsequently recovered within the home range of their colony. On the other hand, all recoveries of colony 23 yearling males made during the

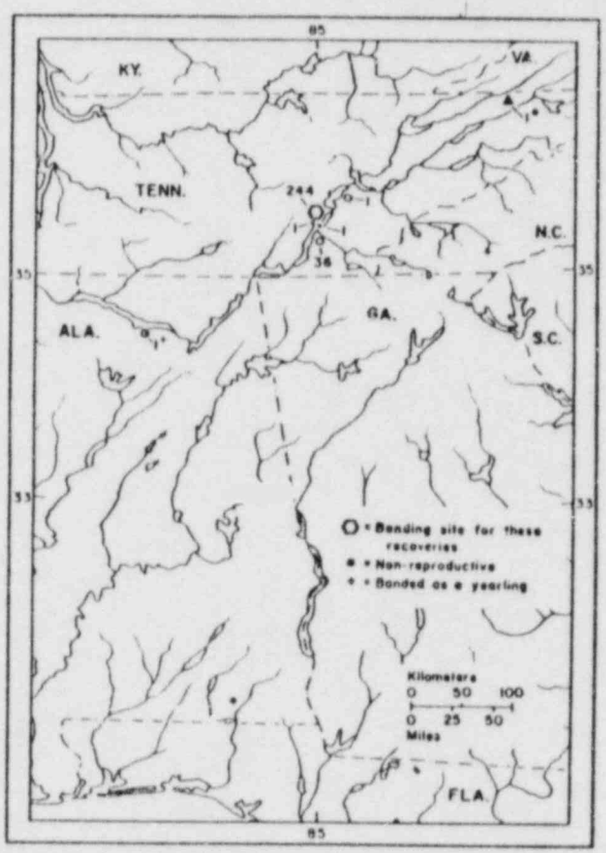


FIG. 2.—Recoveries of adult females from colony 23 during the maternity periods (4 June-3 July) of 1968 to 1970. Numbers indicate recovery sample size; symbols are as in Fig. 1.

maternity period ($N = 7$) were outside of the home range of that colony; three were recovered at cave 12, three at cave 45 and one at cave 47.

Winter philopatry.—At least a small proportion of any given colony was found to use each of the major wintering caves during hibernation. Nevertheless, once an individual bat chose a cave in which to spend its first winter it nearly always returned to that same

site, even though many members of its colony traveled to other wintering sites. Of 3110 gray bats banded during hibernation in cave 5, none were found wintering elsewhere over a 14-year period. During that time 1824 recoveries of these bats were made in cave 5. In the winter of 1973-74, 22 bats banded at cave 5 in the winters of 1960-61 and 1961-62 were found still using that cave. Of these, two had been captured there in five different winters, four in four winters, seven in three winters, and nine had been found wintering for the first time since the year of banding, 13 and 14 years earlier.

Such loyalty was not unique to cave 5; of a total of 6486 recoveries made at the three major wintering caves, only one bat was recovered at more than one. This bat, a juvenile male (banded 7 July 1970 at cave 25), was hibernating in cave 21 on 18 March 1971 but was recovered as an adult two years later hibernating in cave 44 (11 January 1973). These data, I feel, provide significant indication of loyalty due to the large ($N = 261$) number of individuals from colony 25 recovered hibernating in two or more winters. All other colonies demonstrated 100% loyalty to their wintering sites even though many bats were recovered in at least three winters.

Loyalty to both hibernal and maternity caves is further shown by the number of round trips (from maternity cave to winter cave and back) recorded in this study. Between caves 25 and 5, 188 such movements were recorded, with 63 bats making two round trips and one found making three. Sixty round trips were recorded between caves 25 and 21, and 18 bats were shown to have made at least two. Thirty-nine round trips were recorded between caves 25 and 44, with seven bats making at least two round trips. Similar results were obtained from other colonies except 69, from which only 10 round trips were recorded (between Florida localities and wintering cave 44).

PATTERNS AND TIMING OF MOVEMENT

Regardless of sex, age or geographic location, all gray bats moved between cold hibernating caves and warm summer caves each spring and fall. Confirmed round trip movements varied from only 17 km one way (cave 45 to cave 44, see Table 1) to migrations of as much as 437 km (colony 69 to cave 44). Most gray bats congregated in only three wintering caves; approximately 125,000 hibernated in cave 5, 250,000 in cave 21 and 1,500,000 in cave 44. In winter these caves, all of the unusually cool type described above, may contain more than 90% of the gray bats that live in the southeastern United States (south of Kentucky and east of the Mississippi River). Although there are some sex and age differences in movement, adult females from colony 25 were illustrative of patterns of movement for the northern colonies (9, 12, 25 and 50; Figs. 2-4). A different pattern of winter behavior was observed in juveniles and in adult males from Florida and will be presented

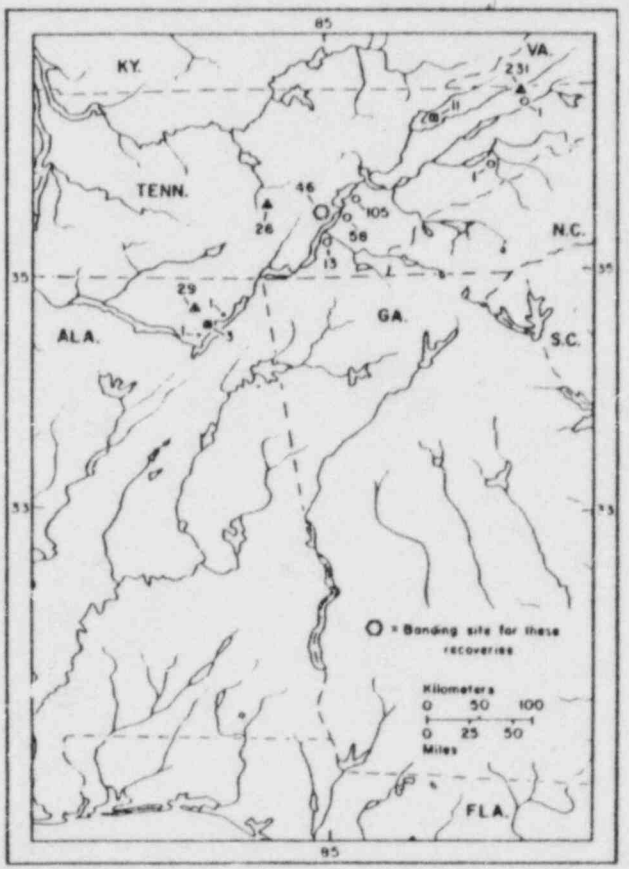


FIG. 3.—Recoveries of adult females from colony 25 during the migratory periods (26 March-21 May and 23 August-20 November) of 1970. Numbers indicate recovery sample size; symbols are as in Fig. 1.

in detail elsewhere. Seasonal recoveries of adult females from Florida, however, follow typical patterns and are shown in Figs. 5-7.

As mentioned above, at least a small fraction from each colony was found hibernating in each of the three wintering caves; however, only colony 25 was well represented in all three. Nearly all bats from colonies 9 and 12 wintered in cave 5, where 1140 recoveries were made from colony 9 and 1124 were made from 12. Only

TABLE 1.—DIRECT DISTANCES BETWEEN THE THREE MAJOR WINTERING CAVES AND THE SUMMER CAVES (IN KM).

Wintering Caves	Summer Caves						
	9	12	25	45	50	58	69
5	47	84	204	355	371	479	668
21	218	179	69	113	122	251	525
44	323	284	160	17	28	139	437

0.4% from each of these two colonies were recovered wintering in cave 21 and even fewer in cave 44, both much more distant (Table 1). Although colony 25 is nearer to cave 21 than to either 5 or 44 (Table 1), bats taking the shortest possible route to 21 must cross the Cumberland Mountains. Two adult males and one juvenile male, banded at cave 24 from a migratory group containing banded bats from colony 25, were found hibernating in cave 21 and later returned to caves 22 and 26. The juvenile made at least two round trips. Cave 24 is a transitory cave located in the Cumberland Mountains about midway between caves 25 and 21 (Fig. 1). It seems apparent, then, that these gray bats crossed directly over the mountains in migration.

Bats banded in cave 50 were found hibernating only in cave 44, were 140 were taken. However, recoveries of bats from cave 45 (a bachelor cave for colony 50) were generally more widely distributed and, of the 478 winter recoveries from bats banded at cave 45, eight (1.7%) were recovered at cave 5 and eight more at cave 21 (Fig. 8). Apparently a very small proportion of the bats from colony 50 uses the more distant wintering sites. Three cave 45 males, one juvenile and two adults (recovered by W. J. Gunier), were found hibernating in two caves in Missouri, 770 and 689 km westnorthwest of cave 45 (Fig. 8). None of the three were recovered subsequently.

During the winters of 1969-70, 1970-71 and 1972-73, 106 adult females from Florida were found hibernating in caves 21 and 44 in the north, while only one was found remaining in Florida (Fig. 7). An additional 29 were found hibernating in the north late in the fall migratory period or in the early spring (Fig. 6), and these also undoubtedly wintered there. Thus, 135 adult females from Florida are known to have hibernated in caves 5, 21 and 44 while only one definitely wintered in Florida.

The two series of seasonal maps, Figs. 2-4 and 5-7, illustrate the general pattern of movement followed by all colonies. Bats remained largely within their home ranges during the summer (particularly during the maternity period; Figs. 2, 5), with spring and fall recoveries spread along migration routes between the summer and winter caves (Figs. 3, 6) and winter recoveries concentrated at the hibernation sites (Figs. 4, 7). The recoveries of

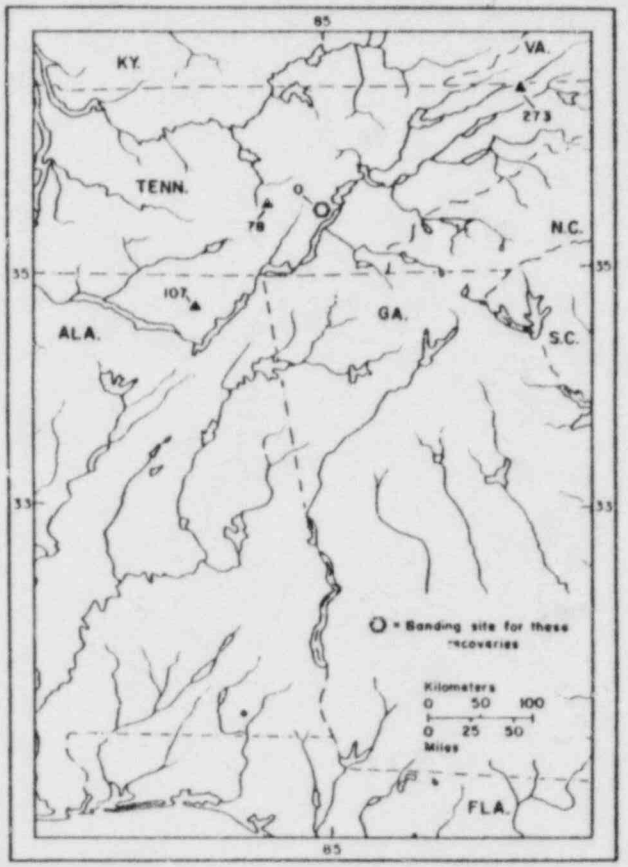


FIG. 4.—Recoveries of adult females from colony 25 during the hibernation period (21 November-25 March). Data were gathered at all caves during the winters of 1969-70, 1970-71 and 1972-73. In addition, cave 5 data include recoveries from the winters of 1968-69 and 1971-72. Numbers indicate recovery sample size; symbols are as in Fig. 1.

Florida (colony 69) bats by the public provided a particularly interesting indication of the migratory route used by this colony. Rather than following the most direct route north, they appear to make a broad westward curve (Fig. 9), which keeps them near available caves as well as rivers. Migratory movements of other

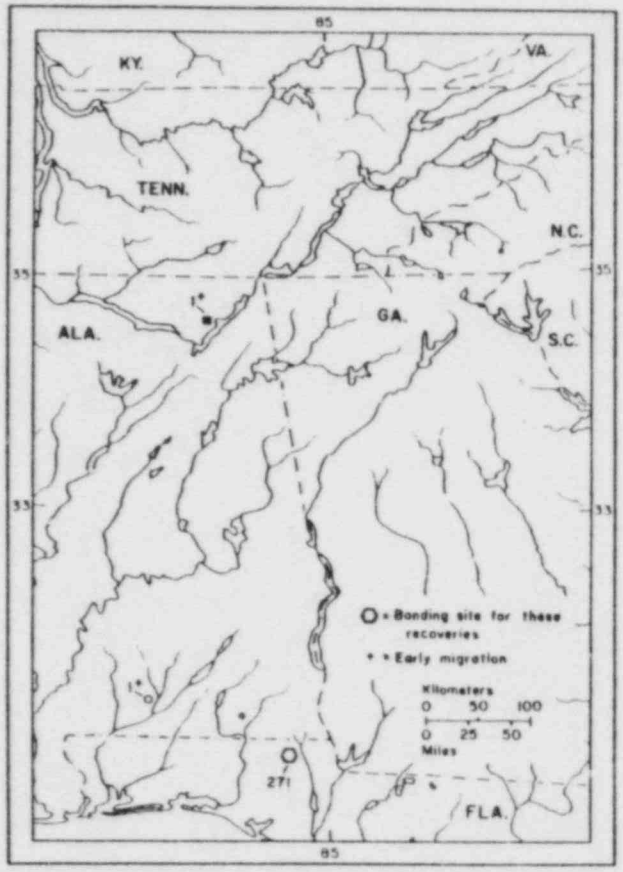


FIG. 5.—Recoveries of adult females from the Florida localities during the summers (25 May-22 August) of 1968 to 1971. The recoveries marked as early migration were taken 14 July and 4 August. In addition, the northernmost recovery was nonreproductive and had been banded at cave 66 one month earlier. Numbers indicate recovery sample size; symbols are as in Fig. 1.

colonies also showed this tendency, but few had to go so far out of their way.

Sex and age differences appeared in the timing of migration and in the choice of summer caves; again, colony 25 is representative of the general pattern. Adult females emerged from hibernation first, beginning in the last week of March. Yearlings lagged somewhat,

TABLE 2.—SEX AND AGE RATIOS OF BATS TRAPPED DURING SPRING EMERGENCE FROM HIBERNATION AT CAVE 5.

Date	N	Per Cent Adult Female	Per Cent Yearling Female	Per Cent Adult Male	Per Cent Yearling Male	Total Per Cent Female
2 Apr. 1969	232	97	0	3	0	97
8 Apr. 1970	576	74	2	24	0	76
18 Apr. 1970	234	20	2	71	7	22
29 Apr. 1970	798	2	12	66	20	14
8 May 1970	188	0	1	86	13	1

although still largely ahead of adult males. Sex ratios of samples trapped during spring emergence at wintering cave 5 clearly demonstrated this behavior (Table 2). Recoveries from 1970 at cave 12, a transitory cave for colony 25 during spring and fall migration, provided further evidence of this differential timing. Captures of adult females at this cave were made on 7 April, 17 April and 28 April. No adult females from colony 25 were found in cave 12 in May; the last yearling female was caught on 7 May. In contrast, captures of males were later in the season. Adult males were found on 28 April and 7 June; yearling males were taken on 28 April, 7 May, 27 May, 7 June and 17 June.

No gray bats had arrived at summer caves 25 and 26 on either 6 or 16 April 1970. On 20 April, when I first checked caves 22, 23 and 30, I found about 550 bats in cave 23 and 69 in cave 30. The sex ratio in these two caves was 89% female. On 1 May, samples including 307 bats from caves 22 and 23 (weighted according to the estimated number in each cave) indicated that 61% were female. By 26 May, 53% of the sample ($N = 74$) from cave 25 were female. This was the first date gray bats were found roosting in cave 25.

Although males were present in increasing numbers through the following week, by the beginning of the maternity period (4 June), distribution among the caves within the colony 25 home range had become largely segregated according to sex and age. On 6 June 97% of the adults in cave 25 ($N = 72$) were female, of which 25% were lactating and the remainder pregnant. From 6 June through 16 July, five samples ($N = 231$) taken at 10-day intervals showed a range of 85-97% females (mean 91%) among adults. This was typical of the distribution in other colonies, where caves having high temperatures and good heat-retaining properties were chosen by adult females for parturition and preflight care of the young (Tuttle, 1975). Adult males and yearlings of both sexes were found most often during this period in bachelor groups at locations from 1 to 35 km from the maternity site; those of colony 25 were observed in groups of 500 to 2000 in caves 22, 23 and 30. During the period when adult females nursed their young in cave 50, males and yearling females of colony 50 were gathered nearby in cave 45.

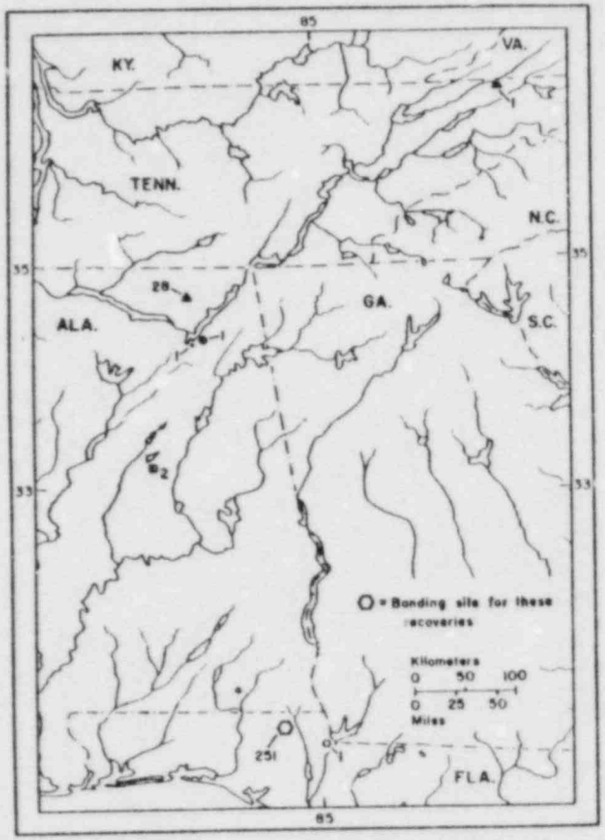


FIG. 6.—Recoveries of adult females from Florida localities during the migratory periods (26 March-24 May and 23 August-20 November) of 1970. Numbers indicate recovery sample size; symbols are as in Fig. 1.

Sex ratios among adults were approximately 80% male in cave 45 and 80% female in cave 50.

By late July and early August at colony 25, many adult females and juveniles of both sexes had moved from the nursery to caves 22, 23 and 30, and sex ratios in all caves occupied by colony 25 had become more nearly even. On 21 August 10,000 gray bats in cave 23 were sampled during emergence ($N = 254$) and found to be 52% adult and yearling females (juveniles excluded), but a group of

1500 in cave 25 were only 35% adult and yearling females ($N = 429$). During several years of observation the entire colony gathered together in cave 25 just prior to fall migration. On 1 September 1970, 21,000 gray bats were found in a single large cluster in cave 25, and a sample of 716 adults and yearlings indicated that 51% were female.

Most fall migration began between 1 and 15 September; after 1 September clusters of 600-1600 bats were the largest seen in caves 22, 23, 25 or 30. Females, especially adults, departed first. On 15 September 38% of 221 bats sampled at cave 25 were adult or yearling females. By 28 September, however, only 17 adult and yearling females were found ($N = 243$). Juveniles of both sexes lagged behind the adult females, with most juvenile females eventually leaving before the juvenile males. Through 29 September the proportions of juvenile males to females were approximately equal in these caves. However, by 12 October only 19% ($N = 109$) of the remaining juveniles were female. Although some adult males left the colony 25 home area with the first females, others remained behind with the juveniles until as late as mid-October. At colonies 9 and 12, however, most bats had left by the end of September.

Once at the winter cave, females entered hibernation first (usually during September or sometimes in early October), immediately following copulation. The males remained active much longer after arrival, entering hibernation by 10 November. The proportions of females found among bats hibernating in cave 5 from 18 September to 24 November of 1970 (Table 3) were illustrative of this behavior. Furthermore, trapping (four samples, $N = 35$-321, mean 179) at the entrance to cave 5 from 18 September to 27 October of 1970 showed a contrasting proportion of only 6-10% females (mean 7%). After beginning to hibernate, bats remained in the cave. Traps set at the entrance to cave 5 on seven dates throughout the winter of 1970-71 (at 14-day intervals, 24 November-16 February) caught only one *Myotis grisescens*, a juvenile male.

Although most of the exceptional movements observed were within the yearly range of a colony (therefore exceptional only in

TABLE 3.—SEX AND AGE RATIOS OF BATS HAND CAPTURED IN HIBERNATION CAVE 5 DURING THE FALL RETURN PERIOD OF 1970.

Date	N	Per Cent Adult Female[1]	Per Cent Juvenile Female	Per Cent Adult Male[1]	Per Cent Juvenile Male	Total Per Cent Female
18 Sep.	186	99	0	1	0	99
1 Oct.	377	93	3	3	1	96
14 Oct.	301	53	17	21	9	70
27 Oct.	486	60	7	24	9	67
10 Nov.[2]	723	33	10	39	18	43
24 Nov.	380	41	12	33	14	53

[1] Includes adults and yearlings.
[2] All bats in hibernation. Sex segregation of clusters biases sampling.

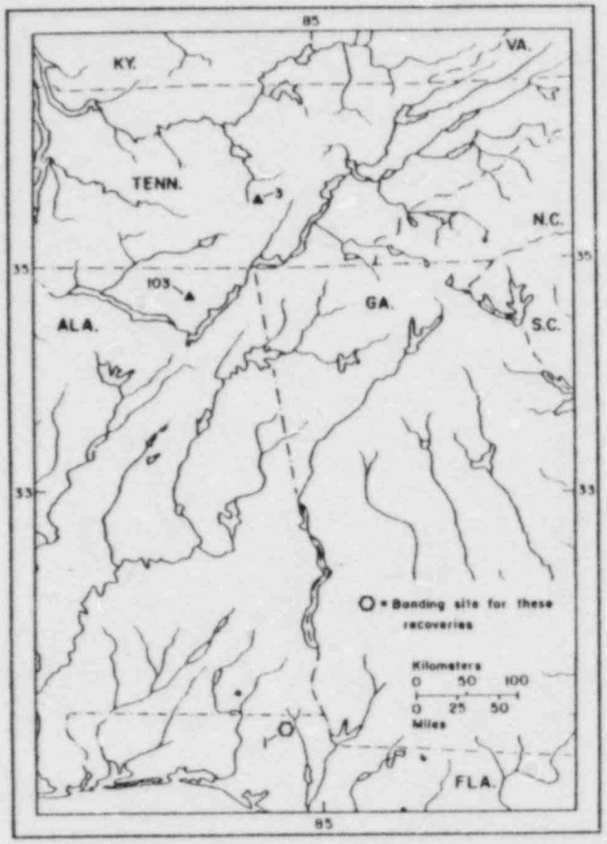


FIG. 7.—Recoveries of adult females from Florida localities during the hibernation periods (21 November-25 March) of 1969-70, 1970-71 and 1972-73. Numbers indicate recovery sample size; symbols are as in Fig. 1.

timing), a few more unusual recoveries were made. Most of these recoveries were of subadults. A yearling female, banded at cave 25 on 12 June 1968, was recovered 1 October 1968 at locality 19. This bat had traveled 229 km east across the Appalachian Mountains. Another yearling female, banded at cave 25 on 9 July 1969, was recovered at cave 20 on 9 September 1970 after it had traveled 126 km northwest across the Cumberland Mountains. No comparable recoveries were made for adults or juveniles of colony 25. One juvenile, however, provided the single occurrence of reverse migration found in this study. A juvenile female, banded 26 July 1970 at cave 25, was recovered 5 September 1970 at cave 5, and then was found again back at cave 25 on 28 September 1970. This apparently was an example of disoriented behavior, and the bat was not seen again.

RATES OF TRAVEL

A number of sequential captures of individual bats provided insight into the minimum possible rates of travel, although exact speeds were never measured. Caves 22, 23, 25 and 30 were occasionally sampled on consecutive days, and recoveries indicated much movement among these localities in single nights. For example, of 516 banded gray bats caught clustering together in cave 25 on 26 July 1970, 133 were recaptured from a single cluster in cave 30 on the following day. They had traveled 15.8 km. A migratory movement was demonstrated by a yearling male, found hibernating in cave 44 on 12 April 1970 and caught again at cave 30 on 20 April 1970. This was a trip of 145 km within eight nights, for a minimum rate of travel of 15.1 km per night. Another yearling male traveled 35.4 km between caves 25 and 22 on the night of 28-29 September 1970.

One of the adult males from cave 45 found hibernating in Missouri had been recovered twice at cave 25 on 11 August 1969 before spending the winter of 1969-70 in Missouri. This represents minimum movement of 768 km between 11 August and the inception of hibernation, probably in early November. However, the fastest movement was of an adult female (7-32638), banded 8 July 1969 at cave 25. She was recaptured twice again that summer, on 7 August at cave 41 and 11 August back at cave 25. In not more than four nights the distance of 207 km between caves 41 and 25 was traveled, at a minimum average rate of 52 km per night. This bat was subsequently captured on 11 May 1970 at cave 22, on 16 June 1970 (lactating) at cave 25, and on 13 January 1973 (hibernating) at cave 44.

Recoveries on the night of 21 April 1970 provided a possible indication of actual flight speed. An entrance trap was checked and emptied at half-hour intervals all night at cave 58, a transitory cave for Florida females moving south for the summer. Of 80 bats caught during emergence (1840-2030 hrs), 89% were males. At 2400, however, many gray bats abruptly arrived and tried to pass through the partly blocked cave entrance. The trap quickly caught four males and 18 females, a sample 82% female. In the next hour 73 additional gray bats were trapped, also 82% female. A large proportion of females continued to appear at the cave entrance until morning, and it was evident that many females had arrived

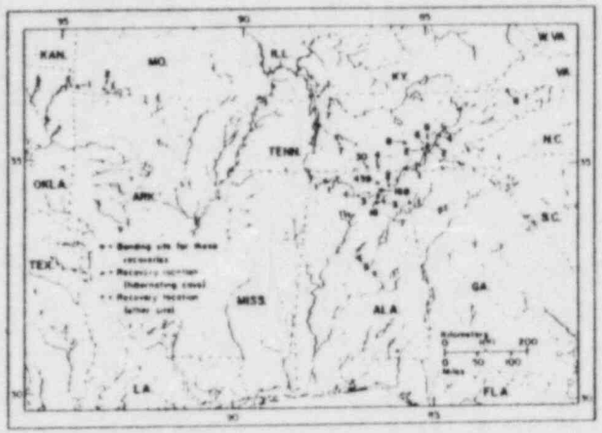


FIG. 8.—Recoveries of all sexes and ages for all periods of the year from cave 45. Numbers indicate recovery sample size; localities other than Missouri sites are as in Fig. 1.

from elsewhere about midnight. Three bats (one adult male and two adult females previously banded in Florida) that were captured after midnight were recaptured later in the same year in Florida. Also, 152 of the adult females trapped that night were banded; three were later recovered in Florida. Cave 53, located 108 km north of cave 58, was the nearest location where bats migrating to Florida were known to stop. If the females that began arriving at cave 58 around midnight had left cave 53 at 1840 (earliest time of emergence at cave 58), they would have had five hours and twenty minutes of flying time. Such a trip would have required a mean flight speed of 20.3 km per hour.

WEIGHT COMPARISONS

Migratory weight loss.—The mean weight of the last sample obtained at the summer cave was compared to the mean of the first sample of banded bats taken after arrival at hibernation cave 5, in order to observe weight change during migration, for colonies 9, 12 and 25 (Fig. 10). Adult females were chosen for this comparison because of their tendency to go immediately into hibernation. These mean weight changes (and mean weights, before and after migration; in gms ± S.E.) were as follows: colony 9, + 0.1 gm (11.2 ± 0.16 and 11.3 ± 0.20); colony 12, 0 gm (11.2 ± 0.16 and 11.2 ± 0.20); colony 25, — 1.2 gm (12.5 ± 0.20 and 11.3 ± 0.11). A *t*-test of equality of mean weight change indicated significant differences between colonies 12 and 25 ($t_s = 3.159$, $P < 0.01$) but not between 9 and 12.

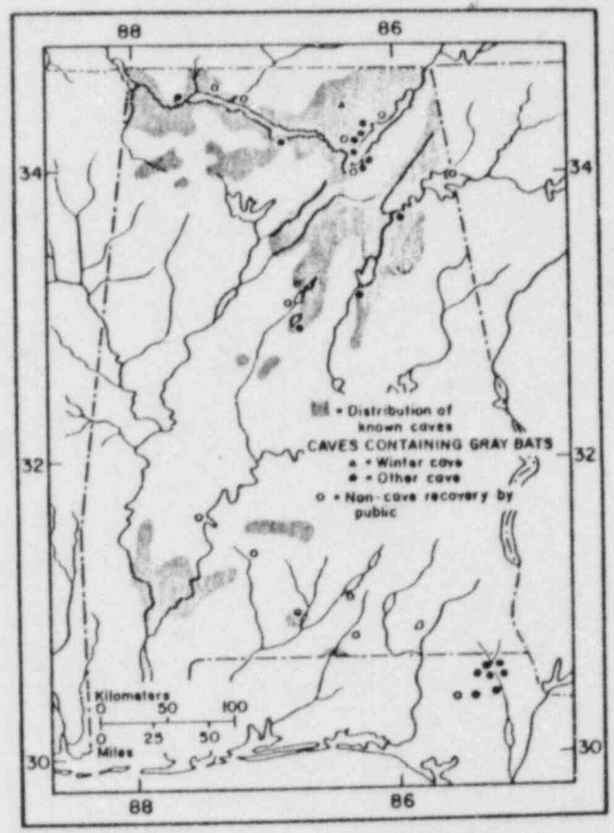


FIG. 9.—The distributions of known caves (Stokes, 1972) and recoveries of banded *Myotis grisescens* in Alabama. The five southernmost Alabama public recoveries are of Florida bats found during the migratory periods.

No correlation between mean weights after arrival and distance traveled in migration was observed for adult females in these samples. However, when all sex and age groups were combined to increase sample size, post-migratory mean weights (in gms, ± S.E.) were as follows: colony 9, 10.5 ± 0.06 ($N = 87$); colony 12, 10.6 ± 0.07 ($N = 85$); colony 25, 11.1 ±0.10 ($N = 59$). These

means differed significantly among colonies ($F = 15.050$, $P < 0.001$), with arrival weight directly correlated with migratory distance.

Another comparison of weight loss during migration was made for adult females of colonies 25, 45/50, 58 and 69 in their migration to cave 44 (Fig. 11). Colonies in caves 45, 58 and 69 were sampled only once per month, however, and it was not possible to compare entire adult female samples as had been done with colonies 9, 12 and 25 because not all bats in the sample would have been ready to migrate. After 1 September at least a small proportion of each colony always appeared to be ready to migrate (in terms of fat deposition) and, in an attempt to sample their weight, only the heaviest 10% of those weighed from each locality were used to calculate the pre-migration mean. Ideally, this should have been compared to the heaviest 10% upon arrival at the winter cave, but it was necessary to take the heaviest 25% there in order to provide reasonable sample sizes, thus exaggerating weight loss.

Clearly, the values presented in Fig. 11 are only rough approximations of actual weight loss; however, they may be used for comparison among themselves since bias from the technique was equal among all colonies. Colony 50 was subdivided into its component caves, 45 and 50, since locality 50 weight data were probably biased

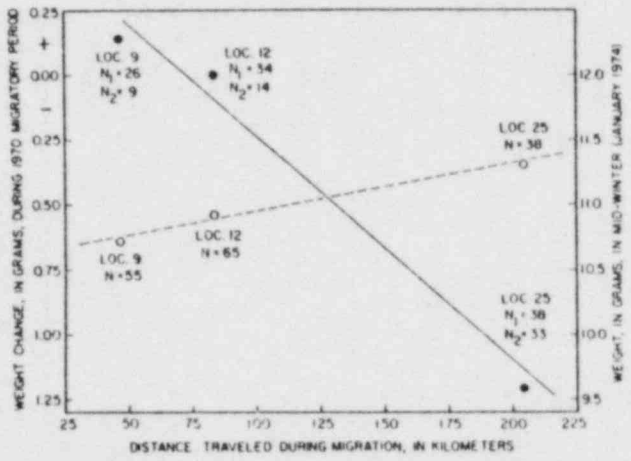


FIG. 10.—The relationship between distance traveled to the hibernating site, cave 5, and weight change during the 1970 migration for adult females from colonies 9, 12 and 25 (solid line, closed figures), and mean weights of adult females from colonies 9, 12 and 25 in midwinter of 1974 (during hibernation) at cave 5 (broken line, open figures). N_1 equals the pre-migration sample size and N_2 equals sample size at the hibernaculum.

(see Discussion). The mean weight changes (and mean weights before and after migration) were as follows: colony 25, —2.4 gm (14.3 and 11.9); cave 45, —1.4 gm (13.6 and 12.2); cave 50, —2.1 gm (14.0 and 11.9); colony 58, —1.9 gm (13.9 and 12.0); colony 69, —3.8 gm (15.6 and 11.8). Spearman's method of rank correlation showed a significant coefficient of correlation between weight loss and distance traveled ($r_s = 0.9$, $P = 0.025$). Again, no significant correlation was found between post-migratory mean weights and distance traveled in migration.

Mid-winter weight.—The differences in arrival weights for the combined samples at cave 5 were confirmed by a comparison of mean weights of samples of banded adult females from colonies 9, 12 and 25, hand-captured during hibernation in cave 5 on 4 January 1974 (Fig. 10). They differed significantly ($F = 11.470$, $P < 0.001$) in the same relationship to distance as the previous combined sex and age samples, as follows (mean weight, in gms, ± S.E.): colony 9, 10.7 ± 0.07; colony 12, 10.9 ± 0.08; colony 25, 11.3 ± 0.09.

Discussion

Band Recoveries.—Most previous banding efforts have been made in winter hibernating caves where bats of unknown age or colony origin have been banded in large numbers. Recovery of

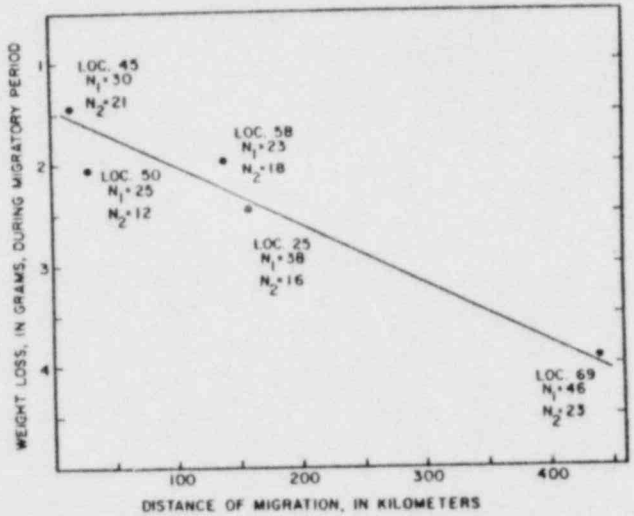


FIG. 11.—The correlation between weight loss during the 1970 migration and the distance traveled to the hibernating site, cave 44, for adult females from 5 locations. N_1 and N_2 are as in Fig. 10.

such bats at places other than the banding site is exceedingly difficult. Usually, recoveries made by the lay public are of bats found dead or otherwise accidently discovered. These chance encounters are unlikely, and the rate of recovery of banded bats is usually measured in tenths of one percent (Griffin, 1970).

In the present study nearly all banding was done at maternity sites, where roughly half the bats banded were juveniles in their first three weeks of flight. Also, as many as 52% of juveniles and 77% of adults from some localities were later recovered one or more times. (High juvenile mortality is a major factor in the differential recovery success by age at banding; Tuttle and Stevenson, 1976.) These recoveries include thousands of multiple recoveries and more than 500 records of round trips between summer and winter caves taken from a large geographic area over a period of several years. Previously, multiple recoveries of bats of known age and origin have been rare, and records of round trips have been virtually nonexistent (Griffin, 1970). For this reason, data obtained in this study provide the most nearly complete record of seasonal movements and of loyalty to given caves or groups of caves that has so far been obtained for a species of bat.

Summer philopatry.—Although yearlings of both sexes wandered considerably at various times of the year, they were not disloyal to the home site for their colony. During the maternity period, all recoveries of yearling males from colony 25 were outside their home (natal) area, and yearling females showed some wandering in late summer and fall; even so, 91.4% (180 of 197) of all summer recoveries for colony 25 yearling males were within the summer home range, and subsequent recoveries of many apparently disloyal yearlings often showed them remaining in the home range later that year or as adults. For example, one of the colony 25 yearling males captured at cave 12 during the maternity period (see Results—Summer Philopatry) was recovered twice more the same year—on 28 September at its home cave 25 and on 24 November at cave 5, where it hibernated. Yearling wandering usually is restricted to the general areas used in migration and may serve the purpose of acquainting young bats with their range. The apparent marked difference in timing of such activities between males and females may be related to a need for females to be especially well imprinted with knowledge of local roosting places used by adult females of their colonies for rearing of young.

The high degree of loyalty to summer caves found in this study is similar to that observed for *M. grisescens* in the Ozarks by Myers (1964). Seventy-two percent of Myers' summer-banded female *M. grisescens* that were recovered were found at the place of original banding, while 28% were taken in nursery colonies within a radius of 14 to 30 km of the original site. He also stated that males tended to return to the same summer caves, and that summer recoveries of summer-banded individuals averaged within 27 km of the original banding location. Since the most clearly defined home range in my study included five caves throughout an area approximately 50 km long by 5 km wide, among which bats from colony 25 made frequent nightly movements, it seems reasonable to assume that most of Myers' recoveries indicate philopatry. Similar home area movements may also account for the apparent switches to new but nearby nursery sites observed for females by Myers.

In addition, no differentiation was made in most of Myers' data between yearlings and adults or between different reproductive conditions; yearling wandering would further reduce estimates of loyalty. In spite of these problems, Myers' bats were usually found close enough to the original site to be considered within the home range of an average colony. Although he did not define them as such, Myers presented evidence of at least two distinct home areas, in each case he found frequent movements of a single group of bats among six different caves.

Loyalty to a particular summer site or area appears to be a rather general phenomenon among bats. Humphrey and Cope (1976) reported 100% loyalty to maternity sites among 2841 adult and juvenile *M. lucifugus* banded in summer colonies in Indiana, and Rice (1957) observed a strong tendency for adult *M. austroriparius* in Florida to return to the summer caves of original banding. Bels (1952) observed that *M. myotis* returned to the same summer roosts in successive years, and observed two round trips between summer and winter caves. As pointed out above, many apparent cases of disloyalty probably are the result of insufficient knowledge of a bat's entire pattern of annual movements. In addition to early or late migration a few bats, most often yearlings or adults without young, may make lengthy trips to other places within their annual home range, as noted before.

That these do not necessarily indicate a lack of loyalty is further demonstrated by the adult female (7-32638) from colony 25, found 207 km distant at cave 41 on 7 August 1969 (after young were weaned), but which returned within four nights to cave 25 (see Results—Rates of Travel). This bat returned in the following year to cave 22 (in the colony 25 summer home range) by 11 May and was taken again that summer at cave 25 where she was lactating. Her later winter recovery at cave 44 demonstrates that her normal spring and fall migration would be in the same direction as cave 41, but if this or the subsequent 1969 and 1970 recoveries in the cave 25 area had not been made, her recovery at cave 41 easily could have been interpreted as disloyalty.

Of the three apparent exceptions noted in adult females in this study (see Results—Summer Philopatry), one (6-83836) was lactating when banded at cave 25 but was nonreproductive when taken at cave 5. This bat could well have visited cave 25 earlier or

later without being detected. The second (6-83927) was a yearling when banded at cave 25 and was later found lactating at cave 41. This bat very possibly was only visiting at cave 25 when originally banded. The third (6-84407) represents the only example of an adult female which probably represents actual maternity cave disloyalty, since she apparently reared young at two distant localities (12 and 30). Unfortunately, although philopatry can be demonstrated, disloyalty almost never can be proven, due to the high mobility of these bats. The large number of round trip recoveries in this study remains the strongest evidence of loyalty to summer home areas.

Winter philopatry.—Multiple round trips, in addition, are highly significant indicators of loyalty to the wintering site. As noted previously, a lower proportion of round trips was recorded from Florida than from other colonies. However, this most likely reflects the much greater difficulty of recovery both in cave 44 and in Florida, rather than indicating reduced philopatry; my observations at three winter caves in the Southeast indicate intense winter philopatry.

Myers (1964) obtained similar hibernating cave loyalty results for gray bats in the Ozarks; he reported 99% loyalty for females and 98% for males. Reports of winter loyalty for other *Myotis* are frequently conflicting, however. Myers (1964) found considerable intercave movement over short distances for *M. sodalis* in the Ozarks, although among the more widely separated caves of Kentucky, Hall (1962) observed approximately 99.8% loyalty for this species in successive winters. Twente (1955) and Kunz (1971) observed some apparent changes in loyalty for *M. velifer* between caves short distances apart in Kansas and Oklahoma, but a majority of the bats apparently were loyal. Dunigan and Fitch (1967) reported 97.5% loyalty in the same area, and Tinkle and Patterson (1965) reported 95% loyalty for this species in Texas. In Europe, Eisentraut (1936) found 99.8% loyalty among 6000 *M. myotis* in winter caves and Bels (1952) observed the following percentages of hibernaculum philopatry among several other species: *M. dasycneme* (94.1%), *M. daubentonii* (97.7%), *M. emarginatus* (85.2%), *M. myotis* (91.2%), *M. mystacinus* (85.9%), and *M. nattereri* (99.0%).

My experience with *M. grisescens* suggests that a number of factors other than actual disloyalty may explain the wide range of reported winter behavior, with the primary factor being human disturbance. Griffin (1945), for example, reported a winter movement of 201 km between caves for *M. lucifugus* in New England; Humphrey and Cope (1976) believed this species commonly changed wintering caves. Myers (1964), however, reported complete loyalty for this species in a winter cave that was seldom disturbed and suggested that the amount of disloyalty might be correlated with intense disturbance. Certainly a 201 km winter movement would

seem unlikely for any other reason. Loyalty differences among species, then, may merely reflect differing tolerances to disturbance along with differing available alternatives. It seems reasonable to assume that if other equally well-suited caves were within a short distance, disturbed bats could be expected to move to them, especially if the original cave were not diverse enough to provide alternate undisturbed roosting places.

Myers and I both limited major disturbances to only two or three visits per winter; even then awakened gray bats would quickly move. However, because the hibernacula were so far apart in my study and each was quite large, movements were restricted to changes between alternate roosts in the same cave. This was a successful avoidance strategy, as pointed up by my continual discovery of new roosts within known caves over the entire 14-year period of study. Until recently *M. grisescens* has been protected from most human disturbance due to its wintering sites; hibernating caves of this species, as pointed out by Myers (1964), are usually extremely difficult to enter and often are protected by vertical entrance drops of more than 30 m. The very high degree of winter loyalty observed for gray bats, then, may indeed prove to be representative of the natural behavior of most *Myotis* when undisturbed.

Patterns and timing of movement.—Most caves within the latitudinal range of this study are not suitable for bats. Many caves are too cold in summer and most are too warm in winter; few are diverse enough to provide shelter on a year-round basis, and even these may not be used if they are too far removed from adequate food supplies. Myers (1964) found that only 31.8% of the 135 caves he visited were used by any species of bat either in winter or summer. In a study of hibernating bats in Kentucky caves, Hall (1962) found *M. grisescens* to be markedly more restricted in its choice of wintering caves than was any other species. Although more than 2000 caves are known within the range of my study, only three of these are known to house major winter populations of gray bats. Even though more caves meet gray bat summer requirements, still only a relatively small proportion of caves is used. As Figs. 1 and 9 show clearly, summer caves used by gray bats were in all cases located as near as possible to major bodies of water. Such a limited supply of suitable caves necessitates seasonal movement for most gray bat colonies. However, as noted by Myers (1964), whenever adequate diversity exists at a single site, little or no movement may be necessary.

Since greatly increased mortality occurs during migratory movements (Tuttle and Stevenson, 1978), selection should favor any reduction of the distance traveled between summer and winter caves. It is therefore not surprising to find that, in all but one case, the large majority of bats from each colony studied used the nearest winter cave. Most bats from colonies 9 and 12 used cave 5, which

was far closer than either of the alternatives, 21 and 44 (Table 1). In spite of the lowered probability of recovering bats in cave 44, nearly all winter recoveries of bats from nearby colony 50 were made there.

Colony 25 bats were exceptional in hibernating primarily in caves 5 and 44, while using the nearer cave 21 to a lesser extent. Although these bats appear (Fig. 4) to have used cave 5 (the most distant site) most frequently, this is partly the result of sampling bias attributable to the greater recovery effort made at that cave and the comparatively greater probability of capture success per effort. Bats from colony 25 probably used caves 5 and 44 with about equal frequency or favored cave 44. But even when sampling biases are considered, cave 21 appears to have been used least.

I consider the observed patterns of winter cave usage by colony 25 to be the result of the combined influence of several selective pressures. First, in comparing cave 5 with cave 44, although the routes traveled are similar, cave 5 is both colder (better suited to gray bat hibernation needs) and more diverse in terms of providing a selection of roost temperatures. Second, it would appear to be more difficult to navigate and more costly energetically to travel across the Cumberland Mountains than it is to travel a somewhat greater distance along the Tennessee River, where both food and shelter are plentiful. Undoubtedly climatic fluctuations, human disturbance and other factors have combined many times to cause changes in the relative advantages of each site. For this reason, multiple use of winter caves by a single colony could prove advantageous in guaranteeing its longterm survival. Indeed, such behavior is apparently widespread among *Myotis* (Bels, 1952; Kunz, 1971).

The fact that a segment of colony 25 regularly crosses the Cumberland Mountains in migrating to and from cave 21 is of particular interest, in that it demonstrates that gray bats are not restricted to orienting along river systems when there is an advantage to doing otherwise. Furthermore, recoveries of bats migrating between Florida and cave 44 (Fig. 9) indicate a willingness not only to go across country between rivers but also to deviate considerably from the shortest possible pathway in order to stay near caves. For Florida bats, a more direct route along the eastern Alabama border would have supplied abundant water but no caves. The shortest route, directly north, would have supplied neither. Myers (1964) observed a tendency for gray bats ... orient along rivers but also noted that they "do not of necessity follow stream valleys." Although Hall's (1962) contention that "major rivers are navigation routes for *M. sodalis*" is probably partly true, it is doubtful that this tendency to follow rivers can adequately account for isolation of populations as he has suggested, and it implies

extraordinarily lengthened migration routes that would proportionately increase the mortality cost of migration.

The summer to winter movements of colony 69 from northwest Florida to northern Alabama are of interest for additional reasons. Rice (1955b) reported seeing 4000 *M. grisescens* in a cool cave (cave 70 of this study) in northwest Florida in late October 1954 and speculated that *M. grisescens* might migrate into Florida from farther north in order to winter there (Rice, 1955a). Myers (1964) further speculated that gray bats in that area might hibernate in exposed places such as culverts, bridges or buildings, as was earlier described for *M. austroriparius* (Rice, 1957). My studies in that area clearly demonstrate that most adult females from Florida are migratory. However, rather than moving south as had been postulated, the vast majority hibernate in cave 44 far to the north. A few appear to use cave 21 and one was found 668 km north at cave 3. Assuming that it traveled the same route that is apparently used by other Florida bats (Fig. 9), this bat traveled more than 775 km.

The route between Florida and cave 44 requires a minimum movement of 437 km; however, based on recoveries plotted in Fig. 9, it is probable that the actual distance traveled by colony 69 to reach cave 44 requires more than 580 km of travel with a round trip of well over 1000 km. Movements reported for *Myotis* in Europe (Eisentraut, 1936; Bels, 1952; Gaisler and Hanák, 1969; Griffin, 1970) and in North America (Rice, 1957; Davis and Hitchcock, 1965; Hall and Wilson, 1966; Fenton, 1970; Humphrey and Cope, 1976) indicate most individuals travel less than 200 km one way between caves, that at least a few from many populations travel as far as 300 km, and that movements in excess of 500 km are very rare. The migration of colony 69 females to cave 44 is by far the longest regular movement pattern yet established for any North American species of the genus *Myotis*. A similar round trip from cave 21 would total more than 1390 km. Some juveniles and adult males also make these long migrations, but many juveniles and adult males appear to remain in Florida. Further analysis of data concerning differential behavior between sex and age groups, and speculations on the adaptive significance of the northward migration, will be presented elsewhere.

Cave 45 was visited for the purpose of banding only in late July and late August, contrary to the procedure followed for other banding caves in this study. This undoubtedly allowed samples there to include bats already moving toward cave 44 from other areas, and may in part explain the exceptionally wide distribution of summer recoveries from that cave. Wintering cave recoveries should not be biased by this factor. The 689 and 770 km movements of two adult males and one juvenile male from Alabama to Missouri, however, seem to represent disoriented wanderers (see Results—Patterns and Timing of Movements). Neither these nor the adult

female that reached cave 5 from Florida were ever found again, and these recoveries cannot be interpreted as regular movement patterns. Gunier (1971) reported an even longer movement by a displaced male *M. grisescens* which had been released in unfamiliar territory and later was recovered 1626 km north in South Dakota, far outside of the normal distribution of the species (Turner, 1974: 150, doubted Gunier's record). Humphrey and Cope (1976) similarly recorded several unusual movements of *M. lucifugus* which they considered to be the result of disorientation.

The general timing of spring and fall movements observed for gray bats in this study is in close agreement with observations of Hall and Wilson (1966) in Kentucky, and of Guthrie (1933) in Missouri for the same species. Hall and Wilson reported spring emergence in late March and early April, with arrivals at summer caves in the same period. I found females emerging earlier than males in successive years at four hibernating sites in Alabama, Kentucky and Tennessee both by sampling in the caves and by trapping emerging bats. Myers (1964) agreed with the general timing of emergence but stated "We have no information suggesting that one sex leaves before the other." Myers indicated, however, that he made only two trips per winter into hibernating caves, and that no samples of emerging bats were trapped during spring departure.

Others have found similar timing of spring emergence for *M. lucifugus* (Davis and Hitchcock, 1965; Humphrey and Cope, 1976) and for *M. sodalis* (Hall, 1962; Myers, 1964), and all but Myers noted earlier spring emergence of females. Both Guthrie (1933) and Myers (1964) agreed that males and females tend to travel separately; such segregation was especially apparent during my observations of migrating gray bats at cave 12. The slower spring emergence and movement in yearlings noted in my study, however, has not been observed previously.

Sexual segregation during the maternity period, with adult males and yearlings of both sexes (females are nonreproductive in their first year) roosting together in separate groups in other caves of the home area or, infrequently, in other parts of the maternity cave, also has been reported by Guthrie (1933), Rice (1955a) and Myers (1964). These bats formed nomadic bands which occasionally visited maternity caves but normally remained separate. They frequently changed roosts and often fell into daily torpor, unlike the lactating females and their young which tended to use a single roost and remain active during the day (Tuttle, 1975). Some of the possible selective advantages of this behavior would seem to be (1) reduction of intraspecific competition for food during a period of major energy stress on the adult females; (2) avoidance by males and nonreproductive females of the parasites that often become extremely abundant on long-occupied maternity roosts; (3) reduction of maintenance costs by males and nonreproductive females by choice of cooler roosts that foster increased frequency of torpor.

The late summer breakup of the maternity colony at cave 25 into small groups (which joined similar groups of males in caves 22, 23 and 30 along the Tennessee River) was also advantageous, both in reducing time spent traveling to and from feeding areas (Tuttle, 1976) and in further reducing the concentration of the population. Such behavior appeared to be less essential at caves 45 and 50, where seemingly ideal foraging habitat in the form of expansive shallow lagoons extended for many kilometers along the huge reservoir. Sexual segregation was continued to a greater extent throughout the summer at this colony. Although behavior similar to that observed for colony 25 was seen at many other locations, local movements appeared to be considerably restricted at localities 9 and 12, where few suitable alternative caves were available. Specific local movement behavior therefore could be expected to vary due to differences in numbers and kinds of caves available, distance from one to the next, and distance from the summer caves to foraging areas and hibernating caves.

Aggregation into a single large group containing nearly all members of colony 25, just prior to fall migration, may serve to aid young bats in finding their way to wintering caves. Myers (1964) observed similar behavior in gray bats in Missouri, and group movement in bats is well known (Griffin, 1970). Many juveniles, however, tend to remain behind for some time after most adults have left the summer area. Young bats may be lacking in feeding skill, and the extra time with reduced intraspecific competition may be of considerable survival value (Davis and Hitchcock, 1965; Kunz, 1974).

At no time were juveniles found alone, however, being always in the company of at least a few adult males. Davis and Hitchcock (1965) found that juvenile *M. lucifugus* lacked homing ability, and it would seem that the constant accompaniment of some adults undoubtedly increases the probability of young *M. grisescens* finding their way during migratory movements. This hypothesis is also in agreement with Hall (1962), who states that *M. sodalis* "must become familiar with certain areas by traveling with other bats." No evidence was found to support Myers' (1964) contention that fall migration took longer than spring migration.

The sex differences in timing of hibernation would seem to have significant adaptive value. Later entrance into hibernation by males allows them to remain in hibernation later, thereby reducing intraspecific competition for limited food resources in the following spring when energy demands on pregnant females are high and food is scarce; conversely, competition for food is reduced for the males in the fall when they are expending energy in breeding.

That I did not find winter movement in *M. grisescens* is con-

trary to Kunz' (1971) observations for *M. velifer*, in which a large number of such movements occurred. Most, however, were insignificantly short (under 2 km), and disturbance may have played a major role in altering normal behavior, as Kunz recognized. Also, these bats were using relatively small caves where fluctuating temperature could have forced frequent movements within or among caves in order to select an appropriate temperature range. Myers (1964) observed limited winter activity on warm evenings in Missouri and found one gray bat among individuals of four other species that were collected. I think such activity may be expected wherever bats hibernate in relatively small caves most exposed to outside climatic fluctuations. As Kunz (1971) has noted, it is most often males or juveniles that occupy these less favorable roosting places.

Rates of travel.—Movements of 15 to 35 km in a single night within the home range apparently are normal. Such movements, however, provide evidence only of the minimum distances traveled in a night. The adult female (7-32638) that traveled 207 km between caves 25 and 41 at a minimum speed of 52 km per night may well have completed her trip in half that time. The smaller *M. lucifugus* has homed 97 km in a single night, averaging speeds of 32 km per hour (Mueller and Emlen, 1957; Mueller, 1966); when traveling a familiar route from a roost to a lake maximum speeds of up to 36 km per hour have been recorded (Mueller, 1966). Humphrey and Cope (1976) reported movements of up to 60 km per night for the same species, and an *Eptesicus fuscus* covered 402 km in four nights for an average of 100 km per night (Cope *et al.*, 1960).

Kennedy and Best (1972) measured a flight speed of 18 km per hour in gray bats flying under confusing conditions in a cave. Patterson and Hardin (1969) and Mueller (1966), however, have demonstrated that bats flying in the open along familiar routes can travel as much as twice as fast as they do in enclosures. I several times observed groups of gray bats that, immediately following emergence, spiraled high into the sky and were lost to view up to 100 m above the ground. It seems quite possible that such bats find favorable air currents that aid in attaining speeds in excess of those normally observed near the ground. The females observed arriving at cave 58 at midnight on 21 April clearly could have flown 108 km from cave 53 in the five hours that had elapsed since emergence. In any case, the nearest known cave where any gray bats roosted was number 55, located 79 km northeast. At a speed of only 16 km per hour these bats easily could have covered the distance between 55 and 58, and the required 20.3 km per hour for the longer distance seems quite possible.

It would appear that, at least for adult females, fast migratory movement is likely; if migration were not direct and rapid, one would not expect to find the correlation between distance traveled and weight change noted in this study. Young bats and males, however, were more often captured during migration than were adult females, indicating that migration for these groups, especially for juveniles, may be considerably more leisurely than for adult females.

Weight comparisons.—Approximately 50 days elapsed between the last premigration weighings and sampling of hibernating bats at the two winter caves (Figs. 10 and 11). Because adult females appeared to migrate rapidly and, unlike adult males and many juveniles, went directly into hibernation after arrival, they were most readily compared for weight loss during migration. If the bats had hibernated during 48 of the 50 days (allowing two days for migratory travel), about 0.5 gm (at 0.01 gm/day; Tuttle, unpublished data) should have been lost in hibernation cost alone.

However, in addition to change from migratory weight loss, bats from each colony also could have continued to feed and gain weight for several days after the last weighing, before leaving for the wintering cave. That this may have occurred is indicated by the fact that colony 9, which traveled only 47 km to reach cave 5, showed a slight gain in weight over the observed period. Clearly, then, even the results presented in Fig. 10 are of value only in pointing out the approximate relative cost of distance traveled, and do not reflect absolute costs. Whatever the true weight loss, it is apparent that colony 25, which travels 204 km in migration to cave 5, loses significantly more weight than does colony 12, which travels 84 km. Since adult female gray bats normally lose approximately 2-3 gms during winter hibernation in cave 5 (Tuttle, unpublished data), any considerable loss during migration must present a major selective disadvantage. Similar relative losses, correlated with distance traveled, also are evident in Fig. 11.

Clearly, the distance from a summer cave to the nearest available winter cave must be an important factor in determining gray bat success and distribution. This is made even more apparent when one considers that migratory energy expenditure is repeated again in the spring when energy reserves are low and feeding more difficult. The high energy demands at that time may account for the significant differences in midwinter weights observed at cave 5; although losing more weight during migration, colony 25 mean weight at midwinter was 0.4 gm above that of colony 12. There may be minimum weights below which energy reserves for return migration are inadequate, and the higher average midwinter weights for bats from colony 25 undoubtedly enhance survival probabilities in the following spring. It follows, then, that in order to withstand the considerable energy drain of migration, colony 25 must be relatively more successful in gaining weight at its summer colony site than is necessary for colonies 9 and 12. That this is so

is demonstrated by the colony 25 mean fall departure weight, which is more than 1 gm heavier than similar means recorded for colonies 9 and 12. Postflight growth data further substantiate this point (Tuttle, 1976).

The apparent lack of correlation between mean weights of adult females following migration to wintering caves 5 and 44 and distance traveled in migration (see Results—Cost of Travel, Migratory weight loss) seems to conflict with the hypothesis that a fat reserve proportional to the distance of spring migration is essential. However, for all colonies except 69, I believe this is primarily due to the small sizes of the post-migration samples. The midwinter samples of adult females taken in 1974 (which did show the predicted correlation between weight and distance) were much larger than the post-migration samples. Moreover, a significant relationship was found in 1970 for post-migration samples from colonies 9, 12 and 25 when males and females of all ages were combined, thereby increasing sample size.

Inadequate sampling may also have obscured post-migration weight differences for colony 69. On the other hand, although these Florida bats lose a great deal of weight in fall migration (see Results—Cost of Travel, Migratory weight loss; Fig. 11), they may not require as much fat reserve prior to spring migration due to the relatively greater abundance of food available to them as they fly south.

The discrepancy between results obtained from caves 45 and 50 (Fig. 11), each occupied by a portion of the same colony, may be only a reflection of the difficulty encountered in sampling at the latter site. At the time of the last fall sample there, rough water at the cave entrance (located in a steep reservoir bank) prevented trapping efforts until nearly all bats had emerged. If any tendency existed for the heaviest females, which might be less agile fliers at that time, to exit last then this might account for the fact that the mean weight for that sample was 0.4 gm heavier than that found at cave 45. At cave 45 the trapped sample included females from the entire emergence period. If sampling bias is assumed and the 0.4 gm difference is subtracted from the cave 50 sample before calculating weight loss, the resulting 1.7 gm loss in migration fits well with the remaining points. As already noted, the comparison in this figure between the mean of the heaviest 10% of pre-migration weights with the mean of the heaviest 25% post-migration bats results in an exaggerated weight loss for all localities. Although this does not detract from the validity of the comparison among colonies in Fig. 11, it does make comparison between values in Figs. 10 and 11 impossible.

Seasonal adaptive strategies.—The widespread occurrence of similar movement and behavior patterns among a variety of European and North American species of temperate, cave-dwelling

Myotis cannot be the result of mere coincidence. The adaptive nature of these patterns is well illustrated by the findings of Dwyer (1966) regarding Australian *Miniopterus schreibersi*, a distantly related bat species. In his detailed study of population patterns and movements of this species, Dwyer reported on a wide variety of behavior bearing striking similarity to that of *M. grisescens*. Dwyer noted the dominant role of cave temperature in determining patterns of movement and aggregation, and observed adaptive responses that were markedly like those of *M. grisescens*. These include: (1) seasonal migration between warm maternity and cold hibernal caves; (2) apparent segregated spring migration of females; (3) marked philopatry, with seasonal variation correlated with sex and age; (4) formation of maternity colonies that serve as focal points for smaller non-maternity groups within what appear to be home range areas; (5) restriction of migratory movements to the minimal distance necessary to reach a site that satisfies physiological needs. (For additional comparisons, see Tuttle, 1975, 1976.)

In observations on birds in fields, Cody (1974) has emphasized that extensive similarities or convergences between unrelated species, separated geographically but facing similar environmental demands, indicate that "selection has reached optimal solutions in both fields despite differences in history, time scale, and genetic origins." He further suggests that "there is reason to believe that there is a single optimal way of dividing up the resources of this kind of field, and that it has been achieved or at least approximated to the same extent, on both continents." His comparisons of similar fields utilized by birds in Chile and Kansas seem to me to be highly applicable to the similar demands which cave habitation places on both *Myotis grisescens* and *Miniopterus schreibersi*. By his definition, then, both populations may be considered to have approached optimal utilization of their habitat.

In this and other papers I have attempted to discuss some of the major selective forces operating on gray bat populations. The distance between summer roosts and feeding grounds was found to constitute one of the most significant factors affecting success (Tuttle, 1976). This is intuitively obvious when the correlation between locations of caves occupied by gray bats and major rivers or reservoirs is noted, and was supported by the significant differential success found for newly volant young according to the distance to feeding areas. Cave temperatures, more particularly the capacity of roosts to trap heat, were found to have a major impact on growth rates of preflight young (Tuttle, 1975) during summer occupation. Furthermore, entirely different temperature conditions have been observed to be required for hibernation (cold caves to facilitate torpor), necessitating seasonal movements between summer and winter sites.

The aggregation of large numbers of bats at maternity caves

was found to contribute greatly toward production of the heat necessary for growth, and it was apparent that reduction of colony size below certain limits was detrimental (Tuttle, 1975). It is obvious, however, that there is also an upper limit to colony size beyond which increasing numbers are no longer advantageous. This limit may be determined primarily by the abundance of food resources available to the colony. Dwyer (1966) has discussed the nature of this possible intraspecific competition well. Finally, the distance a colony has to travel to a hibernating site produces definite pressure for increasing summer colony success proportional to distance.

From the above information, it should be possible to formulate a word model that will predict gray bat success and distribution. This model requires that suboptimal conditions in any of the described factors that are limiting to the population must be compensated for by lowered stress in other factors and, further, that greatest population size and/or growth rate can be expected when all factors affecting one colony approach optimal conditions. A number of colonies in this study provided indications of the validity of some predictions resulting from this model. Colonies 9 and 12, for example, were found to face stressful summer conditions (Tuttle, 1975, 1976): long distance traveled for nightly foraging and low cave temperature, respectively. These colonies were able to survive, I believe, because migration stress was minimized by their proximity to the hibernation site. Conversely, I believe Florida bats to be able to make such long migratory movements only because of the ideal conditions of their summer home. Florida caves, initially warmer than northern caves, also have exceptional heat-trapping qualities. Gray bats augment this by clustering with large numbers of *M. austroriparius* in high domes, thereby profiting from the body heat of the other species as well. As a result, summer growth success is exceptionally good. Further, a large food supply is readily available and, most importantly, already is abundant by the time of spring arrival from hibernation, when energy needs are high. Few sites in the north combine so many advantages supporting long migratory movements.

Finally, at colony 50, high cave temperatures, abundant foraging habitat, and the presence of a hibernating cave in close proximity to the summer caves have resulted in the largest known colony of gray bats. Approximately a half million bats are found in the caves used by colony 50, and it is doubtful that less favorable conditions would support a population that size. I believe that this model for predicting gray bat success and distribution may be found widely applicable to other populations of cave bats as well.

Acknowledgements.—This paper represents a part of a Ph.D. dissertation under the guidance of Robert S. Hoffmann, Department of Systematics and Ecology, The University of Kansas. W. Wilson Baker, Carl G. Craig, John A. French, Kenneth W. and Katherine Gregg, James E. Hall, James H. Johnston, Jr., David S. Lee, D. Bruce Means, Jan A. J. Nel, Paul B. Robertson, Roger A. Sanderson, David H. Snyder, Archer D. Swank, John Van Swearingen IV, William W. Torode, Horace L. Tuttle, and Brad Williamson assisted me in the field. Other hospitalities were extended by Joseph C. Howell, Frances Johnston, Patrick M. Moran, Donal R. Myrick, Lynne M. Swank, and John Van Swearingen III. Mark B. Katz and Diane E. Stevenson provided assistance in data analysis and made editorial suggestions. Thomas H. Kunz and Richard J. Wassersug also criticized the manuscript, and Norman A. Slade furnished advice on statistical matters.

Field work was supported by grants from the Kansas Academy of Sciences, the Committee on Systematics and Evolutionary Biology (N.S.F. grant GB 4446X1 to J. Knox Jones), the Watkins Museum of Natural History Grants, and the Biomedical Sciences Support Grants, all administered through the University of Kansas; the Theodore Roosevelt Memorial Fund of the American Museum of Natural History, and the Ralph W. Stone Graduate Research Award of the National Speleological Society. Computer time was made available through the University of Kansas Computation Center.

Literature Cited

Beer, L. 1952. Fifteen years of bat banding in the Netherlands. Publ. Natuurhist. Genootschap Limburg (Maastricht), 5:1-99.

Climatological Data, Florida, Annual Summary. 1970. United States Department of Commerce Publ., vol. 74, 168 pp.

Climatological Data, Tennessee, Annual Summary. 1970. United States Department of Commerce Publ., vol. 75, 160 pp.

Cody, M. L. 1974. Optimization in ecology. Science, 183:1156-1164.

Cope, J. B., Koontz, K., Churchwell, E. 1960. Notes on the homing of two species of bats. Proc. Indiana Acad. Sci., 70:270-274.

Davis, W. H., Hitchcock, H. B. 1965. Biology and migration of the bat, *Myotis lucifugus*, in New England. J. Mamm., 46:296-313.

Dunnigan, P. B., Fitch, J. H. 1967. Seasonal movements and population fluctuations of the cave bat (*Myotis velifer*) in south-central Kansas. Trans. Kans. Acad. Sci., 70:210-218.

Dwyer, P. D. 1966. The population pattern of *Miniopterus schreibersi* (Chiroptera) in north-eastern New South Wales. Aust. J. Zool., 14: 1073-1137.

Eisentraut, M. 1936. Ergebnisse der Fledermausberingung nach dreijahriger Versuchzeit. Z. Morphol. Oekol. Tiere, 31:1-26.

Fenton, M. B. 1970. Population studies of *Myotis lucifugus* (Chiroptera: Vespertilionidae) in Ontario. Life Sci. Contrib., Roy. Ontario Mus., 77:1-34.

Gaisler J., Hanák, V. 1969. Summary of the results of bat-banding in Czechoslovakia, 1948-1967. Lynx, 10:25-34.

Griffin, D. R. 1945. Travels of banded cave bats. J. Mamm., 26:15-23.

Griffin, D. R. 1970. Migrations and homing of bats. Pp. 233-264, *in Biology of Bats* (W. A. Wimsatt, Ed.), Academic Press, New York.

Gunier, W. J. 1971. Long-distance record for movement of a gray bat. Bat Res. News, 12:5.

GUTHRIE, M. J. 1933. Notes on the seasonal movements and habits of some cave bats. J. Mamm., 14:1-19.

HALL, J. S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Sci. Publ., Reading Public Mus. Art Gallery, 12:1-68.

HALL, J. S., WILSON, N. 1966. Seasonal populations and movements of the gray bat in the Kentucky area. Amer. Midland Nat., 75:317-324.

HUMPHREY, S. R., COPE, J. B. 1976. Population ecology of the little brown bat, *Myotis lucifugus*, in Indiana and north-central Kentucky. Amer. Soc. Mamm., Spec. Publ., No. 4:1-81.

KENNEDY, M. L., BEST, T. L. 1972. Flight speed of the gray bat, *Myotis grisescens*. Amer. Midland Nat., 88:254-255.

KUNZ, T. H. 1971. Ecology of the cave bat, *Myotis velifer*, in south-central Kansas and northwestern Oklahoma. Ph.D. dissertation. The University of Kansas, 148 pp.

KUNZ, T. H. 1974. Feeding ecology of a temperate insectivorous bat (*Myotis velifer*). Ecology, 55:693-711.

MUELLER, H. C. 1966. Homing and distance orientation in bats. Z. Tierpsychol., 23:403-421.

MUELLER, H. C., EMLEN, J. T., Jr. 1957. Homing in bats. Science, 126: 307-308.

MYERS, R. F. 1964. Ecology of three species of myotine bats in the Ozark Plateau. Ph.D. dissertation. Univ. of Missouri, 210 pp.

PATTERSON, A. P., HARDIN, J. W. 1969. Flight speeds of five species of vespertilionid bats. J. Mamm., 50:152-153.

RICE, D. W. 1955a. Status of *Myotis grisescens* in Florida. J. Mamm., 36: 289-290.

RICE, D. W. 1955b. *Myotis keeni* in Florida. J. Mamm., 36:567.

RICE, D. W. 1957. Life history and ecology of *Myotis austroriparius* in Florida. J. Mamm., 38:15-32.

STOKES, J. 1972. Alabama cave density map. Huntsville Grotto Newsletter, 13:66-67.

TINKLE, D. W., PATTERSON, I. G. 1965. A study of hibernating populations of *Myotis velifer* in northwestern Texas. J. Mamm., 46:612-633.

TURNER, R. W. 1974. Mammals of the Black Hills of South Dakota and Wyoming. Misc. Publ., Univ. Kans., No. 60, pp. 1-178.

TUTTLE, M. D. 1974. An improved trap for bats. J. Mamm., 55:475-477.

TUTTLE, M.D. 1975. Population ecology of the gray bat (*Myotis grisescens*): Factors influencing early growth and development. Occ. Pap. Mus. Nat. Hist., Univ. Kans., No. 36, pp. 1-24.

TUTTLE, M. D. 1976. Population ecology of the gray bat (*Myotis grisescens*): Factors influencing growth and survival of newly volant young. Ecology, 57:in press.

TUTTLE, M. D., STEVENSON, D. E. 1976. An analysis of migration as a mortality factor in the gray bat based on public recoveries of banded bats. Amer. Midland Nat., in press.

TWENTE, J. W., Jr. 1955. Some aspects of habitat selection and other behavior of cavern-dwelling bats. Ecology, 36:706-732.

UNIVERSITY OF KANSAS PUBLICATIONS

MUSEUM OF NATURAL HISTORY

The University of Kansas Publications, Museum of Natural History, beginning with volume 1 in 1946, was discontinued with volume 20 in 1971. Shorter research papers formerly published in the above series are now published as Occasional Papers, Museum of Natural History. The Miscellaneous Publications, Museum of Natural History, began with number 1 in 1946. Longer research papers are published in that series. Monographs of the Museum of Natural History were initiated in 1970. All manuscripts are subject to critical review by intra- and extramural specialists; final acceptance is at the discretion of the publications committee.

Institutional libraries interested in exchanging publications may obtain the Occasional Papers and Miscellaneous Publications by addressing the Exchange Librarian, University of Kansas Library, Lawrence, Kansas 66045. Individuals may purchase separate numbers of all series. Prices may be obtained upon request addressed to Publications Secretary, Museum of Natural History, University of Kansas, Lawrence, Kansas 66045.

PRINTED BY
UNIVERSITY OF KANSAS PRINTING SERVICE
LAWRENCE, KANSAS

2.2.8 Section 2.7.1 Reference 6R

REFERENCE 2-23

TELEPHONE CONFERENCE MEMORANDUM

IA-2418

DATE 4/5/79

☐ INCOMING ☐ OUTGOING C.O. G.O.

WITH MR. Dr. Stephen Humphrey OF THE Florida State Museum

WITH MR. OF THE

COPIES TO: J. F. Eveland

D. W. Meyers

H. K. Roffman

SUBJECT: Indiana bat ecology TIME 5:25 p.m.

COST

FILE N-144 CHARGE

DETAIL OF CONFERENCE

Steve Humphrey, the expert on the Indiana bat, returned my call. Steve reported that the Indiana bat winters in caves from September to early April. The females leave caves first and migrate to summer habitat where young are born and raised. Males may remain near the winter caves for a few weeks before they too begin migrating. Summer habitat includes nesting, dead trees and cavities in live trees near a creek and forested, feeding habitat within one-quarter mile. Summer nesting habitat consists of pure or mixed stands of sycamore, cottonwood and willow in a moderately to dense stand on creek margins.

Indiana bat diet is entirely insects. The young first feed on aquatic flies and then switch to beetles, the main adult bat food source. They forage in forest canopies and along narrow stream courses. The best time to observe them is in early to late June. A mist net can be placed beneath an overhanging sycamore across a small stream. The 1977 volume of the Journal of Mammalogy (Volume 58, pp. 334-346) contains one of Steve Humphrey's publications on foraging habitat.

We discussed habitat available in northeastern Kentucky. Steve believes the Indiana bat is likely to remain near the winter caves in significant numbers (several hundred to several thousand).

Steve will send reprints of winter and summer Indiana bat habits.

A biologist in Indiana doing consulting work with bats may be interested in bat mist-netting on a consulting basis. He is James B. Cope at Joseph Moore Museum, Earlham College, Richmond, Indiana 47374. He presently is located at Conner Prairie Musuem (phone - 317-773-3633).

J. R. Bainbridge

DEPT. EXT. NO.

Teleconference
w/Dr. S. Humphrey
April 5, 1979

We discussed winter cave conditions and expected success of a cave search for Indiana bat. Best cave conditions are a basin-like large cavern where cold fall and winter air settles and remains over winter. Spring bat emergence depends on gradual warming of this cool air mass to a specific set-temperature. The bats emerge when air in their cavern reaches this temperature. Once the bats leave a cave, positive identification of their presence is not possible from a simple cave search.

W. A. Beimborn
Terrestrial Ecologist
RESOURCE ANALYSIS

pam

Bats of America

Roger W. Barbour &

Wayne H. Davis

The University Press of Kentucky

TO

Bernice & Shirley

Standard Book Number: 8131-1196-2
Library of Congress
Catalog Card Number 77-90856

A statewide cooperative scholarly publishing agency
serving Berea College, Centre College of Kentucky,
Eastern Kentucky University, Kentucky State
College, Morehead State University, Murray State
University, University of Kentucky, University of
Louisville, and Western Kentucky University
Editorial and Sales Offices:
Lexington, Kentucky 40506

spicuous parasites; most of the bats harbor several (Rice, 1957).

Remarks. Apparently most of the caves in central Florida are too warm (69 to 73° F.; 21°-23° C.) to be suitable as hibernation sites for this species. If the bats remained active during the winter, they would suffer in cold spells when flying insects were scarce. Probably the few active individuals occasionally found in the maternity caves in winter are transients.

At Gainesville they are residents about the sewage disposal ponds of the University of Florida where they are so abundant as to be easily captured with an insect net. They may be found any evening when it is warm enough for insects to fly. Apparently the bats reside in the large concrete drain tiles which connect the ponds.

The population of *M. austroriparius* in the lower Ohio River Valley is apparently isolated from the remainder of the species. It is known only from a few caves in Indiana, Illinois, and Kentucky, where its numbers have been steadily declining. Apparently, this race is nearing extinction.

One of us (WHD) observed a colony of this race in a cave beside the Ohio River in Hardin County, Illinois, on November 29, 1953. The bats were in a tightly packed cluster on the ceiling within easy reach. When gathered for banding they were found to be torpid. There were 120 bats in the cluster, 55 percent of which were males.

MYOTIS GRISESCENS [Howell]

Gray myotis; gray bat; Howell's bat; cave bat

Recognition. Forearm, 40–46 mm.; wingspread, 275–300 mm. A large, big footed (12 mm.) *Myotis*. The wing membrane is attached to the foot at the ankle (fig. 28). Calcar not keeled. A distinct sagittal crest on the skull. Color, uniformly gray from base to tip of hair; occasionally russet.

Confusing Species. Most likely to be confused with *Myotis lucifugus*, *Myotis sodalis*, *Myotis austroriparius* and *Myotis keenii*. From all of these, it may be recognized by the uniformly colored fur; all others have the base and tip of the fur in contrasting shades. Also, the attachment of the wing membrane is unique.

28. Feet of *Myotis* showing attachment of the membranes. Left, *Myotis grisescens*, showing attachment at the ankle. Right, attachment at the base of the toe, as seen in other species of *Myotis*.

29. *Myotis grisescens* at Mammoth Cave National Park, Kentucky.

Range: Concentrated in the cave region of Missouri, Kentucky, Tennessee, and Alabama. Occasional colonies and stragglers occur in adjacent states. Summer and winter range identical.

Habitat: *Myotis grisescens* is almost unknown outside of caves. Most banding recoveries represent individuals that have encountered mishap in transit from one cave to another. No mine has yet been found harboring the species. Wilson Baker has found a few transients in a tunnel on the campus of the University of Georgia. A small maternity colony occupies a storm sewer in Pittsburg, Kansas (Hays and Bingman, 1964).

Thomas C. Barr, Jr., who has probably seen more summer colonies of *M. grisescens* than anyone else, has generalized for us the requirements of this species. He finds the maternity colonies nearly always in rather large caves containing substantial streams. With few exceptions, the colonies are accessible only by boat or by wading deep water.

The species winters in caves; apparently almost the entire population hibernates in five or six major caves.

Reproduction: The males become reproductively active in autumn. Sperm is found in the testes and tubules in October and November and persists until May. Copulation occurs in late fall. Some females have sperm in the uteri as early as October; specimens taken November 11 and December 3 contained many active spermatozoa (Guthrie, 1933b).

In summer *M. grisescens* forms maternity colonies of from a few hundred to a quarter of a million individuals in many large caves in the central part of the eastern United States. Here the bats and their young form great masses clustered on the ceiling. The bats are intolerant of disturbance and take flight in mass when a light is turned on the cluster. Repeated disturbance causes them to move to remote regions of the cave or to abandon it.

Guthrie (1933b) found that in Missouri pregnant and lactating females could be found together in summer. Females in their second summer were nonparous and were rarely in the maternity colonies; more frequently they were with the males in another area of the cave.

Sometime during June a female produces a single young. She rarely carries it, normally leaving it in the cave when going out to feed.

Migration: In autumn the colonies disband and leave the caves where the young were raised. Only rarely are a few found in winter in these caves. Until the work of Richard Myers in Missouri in the late 1950s the winter home of *M. grisescens* was unknown. He discovered three caves where they collect from widely scattered areas to hibernate. More recently John Hall discovered such a cave in Kentucky and Merlin Tuttle one in eastern Tennessee. Probably another great wintering cave exists somewhere in that state. Scalander (1956) found small groups of *M. grisescens* wintering in Arkansas.

Evidence suggests that these bats travel in flocks between summer and winter caves. Tuttle followed their movements from several scattered summer colonies to the wintering cave near Rogersville in northeastern Tennessee. Bats came from as far as 150 miles. He observed bats at a cave near Concord, Tennessee, which seems to serve as a rest stop for transients. This cave often contained 500 to 2,000 *M. grisescens* during the day in spring and fall. Sometimes bats were absent during these seasons. Once during the spring of 1961 he visited this cave and found no bats. Returning that night at 11:00 p.m., he was surprised to find several thousand gray bats. Next day all were gone. Smith and Parmalee (1954) found a cluster of hundreds in an Illinois cave on October 1. None was seen there on June 25, and none could be found in December.

Hall and Wilson (1966) found that bats from summer colonies scattered over about 10,500 square miles of Kentucky, southern Illinois, and Tennessee migrated to a cave in Edmonson County, Kentucky, to hibernate.

Hibernation: Hall (1962) described the clusters of 100,000 gray bats which used to hibernate in Coach Cave, Kentucky. They formed great mats several tiers thick on the ceiling. The forearms of the bats, instead of being held parallel to the body as in other species, stuck out at sharp angles making the cluster appear interwoven.

The gray bats chose areas slightly warmer (45°–50° F.; 7°–10° C.) than those chosen by *M. sodalis*. However there was some area of overlap between the species and in these areas the *M. grisescens* would sometimes hang directly on the clusters of *M. sodalis*.

50. Part of the nursery colony of *Myotis grisescens* at Santa Cave, Alabama. This is the largest known colony of the species, estimated at about 200,000 individuals. *Courtesy of Lyle G. Conrad.)*

Parasites: Ubelaker (1966) found three species of mites, one species of flea, and one species of streblid fly in a summer colony in Kansas. Among internal parasites he found four species of trematodes, two kinds of nematodes, and one cestode.

Remarks: The large winter colonies of *M. grisescens* are in deep caves accessible only by use of the elaborate gear needed for vertical cave work. These colonies were long unknown because they were so inaccessible; however, in the last few years human disturbance has threatened the very existence of the species. Cave exploring has become extremely popular in recent years and vertical pits are an intriguing challenge. One of the wintering caves in Missouri has become very popular with spelunkers. Another is commercialized and stocked as a fallout shelter; the owner wants to get rid of the bats. The cave in which *M. grisescens* of Kentucky and Illinois hibernate has recently been commercialized apparently resulting in the loss of this population. Hall and Wilson (1966) located several maternity colonies in this area in the late 1950s, but the bats were not present in the summers of 1963 and 1964.

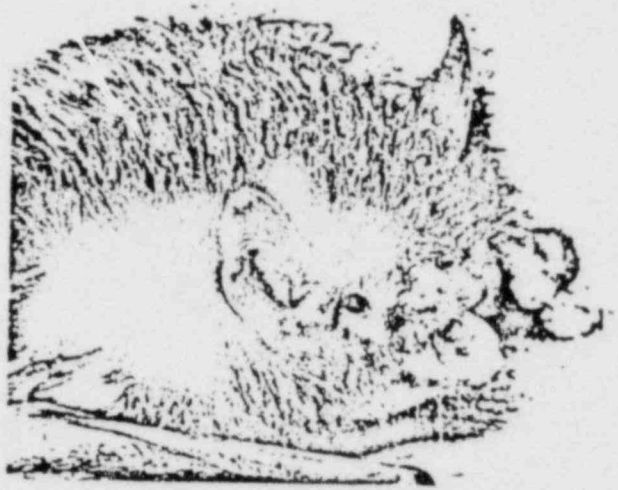
Summer colonies of this species are also receiving ever increasing harassment. The largest known colony (200,000–500,000) inhabits Santa Cave in Alabama. This cave has been converted into a fallout shelter and is being commercialized. The bats were present as late as 1967 but their fate is uncertain. Old Nickajack Cave, the type locality and one of the best known colonies of *M. grisescens*, is being destroyed. The Tennessee Valley Authority has built a dam which will flood the cave.

Thus it seems that *M. grisescens* is destined to continue a rapid decline in numbers and probably faces extinction. It should be on the list of rare and vanishing species. No cave regularly inhabited by this species is protected. Mammoth Cave National Park, which currently protects about 100,000 *M. sodalis* in winter, serves as a shelter for only a few transient *M. grisescens*.

Skull of *Myotis grisescens*, x3

Distribution of *Myotis grisescens*

42. Keeled calcar of *Myotis sodalis*



43. *Myotis sodalis*. Compare the pale nose with *M. lucifugus*, fig. 13.

MYOTIS SODALIS Miller and Allen

Indiana myotis; Indiana bat; social bat

Recognition: Forearm, 35–41 mm.; wing-spread, 240–267 mm. A medium sized *Myotis* of the eastern United States. Foot rather small (9 mm.). The calcar has a slight keel (fig. 42). Color, dark gray, usually nearly black, sometimes brownish. Fur dull, not glossy.

Confusing Species: *Myotis lucifugus* has long hairs on the toes (fig. 14), no keel on the calcar, a slightly larger foot (10 mm.), and usually a glossy sheen to the fur. *Myotis grisescens* has fur the same color from tip to base and a large foot with an unusual membrane attachment (fig. 28). *Myotis austroriparius* has long hairs on the toes and a slightly larger foot (10 mm.). *Myotis keenii* has longer ears (17–19 versus 15 mm.). *Myotis leibii* is smaller. *Pipistrellus subflavus* is smaller, with a light-colored forearm and usually paler, tricolored fur.

Range: Eastern United States, from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida. In summer, apparently absent south of Tennessee; in winter, apparently absent from Michigan, Ohio, and northern Indiana where suitable caves and mines are unknown.

Habitat: *Myotis sodalis* is known primarily from the caves in which it hibernates. In winter it congregates by the thousands in tightly-packed clusters in the relatively few caves and mines which it finds suitable to its needs. Two caves in Kentucky and a cave and a mine in Missouri each harbor about 100,000 in winter, accounting for about 90 percent of the known

population of the species; the rest occur in groups of from a dozen to a few thousand in several dozen caves and mines.

Summer records are rather scarce; no breeding colonies are known. A few males inhabit caves in Kentucky and neighboring states. Occasional individuals have been encountered under a bridge, beneath the bark of a tree, and in buildings. We have reason to believe that they do not commonly inhabit buildings. The recovery rate of banded individuals is very low, compared to the recovery rate for the attic dwelling *M. lucifugus*. If *M. sodalis* regularly lived in buildings, surely more would be encountered.

Although no breeding colonies are known, likely the nursery retreats are in rather cool places. *M. sodalis* is much less tolerant of high temperatures than is *M. lucifugus* which resides in extremely hot attics in summer. Body temperatures of 93–95° F. (34–35° C.) are frequently fatal to *M. sodalis*, whereas *M. lucifugus* can tolerate body temperatures at least 18° F. (10° C.) higher (Henshaw and Folk, 1966). Our guess is that most *M. sodalis* spend the summer singly or in small groups in hollow trees or beneath loose bark.

Reproduction: *M. sodalis* breeds in the caves in fall. At Bat Cave in Kentucky most breeding occurs during about 10 days in early October. At night the bats scatter in pairs over the ceiling of the cave where they can be seen copulating by the hundreds. The breeding occurs mostly in a large room near the upper entrance to the cave. During the day the bats cluster at several localities within the cave and the sexes are almost completely segregated. The males form clusters in the breeding room and the females at the other end of the cave, about 3,000 feet away.

M. sodalis seems to have a more definite mating season than *M. lucifugus*, which commonly breeds throughout the winter. Only occasional *M. sodalis* breed in winter. Hall (1962) noted limited mating activity in late April as the bats were leaving hibernation.

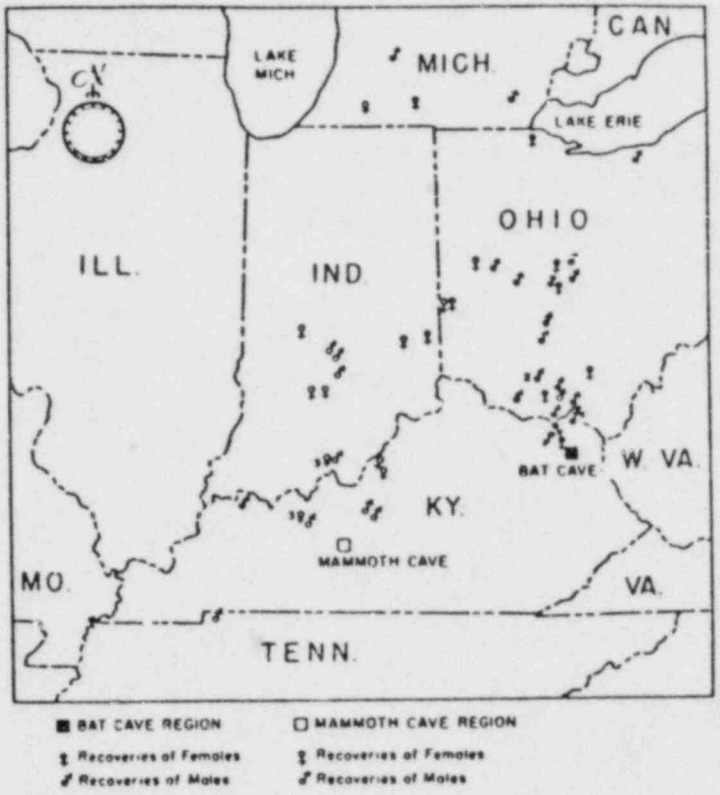
The scant data available suggest that *M. sodalis* produces a single young in the latter part of June. Nothing is known of parturition or development. The only record of a pregnant *M. sodalis* is of one shot as she flew along the edge of a small woodlot on June 18 in northern Indiana. She was carrying a single large embryo (Mumford and Calvert, 1960).

Several immature *M. sodalis* have been taken from beneath a concrete bridge in Indiana. The youngest seen there was captured on July 24. It is questionable whether or not it could fly. Three larger young were captured there on July 27, five years later (Mumford and Cope, 1958).

Migration: The colony of about 100,000 *M. sodalis* hibernating in Bat Cave, Carter Caves State Park, Kentucky, begins to disperse in late March. The females begin leaving first to go to their summering grounds to the northwest. The greatest exodus occurs in late April when nearly half the population leaves within a week. By the end of the first week of May the cave is vacant. A few males usually remain in the vicinity, and can be netted at the cave entrance at night. Most males, however, migrate to the northwest.

In Mammoth Cave National Park where about 100,000 *M. sodalis* also hibernate, several hundred males spend the summer. Hall (1962) found that these formed an active band which wandered about from cave to cave in the area throughout the summer. Such groups also occur in the caves in Missouri.

Although recovery rates for banded bats of this species are low, enough have been banded in Kentucky to determine an approximate migration pattern. After leaving the caves in spring the females and nearly all of the males move northward and occupy Indiana, the western half of Ohio, and southern Michigan (fig. 44).



44. Summer distribution of *Myotis sodalis* which winter in two of Kentucky's cave regions, based upon recoveries of banded individuals. Numbers indicate multiple recoveries from the same locality.

Migrants next appear in numbers during August when nocturnal swarming occurs at the caves. Bats appear at some caves by the hundreds; a net tended all night at the mouth of such a cave may yield nearly a thousand. At this time the population of a cave has almost a complete turnover each day, and only rarely is an individual recaptured at the same cave. It is not known where the bats go after leaving the caves. However, one which was netted at Dixon Cave, Kentucky, the night of September 2 was captured in a barn over 300 miles away in Michigan on September 20. Many of the bats appearing in August can later be found hibernating in various caves in the area.

The wintering population begins to build up in mid-September, and by late November the great mass of bats has settled for the winter. A few straggle in through December.

Homing: That *M. sodalis* has remarkable navigational abilities has been established by several workers. Hassell and Harvey (1965) took groups of 500 from Bat Cave, Kentucky, and released them simultaneously at distances of 200 miles north, south and west of the cave. Two-thirds of the bats from the northern locality were recaptured at the cave, nearly as many as among controls banded and released there. However, that release locality was within the normal summer range, and the bats might be expected to be familiar with the area. Much more remarkable was the recovery of nearly a third of those released south of the cave in North Carolina across the Smoky Mountains, outside the normal range of this population. The recapture of these bats at the cave strongly suggests that they were able to orient and navigate over many miles of rugged, unfamiliar territory. From the western release point only 16 percent of the bats were recaptured at the cave. Possibly the bats can orient better on a north-south axis when in unfamiliar territory.

Hassell (1963) released groups of bats at 12-mile intervals west of the cave at distances up to 144 miles. Some bats returned from all sites, but percentages decreased with distance from 68 percent at 12 miles to 4 percent at 144 miles. We have recently found that the return percentage from the north is essentially unrelated to distance, at least up to 200 miles.

The high rate of return over the rugged and apparently totally unfamiliar territory to the south of the cave poses some interesting questions. How do the bats know which direction they need to go and how do they maintain a course? That they know where they are going is evident from the time lapse; many returned within the first week. That they are accurate in navigation is suggested by the recovery of one bat released in North Carolina and recovered 54 days later near Virgie, Kentucky, on November 28. This locality is roughly half way between the release point and the cave and precisely on a line between the two.

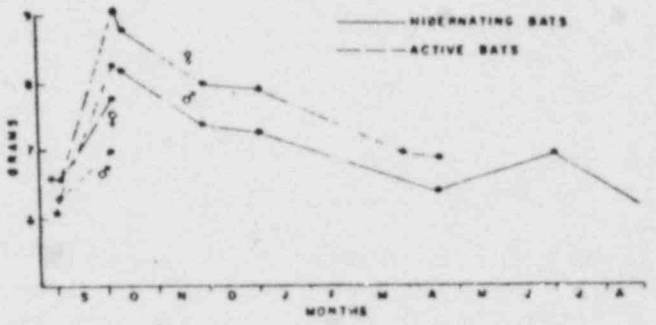
We have investigated the vision of the bats as a possible clue to their navigational abilities. Laboratory tests showed that they can see and that they use their eyes in flight (Davis and Barbour, 1965). Further, we were unable to demonstrate homing of blinded bats from 125 and 200 miles north of the cave (Barbour *et al.*, 1966). More recent experiments, however, have shown that blinded bats can return to the cave from distances of 5, 15, 25, and 40 miles to the north. Return percentages were not as high as controls, and it took the blinded bats longer to return.

Hibernation: *M. sodalis* enters the hibernation caves in the fall. Hassell (1967) found that when they first entered Bat Cave in Kentucky they roosted in the warmest parts of the cave. Many bats became active and left the cave nightly to feed during September and October.

Hall (1962) found that they put on most of their fat after they had arrived at the caves. Weight was minimal about the first of September and the deposition of fat preparatory to hibernation occurred during that month (fig. 45). This contrasts to *M. lucifugus* which becomes very fat by the second week in August. Perhaps *M. sodalis* uses its stored fat during its migration from summer to winter home and must deposit more for the hibernation period.

Hassell (1967) found that the bats moved down a temperature gradient in the cave as the autumn progressed with ever more bats congregating at the wintering site in the colder part of the cave. The clusters form at the same spots on the cave walls and ceilings year after year, such spots can be recognized by brown stains.

The sites favored for hibernation are places in the caves where the temperature averages 37°–43° F. (3°–6° C.) in midwinter (Hall, 1962; Henshaw and Folk, 1966). Temperatures in this range probably require minimum expenditure of energy (Davis and Reite, 1967). In Bat Cave, Kentucky, the temperature where the clusters form ranges from 29°–48° F. (–1.6°–9.2° C.) during December, January, and February, with an average



45. Weight changes of *Myotis sodalis* throughout the year. Each dot represents the average weight of 50 or more bats taken in a cave in Edmonson County, Kentucky. From Hall (1962).

46. Typical hibernating cluster of *Myotis sodalis*.

47. Clusters of *Myotis sodalis* hibernating in Bat Cave, Kentucky. Bands are evident on several bats.

of about 42° F. (5.6° C.). When the temperature drops below freezing this bat, like several others, responds by increasing its metabolism sufficiently to maintain its temperature a few degrees above that of the environment (Henshaw and Folk, 1966; Davis and Reite, 1967).

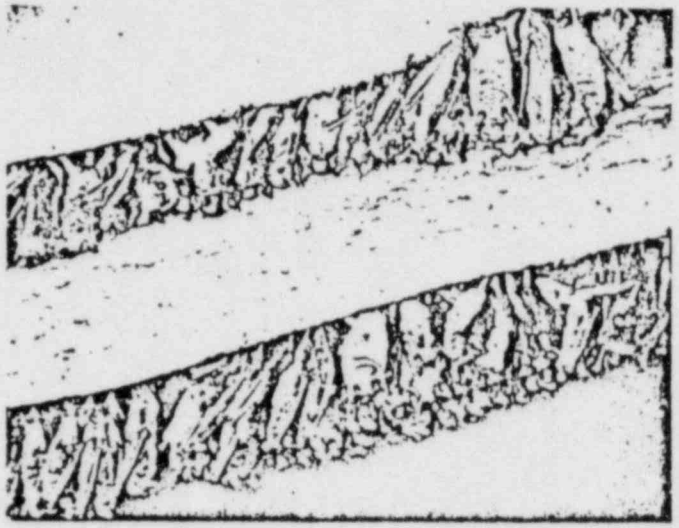
M. sodalis chooses a hibernation site where the humidity is rather high. However, saturation seldom occurs; droplets of moisture do not form on the fur, as they sometimes do on other species. In Bat Cave during the winter months relative humidity at the cluster sites ranges from 66 to 95 percent, with an average of 87 percent (Hassell, 1967).

The hibernating cluster is a characteristic of this species (fig. 46). It appears more tightly packed than any other. Each individual bat graves the cave ceiling with its feet; they do not hang on one another. The forearms are held close and parallel to the body, not angled outward as in *M. grisescens* (Hall, 1962). All that is visible in a blanket of hibernating *M. sodalis* on a cave ceiling are noses, ears, and wrists (fig. 48).

In a cave occupied by great numbers of *M. sodalis*, a few are always active even in the coldest part of winter. Individuals awaken from hibernation approximately every 8–10 days (Hardin, 1967). At any time during the winter one can find dozens of active bats in Bat Cave. These bats form squeaking clusters at four sites in the cave where temperatures are higher (54°–57° F., 12°–14° C.). Hall (1962) described a similar behavior pattern for caves in western Kentucky. A bat which awakens and moves to the active cluster may return to any of the hibernation clusters, not necessarily the one whence he came.

Hall (1962) placed plastic sheets beneath the clusters of active *M. sodalis* in Kentucky caves and measured the deposition of guano. He found that even during the period of January to March the guano deposited was rich in insect remains. Apparently the bats had been feeding during winter.

45. Tightly packed hibernating cluster of *Myotis sodalis*. One bat is awake.



49. *Myotis sodalis* hibernating in a cave.

Skull of *Myotis sodalis*, x3

Distribution of *Myotis sodalis*

50. *Myotis sodalis* with an abnormal color pattern. White spots are frequently seen, but they are rarely this extensive.

Where several hibernating populations are close together, bats move from one cave to another. If a hibernating group is disturbed even in mid-winter, some individuals may move to neighboring caves.

As the bats arouse and leave the cave with the coming of spring, they reverse the behavior pattern exhibited in the fall. They move through the cave in a period of several days resting in progressively warmer areas. After reaching the warmest areas, they leave the cave for their summer home (Hassell, 1967).

The two great populations in Kentucky which hibernate 180 miles apart are almost totally separate. Hall (1962) reported one bat that moved from one cave to the other. Movements between other distant populations are also rare. Hall (1962) found a bat from a hibernating population in northern Illinois, in Coach Cave, Kentucky, 320 miles away. In Bat Cave we recovered two bats banded by James Cope as autumn transients at Wyandotte Cave in Indiana. One male banded by Merlin Tuttle in mid-winter in a cave in Campbell County, Tennessee, spent subsequent winters in Bat Cave, 145 miles to the northeast. The Tennessee cave had been converted to an air raid shelter. This disturbance may have caused the move.

Remarks: *M. sodalis* has shown a drastic decrease in numbers in recent years. Thirty years ago there were several caves and mines in New England, New York, and Pennsylvania which harbored colonies numbering in the hundreds. Now, only occasional individuals can be found throughout most of this area. During the 1950s it has also nearly disappeared in West Virginia, Indiana, and Illinois, and several populations in Missouri have been severely depleted. Causes of such losses are unknown, but are most likely due to man's interference. Unless adequate protection is afforded the hibernation caves, the species will probably disappear within a few years. Fortunately, one major colony is in Mammoth Cave National Park where the bats are protected. The great colony in Bat Cave in Carter Caves State Park, Kentucky, is not yet adequately protected.

One frequently see a conspicuous white patch of fur on *M. sodalis*. Such blotches may be on the dorsal surface or the belly. They vary in size from a small spot to an area involving a third or more of the fur (fig. 50). The frequency of such markings varies from about 1 in 300 in some populations to one in several thousand in others.

Ubelaker (1966) listed a mite and two species of trematodes taken from *M. sodalis*.

DeBlase and Cope (1967) once found a *M. sodalis* impaled on a barb of a barbed wire fence. Although such accidents are common among bats of the genus *Lasiurus*, they have not been reported before for other groups.

Information on the summer habits of the Indiana Bat is slowly accumulating. Perhaps 20 or so have been shot at dusk by collectors at scattered localities in Indiana as the bats fed over fields and clearings. Young have been taken beneath a bridge in Turkey Run State Park, Indiana, and several have been found among little brown bats in buildings. We found a single juvenile male among over 600 *M. lucifugus* in a building in Logan County, Kentucky, on August 1, 1963. Any careful observation of this species in summer will be a real contribution.

2-30 #21 CRRF 2.7-2 REFERENCE 2-30

X-822

TM-

OAK RIDGE NATIONAL LABORATORY
Operated by
UNION CARBIDE NUCLEAR COMPANY
Division of Union Carbide Corporation
Post Office Box X
Oak Ridge, Tennessee

External Transmittal Authorized

ORNL
CENTRAL FILES NUMBER
59-10-126

COPY NO. 276

DATE: October 26, 1959

SUBJECT: LONG-TERM ECOLOGICAL STUDY OF THE OAK RIDGE AREA: II. OBSERVATIONS ON THE MAMMALS WITH SPECIAL REFERENCE TO MELTON VALLEY

TO: Distribution

FROM: J. C. Howell
P. B. Dunaway

Key
Mammals
Melton Valley
Terrestrial
Section 2.7

NOTICE

This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report. The information is not to be abstracted, reprinted or otherwise given public dissemination without the approval of the ORNL patent branch, Legal and Information Control Department.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE NUCLEAR COMPANY
UCC
POST OFFICE BOX X
OAK RIDGE, TENNESSEE

December 2, 1959

Report No.: CF 59-10-126 Copy: _____ Classification: Unclassified

Author(s): J. C. Howell, P. B. Dunaway

Subject: LONG-TERM ECOLOGICAL STUDY OF THE OAK RIDGE AREA: II. OBSERVATIONS ON THE MAMMALS WITH SPECIAL REFERENCE TO MELTON VALLEY.

Request compliance with indicated action:

The attached drawings, ORNL-LR-Dwg. 35961 and ORNL-LR-Dwg. 24091, were erroneously omitted from the subject memorandum and should be attached to your copy.

N. T. Bray, Supervisor
Laboratory Records Department
Technical Information Division

NTB:WCB:dbt

ORNL:RC

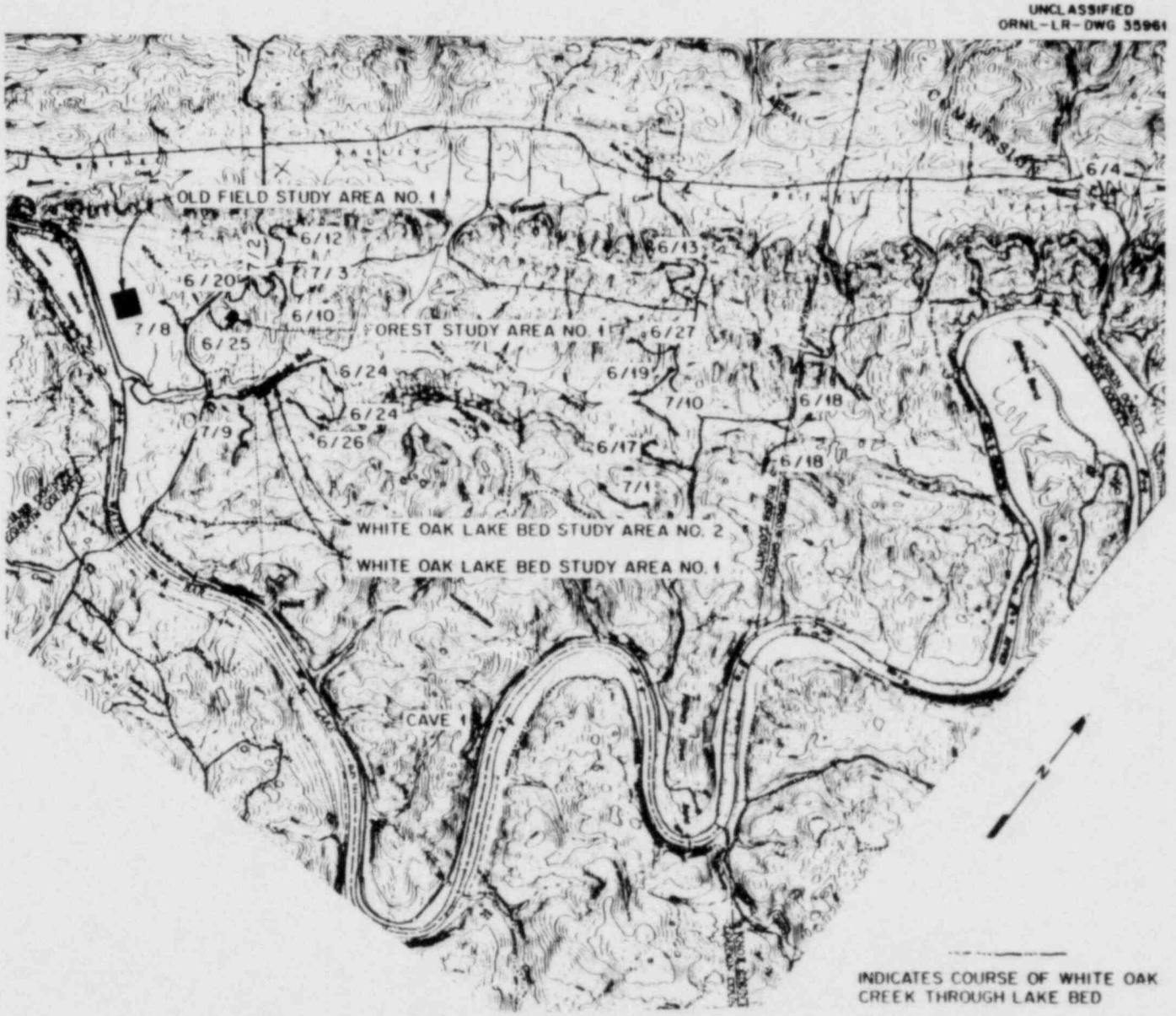


Fig. 1. Small-Mammal Study Areas and Trap Lines. Arrows on Trap Lines Indicate the Directions in Which the Traps were Set and Run; the Numbers Indicate Date.

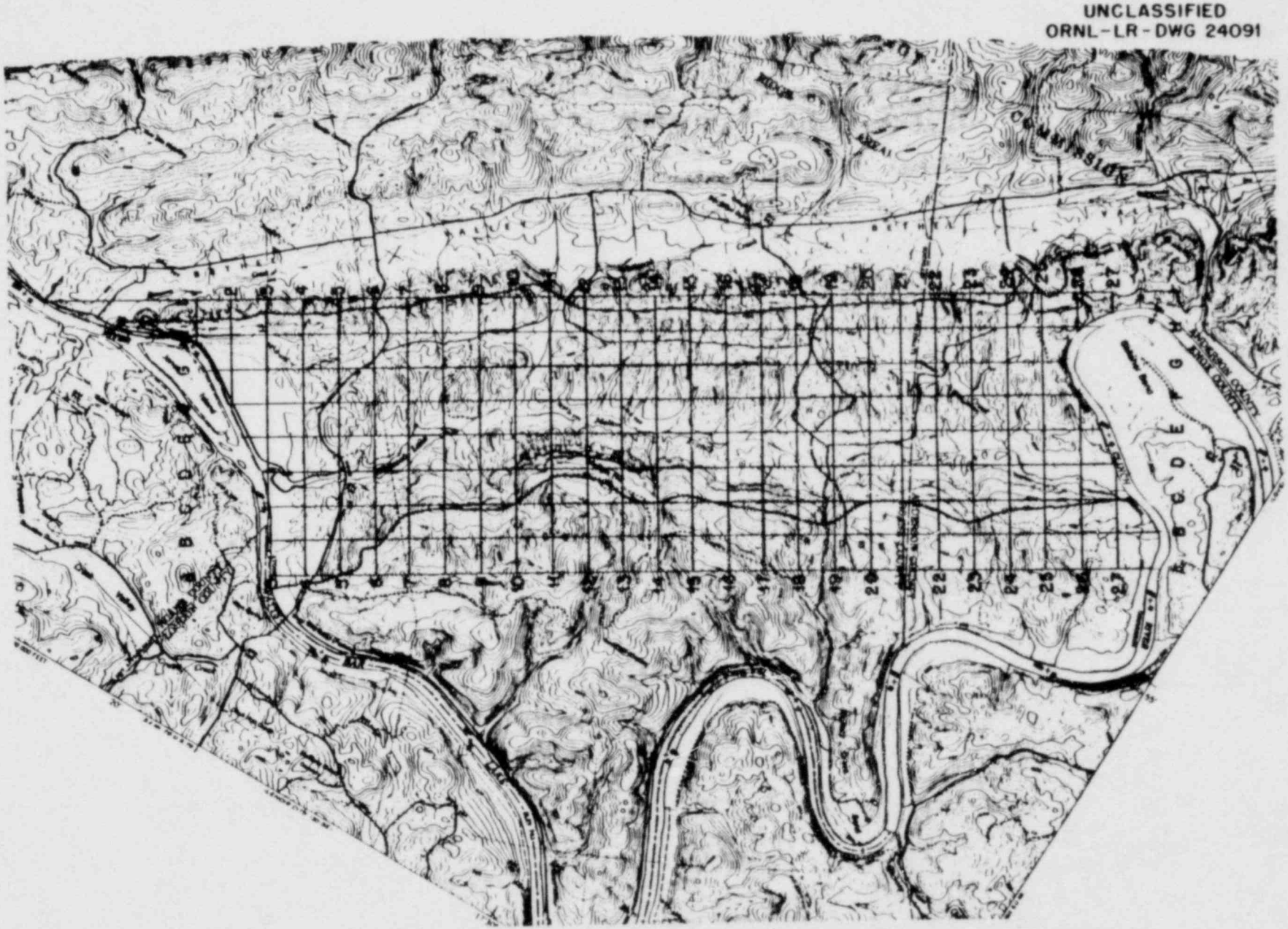


Fig. 2. Map of the Melton Valley. Heavy Solid Lines Mark Boundaries of Valley; Light Solid Lettered and Numbered Lines Form Grid; Dashed Line Marks Divide Separating Melton Branch and Bearden Creek Drainages.

LONG-TERM ECOLOGICAL STUDY OF THE OAK RIDGE AREA:
II. OBSERVATIONS ON THE MAMMALS WITH SPECIAL REFERENCE TO MELTON VALLEY*

J. C. Howell** P. B. Dunaway***

Abstract

This study of the mammals occurring in Melton Valley has had two important functions: first, to secure ecological information about this important segment of the animal life and, second, to select areas suitable for long-term studies of the ecological effects of radiation.

Records of occurrence of 27 species of mammals in the area were secured by qualified observers. The level of mammal populations in the valley was low except near streams. The fertility of the soil is also low except in the valleys along streams, and the litter and humus are thin.

During the period from June 5 to August 1, 1958, 48 specimens representing 5 species were collected with snap-back traps, live traps, and pitfall traps in habitats of 4 plant successional stages.

*Research performed in the Health Physics Division, Oak Ridge National Laboratory, operated by Union Carbide Corporation for the Atomic Energy Commission, Oak Ridge, Tennessee.

**Department of Zoology, University of Tennessee, and Research Participant, Health Physics Division, Oak Ridge National Laboratory, Summer 1958.

***Ecology Section, Health Physics Division, Oak Ridge National Laboratory.

Introduction

A study of mammals on the AEC Controlled Area in Oak Ridge during the summer of 1958 accomplished two objectives. These were: (1) the selection of the more desirable areas on which to conduct long-term studies of mammals, and, (2) the determination of the species which occur in the area and their relative abundance. The purpose of these objectives is to provide additional characterization of the local fauna. This characterization is essential for long-term programs on the distribution, fate, and effects of fission products released to the natural environment.

Description of Area

General Features

For a description of the area the reader is referred to a report on the birds (Howell, 1958).

The soil of the area is of more direct importance to most mammals than it is to birds. A report by Swann et al., 1942, provides a description of the soils of the Roane County portions of the Controlled Area and of Melton Valley. A large part of Haw Ridge (the northwest ridge shown in Fig. 1) is Apison very fine sandy loam, eroded phase; a fifth class, low fertility upland soil with considerable shale present in it. This soil is underlaid by a bedrock of shale and sandstone. Copper Ridge is chiefly Fullerton cherty silt loam, steep phase, with much chert. Here the underlying bedrock is limestone. Apparently extensive portions of both of these ridges have been used for raising crops or grazing within the last 50 years. A narrow band of second class soil, chiefly Pope very fine sandy loam, which is bottomland of medium productivity, underlies most of the White Oak Lake bed. The Old-Field Area is second class, chiefly Wolftever silt loam, terrace soil of high fertility. This area was under intensive agriculture in 1942.

The Live-Trapping Study Areas

The plots on which live-trapping studies were made are located in the White Oak Lake bed, an old field, and a forest. Each plot was marked off into a grid of trapping stations. The interval between stations was 10 meters (except that the original plot on White Oak Lake bed (WOL-1) had a 12-meter interval).

The one-hectare forested area live-trapped between July 17 and August 1, 1958, is located between F-5 and F-6 (see Fig. 2 for all locality designations). The area is on the southeastern slope of Haw Ridge about 150 yd east of Tennessee Highway 95 and includes a small valley having a normally dry stream bed which has an altitude of about 800 ft. One ridge of the valley is steep and its crest is about 860 ft in elevation while the other slopes gently up to an altitude of about 825 ft at the boundary of the area. The oldest trees on the area are about 75 years of age. The most common large tree is the White Oak. Additional trees of importance are other species of oaks, Red Maple, and Scrub and White Pines. The leaf litter averages about an inch in thickness. In the low lying areas there are open thickets of bushes and vines. On the higher, better drained parts of the area there is somewhat less bushy growth. The canopy formed by the trees is about 90% complete over much of the area.

The original White Oak Lake bed live-trapping area (WOL-1) covered about 0.75 hectare. It was largely on ground which lay beneath White Oak Lake from 1943 until October 1955. The lake bed is still subject to frequent flooding. The vegetational changes on this area have been dramatic. During the first growing season after the draining of the lake, that of 1956, smartweed and sedges covered much of the bare ground (Morgan, 1957). During the second season a variety of new plant associations appeared and prominent among these was the Black Willow (Auerbach, 1958). Little bare ground was present on the mammal trapping area. By the summer of 1958 the willows greatly increased and the amount of bare ground was further reduced (it is estimated that less than 1% of the area was bare ground). In 1958 a different plot (WOL-2) with an area of about one hectare was established beside WOL-1.

The Old Field Area lies near F-3 and covers four hectares. The area is on a nearly level abandoned field on a terrace and is about 600 ft from the edge of Watts Bar Reservoir (Clinch River). The field is poorly drained and frequently soggy. The maximum water level of Watts Bar Reservoir is 742 ft and that of the plot varies from 750 to 755 ft. The vegetation is luxuriant and made up of aster, goldenrod, grasses, sedges, trumpet-flower vines, and patches of briers. A few pines, the largest of which are about 10 ft in height, are present now. During the winter of 1957-1958 many small pines which had been planted in the

area were removed. Small cedar, cherry, dogwood, sumac, and other trees are scattered over the area. The eastern and western borders of the plot lie within about 40 ft of hedge rows of osage orange trees.

Materials and Methods

Most small mammals cannot be observed directly since they are usually silent, nocturnal, live in burrows, or inhabit dense cover. As a consequence traps are used to determine which species occur and their relative abundance. In this study three distinctly different types of traps were employed: snap-back traps, live traps, and pitfall traps. The familiar mouse and rat traps are snap-back traps. In these the back or skull of an animal is broken by means of a spring-powered metal bar. Live traps were extensively used in the White Oak Lake bed and Old Field Areas and for a limited time in Forest Area 1. These were of masonite with inside dimensions (width, height, and front-to-back) of 3 x 3 1/8 x 10 1/2 in. They had a gravity-operated falling door. The pit-fall type consisted of fruit juice cans sunk into the ground deep enough so that the lip of the open end of the can was just below the level of the ground. The cans used had a diameter of 4 in. and a depth of 7 in. The walls of the cans were pierced with an ice pick about 2 in. above the bottom and filled with water to the level of the holes to prevent small mammals from jumping out.

The snap-back traps were baited with peanut butter to which on a few occasions some rolled oats were added. The live traps were baited with a mixture of peanut butter and rolled oats with just enough rolled oats used to keep the peanut butter from sticking to the trap floors. No bait was used in the can traps although the water placed in the bottom of the cans may have attracted thirsty mammals. In the early history of the can traps they captured large numbers of arthropods which subsequently decayed and imparted a strong odor to the water which also may have attracted small mammals.

Snap-back traps were placed along a trap line which consisted of a series of trapping stations. Trap lines were placed in areas which might be suitable for long-term live-trapping studies or which might be frequented by small mammals not known to occur on the area. Each trap line was used only once. Trapping

stations were places irregularly distributed along a trap line (Fig. 1). Two traps were placed at each trapping station. Usually one of these was a mouse trap of the household type and the other was a slightly larger museum special[1].

At each station the two traps were not placed at random or in a fixed pattern but were set in the places judged most likely to yield a capture. In general these sites were across a burrow, beside a log, beside a stump, at the base of a tree, beside a rock, or across a runway. It frequently was necessary to dig into a burrow in order to provide the best set for a particular trap.

Traps were baited, set, and placed along the trap line between 1:00 and 4:00 PM. The traps were recovered the following morning between 8:15 and 10:00 AM. The captured mammals were brought back to the laboratory and weighed, measured, examined, and then given to a pathologist[2] for a parasitological examination.

Results

Mammal trapping success is usually evaluated in terms of mammals captured per trap night. When a trap is left set overnight this is called a trap night. In general trapping success is directly proportional to the population.

Table 1 presents by species the number of small mammals captured in the course of 1000 snap-back trap nights and 1085 can trap nights. The catch for snap-back traps is separated into museum special and household mouse trap captures.

Table 2 contains the species taken, the number of individuals trapped, and the total number of captures during 474 live trap nights in the forest small-mammal study area.

Table 3 lists all of the small mammals handled by the senior author and includes the date of capture (initial capture in the mammals live trapped); locality (in terms of the nearest station); type of trap: sex; age; weight; and measurements of the total length, tail, and hind foot.

[1]Both of these traps are manufactured by the Animal Trap Company of Lititz, Pa.

[2]G. E. Cosgrove, Biology Division, ORNL.

Table 1. Mammals Taken During 1000 Snap-back Trap Nights (Museum Special (MS), 494, and Mouse (MO), 506) and 1085 Can Trap Nights.

Name	Snap-back MS	Snap-back MO	Can	Total
Southeastern Shrew, *Sorex longirostris*	0	0	2	2
Short-tailed Shrew, *Blarina brevicauda*	9	9	1	19
White-footed Mouse, *Peromyscus leucopus*	10	6	0	16
Golden Mouse, *Peromyscus ruttalli*	0	1	0	1
Rice Rat, *Oryzomys palustris*	0	1	0	1
Total	19	17	3	39

Table 2. Number of Different Individuals and Number of Captures During 474 Live Trap Nights on the Forest Small-Mammal Study Area.

Name	Different Individuals	Times Captured
Short-tailed Shrew, *Blarina brevicauda*	5	5
White-footed Mouse, *Peromyscus leucopus*	4	15
Totals	9	20

Table 3. Chronologically Arranged List of Small Mammals Trapped.

Localities are given by nearest station on grid (see Fig. 1) except one which was near a cave on the UT-AEC Farm.

Abbreviations used: ad - adult, D - day, f - female, HF - hind foot, juv - juvenile, lt - live trap, M - month, m - male, MS - museum special, MO - mouse, nt - not taken, sa - subadult, sta - station, T.L. - total length, Tl - tail, u - unknown, Wt - weight, and Y - year.

No.	Date (M/D/Y)	Name	Near Sta	Trap Type	Sex	Age	Wt (g)	T.L. (mm)	Tl (mm)	HF (mm)
1	6/10/58	Blarina brevicauda	G-7	MO	f	ad	13	100	15	9
2	6/12/58	Peromyscus leucopus	H-7	MO	m	ad	21	165	77	22
3	6/12/58	Peromyscus leucopus	L-7	MS	m	ad	22	167	74	21
4	6/12/58	Blarina brevicauda	I-7	MO	f	ad	11	98	18	11
5	6/17/58	Peromyscus nuttalli	C-18	MO	m	ad	22	172	84	18
6	6/17/58	Peromyscus leucopus	C-16	MO	m	ad	23	158	70	20
7	6/18/58	Peromyscus leucopus	E-22	MS	m	ad	22	168	74	20
8	6/19/58	Blarina brevicauda	F-18	MO	f	ad	13	113	23	13
9	6/19/58	Blarina brevicauda	E-17	MO	f	ad	13	110	27	14
10	6/20/58	Blarina brevicauda	F-5	MS	m	ad	12	nt	nt	nt
11	6/20/58	Blarina brevicauda	F-5	MS	m	ad	13	nt	nt	nt
12	6/20/58	Blarina brevicauda	F-5	MO	m	ad	13	nt	nt	nt
13	6/20/58	Blarina brevicauda	G-7	can	u	ad	12	nt	nt	nt
14	6/20/58	Peromyscus leucopus	G-6	MO	f	ad	nt	nt	nt	nt
15	6/20/58	Peromyscus leucopus	G-6	MS	m	juv	13	nt	nt	nt
16	6/20/58	Peromyscus leucopus	F-5	MS	m	ad	22	nt	nt	nt
17	6/20/58	Peromyscus leucopus	F-5	MO	m	ad	nt	nt	nt	nt
18	6/24/58	Peromyscus leucopus	D-9	MS	m	ad	23	161	75	21
19	6/24/58	Peromyscus leucopus	D-9	MS	f	ad	nt	nt	nt	20
20	6/24/58	Peromyscus leucopus	D-8	MO	m	ad	20	158	67	19
21	6/25/58	Blarina brevicauda	F-5	MS	m	ad	12	110	22	13
22	6/25/58	Blarina brevicauda	F-5	MO	m	ad	nt	nt	22	14
23	6/25/58	Blarina brevicauda	F-5	MS	f	ad	13	nt	21	12
24	6/25/58	Blarina brevicauda	F-5	MS	u	sa	9	101	22	12
25	6/25/58	Peromyscus leucopus	F-5	MO	m	ad	20	nt	72	21
26	6/27/58	Blarina brevicauda	F-17	MS	m	sa	9	nt	20	12
27	7/ 1/58	Peromyscus leucopus	B-17	MS	m	ad	23	165	75	19
28	7/ 1/58	Blarina brevicauda	B-17	MO	f	ad	11	99	20	14
29	7/ 2/58	Peromyscus leucopus	G-6	MS	u	ad	nt	nt	75	nt
30	7/ 2/58	Blarina brevicauda	G-6	MS	f	ad	11	113	22	13
31	7/ 2/58	Blarina brevicauda	G-7	MO	f	ad	12	118	23	13
32	7/ 2/58	Blarina brevicauda	G-7	MS	f	sa	10	94	21	12
33	7/ 3/58	Blarina brevicauda	F-7	MO	f	ad	12	107	22	13
34	7/ 8/58	Oryzomys palustris	F-4	MO	f	ad	70	246	120	28
35	7/ 9/58	Peromyscus leucopus	C-6	MS	f	ad	nt	nt	nt	nt
36	7/ 9/58	Blarina brevicauda	C-6	MS	m	ad	13	118	24	13
37	7/18/58	Sorex longirostris	F-5	can	u	u	nt	76	29	11
38	7/18/58	Sorex longirostris	G-6	can	u	u	nt	78	31	10
39	7/23/58	Peromyscus leucopus	F-5	lt	m	ad	nt	nt	nt	nt
40	7/24/58	Peromyscus leucopus	UT-AEC Farm	MS	m	ad	23	160	69	21
41	7/24/58	Peromyscus leucopus	F-5	lt	m	ad	nt	nt	nt	nt

Table 3. Chronologically arranged List of Small Mammals Trapped. (contd.)

No.	Date (M/D/Y)	Name	Near Sta	Trap Type	Sex	Age	Wt (g)	T.L. (mm)	Tl (mm)	HF (mm)
42	7/24/58	Peromyscus leucopus	F-5	lt	f	ad	nt	nt	nt	nt
43	7/24/58	Blarina brevicauda	F-5	lt	u	ad	nt	nt	nt	nt
44	7/29/58	Blarina brevicauda	F-5	lt	u	sa	nt	nt	nt	nt
45	7/29/58	Blarina brevicauda	F-5	lt	u	ad	nt	nt	nt	nt
46	7/29/58	Blarina brevicauda	F-5	lt	u	ad	nt	nt	nt	nt
47	7/29/58	Peromyscus leucopus	F-5	lt	m	ad	nt	nt	nt	nt
48	7/30/58	Blarina brevicauda	F-5	lt	u	ad	nt	nt	nt	nt

An annotated list of the mammals known to occur on the AEC Oak Ridge Controlled Area is given at the close of this report as an appendix.

Discussion

The trapping success obtained with snap-back traps in and close to the Melton Valley is low. As shown in Table 1 only 36 small mammals were taken during 1000 trap nights. This figure (3.6% trapping success) compares rather closely with a figure obtained on the Cumberland Plateau and adjoining areas. These areas lie from 20 to 65 miles to the west of the AEC Controlled Area. Here, between July 21 and August 26, 1950, 54 small mammals were taken in 2129 trap nights for a 2.5% trapping success (Howell and Conaway, 1952).

That these percentages of trapping success are low is shown by comparing them with figures which were obtained in the mountains of northeastern Tennessee. In 1711 trap nights 205 small mammals were taken for a trapping success of almost 12% (Conaway and Howell, 1953).

For purposes of comparison, data may be considered from the North American Census of Small Mammals secured from many parts of the United States and some parts of Canada. During the years 1948 through 1956 in the first day of a three-day trapping period 7753 small mammals were taken in 96,900 trap nights for a trapping success of 8% (Calhoun and Arata, 1957).

While numerous objections to the above comparisons are justified, nevertheless the writers believe that these comparisons support the generalization that populations of small mammals in Melton Valley are low.

Actual population figures of the number of mammals per acre are few for this region. Hilbert (1954) found that there were 4.25 white-footed mice (Peromyscus leucopus) per acre on a plot lying in a mature deciduous woods similar to the forest study plot. Hilbert's study plot was about 30 miles air line upstream on the Clinch River and about the same distance back from the river edge as is the Forest Study Area. His live-trapping success was 17.4% based on 2139 trap nights. This last figure may be compared with the 4.2% obtained in 474 nights of live trapping in the Forest Small Mammal Area.

In a live-trapping study of small mammals on an overgrown field near Knoxville,

Tennessee (Howell, 1954), 465 captures of small mammals were made in 2362 trap nights for a per cent success of 19.7.

Since two types of snap-back traps, the regular mouse trap and the museum special were used in this study, their performances may be compared. They were about equally successful in taking small mammals. The regular type mouse trap took 17 small mammals in 506 trap nights for a trapping success of 3.36%. The museum special type took 19 small mammals in 494 trap nights for a trapping success of 3.85%. One pronounced difference was that the regular mouse traps were sprung only about half as often as were the museum specials. In 506 trap nights the regular type were sprung in 105 instances (20.8%). For the museum special in 494 trap nights the traps were sprung 216 times (43.7%).

In regard to mammals one of the more important characteristics of this area is that populations are low. This is particularly true of the upland areas. In a few restricted areas beside the Clinch River and some of its more important local tributaries there are larger populations.

An important factor in accounting for the low level of mammal populations is the structure and fertility of the soil. Small mammals, such as shrews and mice, make extensive use of burrows. These burrows are usually in the soil, but if the litter is thick the burrows often come up from the soil and extend into the overlying litter.

In the Melton Valley both the litter and the soil tend to be relatively thin (the Aoo, Ao, and A layers of Allee, et al., 1949). In general the depths of these are inversely proportional to the intensity of the use which the land has received. The minimum of human disturbance on the area seems to have been the selective cutting of timber. Even this practice opens the land surface to some erosion. The ridge tops are the places least disturbed by man and on these there are scattered stumps among even the most mature woods. It seems probable that at some time in the past virtually all the area up to and including the ridge tops has been cut over for timber, pastured, or used as crop land. In Roane County the most intensive agricultural use of land was in 1880 when 88.4% of the land was in farms (Swann, et al., 1942).

Many forested areas within the valley in which there are numerous mature trees have very thin covers of litter with stony or cherty soil frequently ex-

posed. Because of the fine trees on them these areas seem superficially suited to small mammal use, but support only very light populations of shrews and mice.

The cover of the area was discussed in the report of the summer birds of the Melton Valley (Howell, 1958). Habitats are there classified in relation to stages in plant succession. Stage I habitats have at least some bare ground; stage II habitats are dominated by herbaceous growth; stage III habitats begin when woody plants (bushes and low saplings) appear; and stage IV includes tall saplings and trees.

The only stage I habitat studied was that occurring on the White Oak Lake bed in 1956 and on into the spring of 1957. In live trapping carried out between October 13, 1956 and May 19, 1957, only House Mice (Mus musculus) seem to have been characteristic of this stage in plant succession; 40 individuals of this species were trapped. During this period other small mammals using the plot were Small Short-tailed Shrew (Cryptotis parva) 1 capture, Short-tailed Shrew (Blarina brevicauda) 1 capture, and P. leucopus (many captures of 15 individuals). Both B. brevicauda and P. leucopus are characteristic of the woods near the lake bed although P. leucopus used the lake bed regularly.

By the summer of 1957 the herbaceous growth on the lake bed plot had increased in extent and matured to become characteristic of stage II. In a trapping period lasting from July 11, to September 2, 1957, it was found that a new species, the Cotton Rat (Sigmodon hispidus) had appeared and become dominant. The area was still being utilized by M. musculus and P. leucopus. A single Norway Rat (Rattus norvegicus) was trapped. The number of individuals of each species captured during this period was: Sigmodon hispidus, 11; Mus musculus, 6; Peromyscus leucopus, 5; and Rattus norvegicus, 1.

During the spring and summer of 1958 the habitat on the lake bed plot was still in stage II although the Black Willow was increasing in importance. In a trapping period between April 6 and August 5, 1958, a new species, the Rice Rat (Oryzomys palustris), appeared among the mammals taken. A total of 20 individuals was trapped. The dominant small mammal was still S. hispidus, of which 45 individuals were trapped. In this interval M. musculus had all but disappeared, only one individual being caught.

Stage III habitats are widely distributed over the area and cover about 35%

of the entire Melton Valley. The Old Field Area 1, in which trapping began on March 18, 1958, is the most studied example of this habitat. The dominant small mammal on this plot was the Pine Mouse (Pitymys pinetorum); 37 individuals being trapped through August 1, 1958. Peromyscus leucopus was represented among the trapped mammals by 12 individuals. Probably these mice primarily utilized dense hedge rows of osage orange trees near the trapping plot and were in reality only secondary users of the plot. The Harvest Mouse (Reithrodontomys humulis) occurred on the plot and 10 were taken. This species is characteristic of habitats of this stage and of late stage II. Two M. musculus were trapped; they were perhaps wanderers. While S. hispidus may be expected in habitats of this stage none was recorded.

Stage IV habitats cover more than half of the Melton Valley. Early stage IV habitats may have very little litter and are poor in terms of small mammal populations. As a leaf litter builds up habitats of this stage support more small mammals. The dominant small mammal of the more mature habitats of this stage is probably B. brevicauda. Certainly in the summer of 1958 this species was the most numerous in mature woods having considerable litter. In the optimum habitat for B. brevicauda there are also many P. leucopus. The latter species has broader ecological tolerances and makes frequent brief visits into all of the earlier stages in succession providing these stages lie near some area of stage IV habitat. Because of the greater ecological tolerance it is possible that if all habitats are taken into account P. leucopus is the most numerous species in Melton Valley.

The foregoing account of the habitats of the four successional stages is concerned with small mammals which characteristically spend most of their lives within an acre or two. Animals as large as or larger than the Gray Squirrel move about over much larger areas and as a consequence utilize habitats of all four stages to some degree. Usually, however, these mammals do have a characteristic habitat; for some species these are given in the Annotated List (see appendix).

The information on which this account is based has certain limitations. Most of the data are for the years 1956, 1957, and 1958. The summer season is the one in which field studies have been most extensive. Trapping has been

largely limited to those species which may be taken in small traps. Only the White Oak Lake bed and Old Field Areas have been studied intensively enough to yield satisfactory information as to which species are present. A number of habitats of plant succession in stages III and IV have been poorly sampled and a few have not been studied at all.

Although no records are available, the following species may be expected to occur: Indiana Bat (Myotis sodalis), Eastern Pipistrelle (Pipistrellus subflavus), Big Brown Bat (Eptesicus fuscus), Long-tailed Weasel (Mustela frenata), and Flying Squirrel (Glaucomys volans).

Some probability exists that the following mammals occur on the AEC Controlled Area: Smoky Shrew (Sorex fumeus) (2 taken at Norris by Hilbert in 1953), Southeastern Bat (Myotis austroriparius), Gray Bat (Myotis grisescens), Keen's Bat (Myotis keenii), Silver-haired Bat (Lasionycteris noctivagans), Hoary Bat (Lasiurus cinereus) (2 records for nearby Knox County), Evening Bat (Nycticeius humeralis), Eastern Lump-nosed Bat (Corynorhinus macrotis), Spotted Skunk (Spilogale putorius), Eastern Fox Squirrel (Sciurus niger), and Eastern Wood Rat (Neotoma floridana).

Feral domestic animals are not included in this account. Both wild dogs and cats occur. Occasional stray individuals of other kinds, such as swine, probably occur.

Three caves were visited. Cave 1 is beside the Clinch River, about four miles (by road) due east of the White Wing Bridge (almost at mile 26 on the Clinch River, Bethel Valley Quadrangle, 1953 map, Fig. 1). Cave 2 lies beside the A Road on the east face of Rainy Knob about one mile southeast of the UT-AEC Cow Barn and about 100 yards southwest (across the road from the Clinch River) of a small square building used for salt storage. Cave 3 lies near the Bear Valley Road one mile northeast of the Gallaher Gate and a quarter of a mile southeast of the road on the steep east (far) bank of Grassy Creek, 150 ft back from the creek.

Cave 1 showed no signs of being currently occupied by bats when visited on June 27, 1958, although it seemed quite suitable. Cave 2 had a number of recent bat dung drops but no bats were present during visits made on July 3, and August 1, 1958. Cave 3 was visited August 1, 1958, and found to contain

no bats. No signs of Eastern Wood Rats were found in any of these caves. All of the caves contained some cave crickets. Cave 3 contained a few cave salamanders (Eurycea lucifuga) and two species of Plethodon glutinosus, and probably nettingi. J. W. Ball reported that a few bats were taken from cave 2 in February 1958.

A companion report on the birds of this area has been published (Howell, 1958). Some of the information contained in the report of the birds is also important to this report.

In planning the field work for the summer of 1958 the senior author omitted trapping in the vicinity of White Oak Lake and in the fields near the Old Field Area No. 1 (Fig. 1), since these sites were under intensive study by the junior author. Unless another observer is given all data from White Oak Lake and the Old Field Area No. 1 were obtained by the junior author. More detailed accounts of the mammals of these two areas will appear later.

The field studies of the senior author during the summer of 1958 extended from June 5 to August 1.

It is a pleasure to acknowledge help received from a number of people. A valuable source of information was an unpublished report of a rabies control program in 1958 (Thomas, 1958). J. W. Ball of the UT-AEC Farm Staff went with the senior author to the three caves visited and gave information concerning many of the mammals of the area. Captain W. B. Snyder of the AEC Patrol provided records of a number of species and alerted the Patrol to record sightings of certain mammals. S. I. Auerbach and D. A. Crossley of the Ecology Research Group, ORNL Health Physics Division, have helped in many ways.

APPENDIX

Annotated List of the Mammals of The Oak Ridge Atomic Energy Commission Controlled Area With Special Reference to Melton Valley

The abundance of each mammal is given in terms of five categories which are (from most numerous to least numerous): abundant, common, fairly common, uncommon, and rare. A statement summarizing the writers' knowledge of the ecology of each species is given. For some species observations of general interest are given. The concluding information for each species is usually given under the heading of "Records". Each record gives (if the data are available) the date of the observation, the number of individuals observed, age, sex, locality, and observer. Many of the abbreviations used in Table 3 are used here. Additional abbreviations used include: GEC - G. E. Cosgrove, Biology Division, ORNL; HH - Henry Howden, JCH - J. C. Howell, MP - Madison Pryor, PD - Paul Dunaway, Ecology Group, H. P. Division, ORNL; and WOL - White Oak Lake.

1. Opossum (Didelphis marsupialis) - Fairly common. Occurs in wooded areas and wanders out from woods into nearby areas. Usually occurs in moist areas. Frequently observed dead on roads. Aug. 28, 1956, 1, y, m, WOL, PD; Sept. 9, 1956, 1, a, f, WOL, PD.

2. Eastern Mole (Scalopus aquaticus) - Uncommon. Occurs in moist places where the forest has been cleared and the soil permits burrowing. (Listed by Krumholz, 1954). Characteristic mole burrows were observed in July 1958 on WOL bed, PD.

3. Southeastern Shrew (Sorex longirostris) - Rare. Known from four specimens taken in jar or can traps. Two were taken on the White Oak Lake bed in 1957 in areas dominated by grass, sedge, or jewel weed and were 35 and 60 meters out from the edge of a woods of young trees. Two were taken in 1958 in woods about 75 years old. The presence of these tiny shrews in the herbaceous vegetation of the White Oak Lake bed and also in the woods indicates that they have a wide ecological tolerance. Records: July 26, 1957, 1, TL - 70, T1 - 25, HF - 10, WOL, HH; Aug. 19, 1957, 1, TL - 72, T1 - 25, HF - 10, WOL,

MP; July 18, 1958, 2, F-5 and G-6, JCH. (additional data in Table 3).

4. Small Short-tailed Shrew (Cryptotis parva) - Rare. Inhabits weedy, grassy, or bushy fields. Known from two specimens taken on the White Oak Lake bed. Records: Nov. 25, 1956, 1, y, WOL, PT, Aug. 23, 1957, 1, WOL, MP.

5. Short-tailed Shrew (Blarina brevicauda) - Abundant. It is found in woods, being most common in the more mature woods. During the 1958 snap-back trapping program 18 of the 36 small mammals taken were of this species. It probably was the most numerous mammal in the wooded areas in 1958. Trapping data from surrounding areas indicate that this mammal may be more numerous than usual this year. It is important to note that this mammal spends most of its time in burrows and only when traps are placed across or near these burrows can the population be sampled. This mammal is probably active throughout the daylight hours since two were taken between 2:00 and 4:00 PM on July 2, 1958. Records: see Table 3.

6. Little Brown Bat (Myotis lucifugus) - Listed, name only, by Krumholz, 1954.

7. Red Bat (Lasiurus borealis) - One shot August 15, 1958, at F-2 was in the company of at least two other similar appearing bats. It was an adult male with the following measurements: TL - 106, Tl - 48, HF - 8, forearm - 39, ear (from crown) - 7. It weighed 11 g. (JH and PD). G. E. Cosgrove took a male on his farm just outside of the Controlled Area on Brashear Creek on December 6, 1957.

8. Raccoon (Procyon lotor) - Fairly common. Found in wooded areas near streams or other areas of water. An adult was killed by poison on the Old Field Area on May 8, 1958. The next day two adults and a sub-adult were found dead in the same area; they were also killed by poisoning. Road kills of this species are not uncommon.

9. Mink (Mustela vison) - Uncommon. Occurs along the water ways. J. W. Ball reports it to be widely distributed over the Controlled Area and estimates the area population at 25 to 30 animals. One adult was taken in the winter of 1954-1955 on the White Oak Lake bed (Miller, 1955).

10. Striped Skunk (Mephitis mephitis) - Fairly common. Occupies almost all of the habitats occurring in the area. This animal is frequently killed on

the roads of the area. Record: July 2, 1957, 2, WOL, JCH.

11. Red Fox (Vulpes fulva) - Fairly common. It occurs in all of the habitats of the area. Thomas, 1958, reports that the AEC Patrol killed nearly 300 foxes in 1953 by shooting. He also estimates that during the rabies control campaign of 1958, 234 foxes were killed by poisoned bait. Both Red Foxes and Gray Foxes were included under the heading "foxes". In conversation Captain Thomas and Mr. Ball agreed that the Red Fox was about twice as common as the Gray Fox. In traps they took 8 Red Foxes and 4 Gray Foxes. Records: July 4, 1958, 1, Bear Creek Road, west end of Y-12, AEC Patrol; July 15, 1958, 1, near White Wing Bridge, a road kill, GEC; July 18, 1958, 1, White Oak Lake area, PD; July 21, 1958, 1, 1/2 mile east of White Wing Gate on A Road, AEC Patrol; July 26, 1958, 1, White Wing Road and Tower Shielding Road, AEC Patrol.

12. Gray Fox (Urocyon cinereoargenteus) - Fairly common. It usually occurs in wooded or brushy areas. Some of the information presented above concerning the Red Fox pertains also to the Gray Fox. Applying the estimated ratio of Red to Gray Foxes (2:1) to the number of foxes killed by the AEC Patrol in 1953 (300 foxes) indicates that about 100 Gray Foxes were killed that year. This method indicates that about 75 Gray Foxes were poisoned during the 1958 control campaign. Records: June 21, 1957, 1, H-17, JCH; July 18, 1957, 1, F Road, 3.7 miles west of the Turnpike Gate, JCH; Jan. 23, 1958, 1 dead on road, Oak Ridge Turnpike at Country Club, GEC; June 18, 1958, 1, Brashear Creek, GEC.

13. Bobcat (Lynx rufus) - Rare. Known from only a few sight records none of which is wholly satisfactory. Captain Snyder and Mr. Ball both recall the killing of a female Bobcat by steel riggers at the K-25 plant about 1953. Other less definite sight records have been recounted. There is little reason to doubt the occurrence of this secretive species in this area.

14. Woodchuck (Marmota monax) - Fairly common. Occurs in or near areas of lush herbaceous vegetation. Its burrows are often in woods although usually near a road shoulder or other opening. Commonly observed on road shoulders throughout the area. Road kills are numerous. Sighted almost daily during field work in the summers of 1957 and 1958. Records: June 26, 1957, 1, whistled persistently, G-3, JCH; Feb. 10, 1958, 2, Y-12 to X-10 to K-25 roads, PD; Apr. 29, 1958, 2, very small young (about 6 inches long), G-2, PD.

15. Eastern Chipmunk (Tamias striatus) - Rare. It occurs in the woods, often near an openirg of some kind. An adult female was taken on Nov. 4, 1956, on the White Oak Lake bank, PD. One squealed frequently on July 10, 1957, beside the A Road 0.6 mile east of the White Wing Bridge (JCH).

16. Eastern Gray Squirrel (Sciurus carolinensis) - Common. The Gray Squirrel is primarily an animal of mature deciduous woods, but frequently uses coniferous woods and sometimes visits hedgerows and lone nut-bearing trees in fields. Its churring notes are often heard when the animal cannot be seen. It is found in most of the woods of the area and its presence can be known by its characteristic leaf nests and by the remains of nuts and acorns that it has eaten. Seen almost daily during field work.

17. Harvest Mouse (Reithrodontomys humulis) - Fairly common. These mice inhabit old fields in which the herbaceous plants dominate the woody ones. Known only from the Old Field Area No. 1 where the junior author trapped 10 individuals during 1958. Records: May 10, 1; June 17, 2; June 24, 1; June 26, 1; July 1, 3; July 16, 1; and July 29, 1 (PD). Four were judged to be adult (3 females and 1 male) and the others were subadult or juvenile.

18. White-footed Mouse (Peromyscus leucopus) - Abundant. Found in all of the woods of the area and also, although less commonly, in hedgerows and overgrown brushy fields. This species and the Short-tailed Shrew are the most numerous ones in the Melton Valley. This mouse is found in areas in which the shrew occurs and also in other areas in which the shrew is either less common or absent. Records: see Table 3.

19. Golden Mouse (Peromyscus nuttalli) - Fairly common. Usually occurs in or close to thickets and tangles of vines either in woods or overgrown fields, often in stream beds. These mice spend the day in their globular nests which are usually between four and ten feet above the ground. Most records are of animals driven from their nests. Records: Mar. 3, 1958, 1 sa f, WOL, PD; June 17, 1957, 1, C-27, JCH, ran from nest in honeysuckle growing on a maple, 4 ft up; June 17, 1958, 1, ad m, C-19, JCH; June 20, 1957, 1, H-23, JCH, ran from a nest 10 ft up in a thin Post or Blackjack Oak, which was 20 ft in height; July 8, 1957, 1, between E-13 and F-13, JCH, ran from poorly built nest located 5 1/2 ft up in a 15-foot elm.

20. Rice Rat (Oryzomys palustris) - Fairly common. Usually occurs in wet or moist areas having a dense herbaceous growth of grasses and sedges. These habitats occur in scattered localities along the edge of the Clinch River and along the beds of some of the streams which are tributary to it. As a consequence of the dispersed state of its habitat locally the populations of this species tend to be relatively small and occur as isolated colonies. Records: Apr. 6 - Aug. 5, 1958, 20 ads and sas, 15 ms and 5 fs, WOL, PD; July 8, 1958, 1, ad m, F-4, JCH.

21. Hispid Cotton Rat (Sigmodon hispidus) - Fairly common. Inhabits lush herbaceous growths on wet or moist areas. Surprisingly, it is not known to occur in the drier overgrown fields of this area, although to the south similar fields are inhabited by this species. This area lies on the northern edge of the range of this species. Records: July 11 to Sept. 2, 1957, 11 ads, sas, and y, 4 ms, 6 fs, 1 u, WOL, PD. [Note: in trapping done between Oct. 13, 1956, and May 19, 1957, this species was not taken on the lake bed]; Apr. 6 - Aug. 5, 1958, 45, ads, sas, and y, 26 ms and 19 fs, WOL, PD.

22. Pine Mouse (Pitymys pinetorum) - Fairly common. In this area this species is known to occur only in moist fields having a heavy growth of herbaceous and a light growth of low woody plants. Additional trapping may be expected to show that it occupies other habitats. Records: Mar. 18 to July 29, 1958, 3[illegible] ads and sas, 14 ms and 23 fs, Old Field Area, PD.

23. Muskrat (Ondatra zibethica) - Fairly common. This species occurs along the Clinch River, the streams, and in other areas where there is a dependable water supply. Locally, this species does not usually build houses but utilizes burrows. Records: July 12, 1957, 1, in drainage ditch beside the road north of X-10, JCH; July 17, 1957, 1, swimming in the Clinch River near H-1, JCH; Apr 5, 1958, 1, WOL, PD.

24. Norway Rat (Rattus norvegicus) - Uncommon. This species probably now occurs in Melton Valley only as occasional wanderers. Prior to 1942 when parts of the valley were being farmed it is virtually certain that this animal was common in the barns. In the Controlled Area outside of Melton Valley, it now occurs in and about at least some of the barns of the UT-AEC Farm. Probably it occurs in and about many of the buildings on the Controlled Area. Records:

Sept. 2, 1957, 1, y, m, WOL, PD; July 25, 1958, 1, road kill near G-6, PD; Aug. 1, 1958, 1, sa, UT-AEC Cow Barn, JCH.

25. House Mouse (Mus musculus) - Fairly common. The House Mouse requires open areas such as occur about houses and cultivated fields. Doubtless this species is found in and about many of the buildings on the Controlled Area. During the early stages of plant succession which followed the draining of White Oak Lake during the fall and winter of 1955-1956 this species was common. Many were live-trapped during a trapping period extending from Oct. 13, 1956, to Sept. 2, 1957 (see records below). As the sparse vegetation of the first stage of plant succession gave way to the denser growth of later stages this species rapidly decreased in number. In the live trapping period of Apr. 6 to Aug. 5, 1958, only one House Mouse was taken. Records: Oct. 13, 1956 to Sept. 2, 1957, 43, ads, sas, and y, 24 ms and 16 fs, and 3 u, WOL, PD; Mar. 18 to Aug. 1, 1958, 2, 1 m and 1 f, control area, PD; Apr. 6 to Aug. 5, 1958, 1, m, WOL, PD.

26. Eastern Cottontail (Sylvilagus floridanus) - Common. Rabbits are found in all parts of Melton Valley and the Controlled Area. They are most numerous in and near old fields, only a few occur in the wooded areas and these are usually near an opening. Despite the fact that the Cottontail is chiefly a nocturnal mammal they are regularly seen feeding along the edges of roads at both ends of the daylight period. Sight records are too numerous to list and the same is true of road kills.

27. Whitetail Deer (Odocoileus virginianus) - Uncommon. Captain Snyder states that this species is currently most numerous in that part of the Controlled Area lying in Roane County. It is his belief that this species probably entered the area in the vicinity of the Blair Gate. It seems probable that if this species is permitted to increase without interference it will become abundant within a decade. Records: Nov. 6, 1957, 1, shot near the UT-AEC Cow Barn; Nov. 24, 1957, 1, tracks observed, WOL, PD; July 7, 1958, 1, tracks observed near F-4, JCH.

REFERENCES

Allee, W. C., A. E. Emerson, O. Park, T. Park, and K. P. Schmidt, 1949, Principles of Animal Ecology, W. B. Saunders Co., Philadelphia.

Auerbach, S. I., 1958, Health Physics Division Annual Progress Report for Period Ending July 31, 1958. ORNL-2590.

Burt, W. H., 1957, Mammals of the Great Lakes Region, University of Michigan Press, Ann Arbor.

Calhoun, J. B. and A. A. Arata, 1957, 1955 and 1956 Annual Reports - North American Census of Small Mammals, and Certain Summaries; Population Dynamics of Vertebrates. Compilation of Research Data, Release No. 9, U. S. Dept. Health, Education, and Welfare.

Conaway, C. H. and J. C. Howell, 1953, "Observations on the Mammals of Johnson and Carter Counties, Tennessee, and Avery County, North Carolina". Journal of the Tennessee Academy of Science, 28 (1): 53-61.

Hilbert, D. L., 1954, A Study of the Small Mammals and Their Home Ranges on a Nine-Acre Plot of Mature Deciduous Woods Near Norris Dam. Unpublished M.S. thesis study, University of Tennessee.

Howell, J. C., 1954, "Populations and Home Ranges of Small Mammals on an Overgrown Field". Journal of Mammalogy, 35 (2): 177-186.

Howell, J. C., 1958, Observations on the Summer Birds in Melton Valley, ORNL CF-58-6-14.

Howell, J. C. and C. Conaway, 1952, "Observations on the Mammals of the Cumberland Mountains of Tennessee". Journal of the Tennessee Academy of Science, 27 (2): 153-158.

Krumholz, L. S., 1954, A Summary of Findings of the Ecological Survey of White Oak Creek, Roane County, Tennessee, 1950-1953, U.S.A.E.C. ORO-132. Technical Information Service, Oak Ridge, Tenn.

Miller, W. T., 1955, Radioactivity in Miscellaneous Animals Caught in the X-10 Waste Disposal System. (Unpublished multilithed memorandum of September 14, 1955, to J. C. Hart)

Morgan, K. Z., 1957, Health Physics Division Annual Progress Report for Period Ending July 31, 1957. ORNL-2384.

Palmer, R. S., 1954, The Mammal Guide, Doubleday and Co., Garden City, N. Y.

Swann, M. E., W. Roberts, E. H. Hubbard, and H. C. Porter, 1942, Soil Survey of Roane County, Tennessee, U. S. Dept. Agriculture, Series 1936, No. 15, 1-125.

Thomas, R. E., 1958, Summary of Rabies Control Program. (Unpublished, mimeographed report to files, UT-AEC Agricultural Research Farm)

INTERNAL DISTRIBUTION

1. C. E. Center
2. Biology Library
3. Health Physics Library
4-5. Central Research Library
6-29. Laboratory Records Department
30. A. M. Weinberg
31. J. A. Swartout
32. W. H. Jordan
33. K. Z. Morgan
34. W. S. Snyder
35. E. E. Anderson
36. C. P. Keim
37. A. Hollaender
38. K. E. Cowser
39. E. G. Struxness
40. J. C. Hart
41. G. E. Cosgrove
42. D. Brogan
43. M. A. Kastenbaum
44. J. R. Muir
45. R. J. Morton
46. A. C. Upton
47. C. C. Congdon
48. T. T. Odell
49. R. R. Ritchie
50. R. P. Birkhoff
51. D. M. Davis
52. T. A. Lincoln
53. M. J. Cook
54. C. E. Haynes
55. T. H. J. Burnett
56. G. S. Hurst
57. E. D. Gupton
58. H. H. Abee
59. M. F. Fair
60. F. L. Parker
61. B. R. Fish
62. W. H. Langham (consultant)
63. ORNL-Y-12 Technical Library, Document Reference Section
64. M. J. Skinner
65. D. A. Crossley
66. J. S. Olson
67. D. J. Nelson
68-167. S. I. Auerbach
168-217. P. B. Dunaway

EXTERNAL DISTRIBUTION

218. John N. Wolfe, Division of Biology and Medicine, AEC, Washington
219. Vincent Schultz, Division of Biology and Medicine, AEC, Washington
220. C. S. Shoup, AEC - ORO
221. Nathan S. Hall - UT AEC Experimental Farm
222. John W. Ball - UT AEC Experimental Farm
223. R. E. Thomas - UT AEC Experimental Farm
224. Orlando Park, Cresap Biological Laboratories, Northwestern University Evanston, Illinois
225. Eugene Odum, Department of Zoology, University of Georgia, Athens, Georgia
226. Joseph Camin, Chicago Academy of Sciences, 2001 N. Clark St., Chicago, Illinois
227. H. F. Howden, Insect Identification Section, Science Service, Department of Agriculture, Ottawa, Canada
228. Division of Research and Development, AEC, ORO
229. Francis Evans, Department of Zoology, University of Michigan, Ann Arbor

EXTERNAL DISTRIBUTION (Cohtd)

230. J. J. Davis, Hanford Atomic Project, Biology Division
231. Royal Shanks, Department of Botany, University of Tennessee
232. Robert Platt, Department of Biology, Emory University, Atlanta, Georgia
233. William Dryer, Department of Zoology, University of Cincinnati, Cincinnati, Ohio
234. Capt. W. B. Snyder - AEC Patrol
235. Zola M. Fineman - Health Physics, N.R.T.S., Idaho Falls, Idaho
236. Frank Golley - Department of Zoology, University of Georgia, Athens, Georgia
237-286. J. C. Howell, Department of Zoology, University of Tennessee
287-301. TISE, AEC

2-31 CRRF 2.7-22 PMC-368 Pt 2, REFERENCE 2-31

MAMMALS OBSERVED OR TRAPPED ON THE OAK RIDGE RESERVATION sect. 2.7

FAMILY	GENUS	SPECIES	COMMON NAME
Didelphiidae			
	Didelphis	marsupialis	Virginia opossum
Talpidae			
	Scalopus	aquaticus	Eastern mole
Soricidae			
	Sorex	longirostris	Southeastern shrew
	Cryptotis	parva	Least shrew
	Blarina	brevicauda	Shorttail shrew
Vespertilionidae			
	Myotis	lucifugus	Little brown bat
	Myotis	keenii	Keen's bat
	Myotis	sodalis	Indiana bat
	Lasionycteris	noctivagans	Silver-haired bat
	Pipistrellus	subflavus	Eastern pipistrelle
	Eptesicus	fuscus	Big brown bat
	Lasiurus	borealis	Red bat
	Lasiurus	cinereus	Hoary bat
	Nycticeius	humeralis	Evening bat
Procyonidae			
	Procyon	lotor	Raccoon
Mustelidae			
	Mustela	frenata	Longtail weasel
	Mustela	vison	Mink
	Mephitis	mephitis	Striped skunk
Canidae			
	Vulpes	fulva	Red fox
	Urocyon	cinereoargentius	Gray fox
Felidae			
	Lynx	rufus	Bobcat
Sciuridae			
	Marmota	monax	Woodchuck
	Tamias	striatus	Eastern chipmunk
	Sciurus	carolinensis	Eastern gray squirrel
	Glaucomys	volans	Southern flying squirrel
Cricetidae			
	Reithrodontomys	humulis	Eastern harvest mouse
	Peromyscus	leucopus	Whitefooted deer mouse
	Ochrotomys	nuttalli	Golden mouse
	Oryzomys	palustris	Rice rat
	Sigmodon	hispidus	Hispid cotton rat
	Microtus	pinetorum	Pine vole
	Ondatra	zibethica	Muskrat
Muridae			
	Rattus	norvegicus	Norway rat
	Mus	musculus	House mouse
Leporidae			
	Sylvilagus	floridanus	Eastern cottontail
Cervidae			
	Odocoileus	virginianus	Whitetailed deer

J.D Story (ORNL)

Section 2.7.1
reference 8R

{ REFERENCE 2-32

Large Animals

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION

POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37830

December 19, 1973

Jerry Webb
Tennessee Wildlife Resources Agency
216 East Penfield Street
Crossville, Tennessee 38555

Dear Jerry:

In response to your telephone request yesterday, I am enclosing a map showing the locations of all cougar and large cat sitings that have been reported to me for the Oak Ridge Reservation. I have also listed these reports which are rather "sketchy" in content and for which I do not have the name of the observer, even though they may be of little use.

1944 or 1945: An employee here at X-10 who lived in this area before the government purchased the land in the early 1940's told me a "mountain lion" was killed on the farm near the U.T. Comparative Animal Research Laboratory. The owners of the farm are no longer living.

Early 1950's: In the mid-1960's an AEC guard (no name) told me he and his wife got a good look at a lion as it crossed Highway 95 about midnight. The animal was tan in color and had a long tail. This was during the time when a pontoon bridge was carrying traffic across the Clinch while the bridge below Melton Hill Dam was being constructed.

1957 or 1958: Cougar seen by Corbett Brashear, X-10 employee, in 7500 area of X-10 facility about dusk one evening.

1966 or 1967: Mr. Blevins, X-10 employee, saw a tan cougar southwest of X-10 facility.

1968: Tan cougar seen by Mr. Blevins, X-10 employee, on Bear Creek Road about 150 yards north of old Gallaher Bridge site.

1969 or 1970: No information other than location.

1971: No information other than location.

Spring 1975: Large, long-tailed cat crossed Bethel Valley Road in front of two X-10 guards, Justice and Clowers.

Summer 1975: Big, long-tailed cat, tan in color, crossed Bethel Valley Road in front of Julian Hackney, X-10 employee, about lunch time. Mr. Hackney was reluctant to talk about siting because he was sure nobody would believe him.

Fall 1975: No information other than location.

December 23, 1975: X-10 laborer, White, saw large, long-tailed, reddish-brown cat near 7500 area of X-10 site about 9:00 AM.

February 27, 1976: No information other than location.

March 12, 1976: Large (80-100 pounds), long-tailed cat reddish-brown in color. Tail appeared darker color than rest of body with tip very dark. Animal's overall color was very similar to that of a deer in summer coat. Animal was seen about 9:45 PM near North Portal of X-10 facility on Bethel Valley Road by Jay Story.

August 18, 1976: Reported to me by TWRA officer, Bill Holladay, who received report from lady who had hit a deer with her car near this site on Blair Road. She just told him of seeing a mountain lion.

July 1976: Seen by X-10 guard, Roop, near DOSAR facility. Described as large cat with long tail of large diameter and colored like a deer.

Summer 1976: Seen by Pete Van Voris and Sherwood Foster, X-10 employees. Described as cougar weighing 75-80 pounds, gray-brown color, with long tail. 7:45 AM.

November 26, 1976: Joanie Walls, X-10 employee, saw a large, black, long-tailed cat near west end of X-10 facility late at night.

December 3, 1976: Dave Shriner, X-10 Ph.D., reported hearing screams of large cat about ten times over five minute period around 11:00 PM. Dave's property adjoins Reservation land on south side of East Fork Ridge.

January 17, 1977: TVA employee, Steve Millsap, (phone 632-3655) reported finding cougar tracks in snow on Blackoak Ridge just north of ORGDP.

April 4, 1977: X-10 Fire Captain, Pat Whaley, and guard, Sproles, watched a large, long-tailed cat trying to find a place to cross rain-swollen White Oak Creek just south of X-10. Whaley said animal was 2-3 feet long with tail almost that long and half of tail (end) appeared black.

April, 1977: Employee at X-10 steam plant saw an animal he at first thought was a small deer but when he got closer he saw that it was a big cat with a long tail. This was near White Oak Dam on Highway 95 about midnight.

May 31, 1977: X-10 guard, Eslinger, reported seeing a large, long-tailed cat sitting in the road eating a rabbit. Cat was reddish brown and would weigh maybe 80 pounds. This was on Melton Valley Drive south of X-10.

October, 1977: K-25 guard, C. E. Norden, and another guard saw a large, long-tailed cat near old Gallaher Bridge late at night.

October, 1977: X-10 guards, Pratt and Hughes, saw two small cougar-type animals near DOSAR facility. These animals were reported too big for tom-cats or bobcats and had long tails. On the same night these men did observe a bobcat in a different area.

December, 1977: Large, brown, long-tailed cat observed by X-10 employee, J. T. Davis, Jr., about 3:30 PM on gravel road southeast of X-10.

December 13, 1977: Big cat sighted near Eaton's Crossroads and reported to TWRA officer, Fonda Payne.

January 1, 1978: No details. Cougar sited same night by two X-10 guards near 7530 area.

August 11, 1978: Large, black, long-tailed cat (body 4 feet, tail 3 feet long) about 5:30 PM on Bethel Valley Road near west entrance to X-10 by Tom Coker, X-10 employee, and his wife. Tom called me from Nashville that night to ask if we were supposed to have such animals on the Reservation.

November 30, 1978: Mr. Ruth, X-10 employee (I&C Division), told me his brother was on a bow hunt in Scott County west of Pocket Wilderness this fall and saw an adult cougar jump over a fallen tree. This animal was then followed by two young cats which climbed through the branches of the tree. Mr. Ruth's brother and his wife later tracked these animals for some distance in a rather muddy road til the cats left the road, going into the woods. The man's wife was reportedly so unnerved by the presence of the animals that she spent the night in their car.

1978: I have been unable to track down the man who saw this animal, but a cougar was reported seen sitting on a dumpster in the 7500 area south of X-10.

I hasten to mention that as of now I have no solid evidence of the cougar's presence here on the Oak Ridge Reservation. Of course, several of us here at ORNL are hoping to find some kind of evidence eventually and maybe with patience and perseverance we will finally come up with a good cast of a cougar track, or a scat sample, or a photo of the critter, or a freshly killed deer carcass.

You might be interested to know that I sent in a TWRA found dead form on a roadkilled beaver and will have another for this year. The '77 beaver was killed on 95 at White Oak Dam, and the '78 beaver, a young one, was killed on the paved road going into Melton Hill Dam on the Reservation side of the river.

I have also received two reports of possible coyote sitings on the Reservation during the year. The first was near the junction of 58 and 95, and the observer was not sure about what he saw, but the second was north of Oak Ridge Turnpike (95) about one mile west of the old guard building. The second siting was made by one of our (Env. Sci. Div.) Ph.D.'s who is quite familiar with coyotes from living in the midwest, and he was confident the animal he saw was a coyote.

I have received two reports from people who have seen black bear near here during 1978. One was seen by two fishermen back in early fall as it was swimming across the mouth of Beaver Creek. The men got close enough to positively identify the animal and watched it continue to the north bank of Beaver Creek where it climbed out of the water and went into the woods. The second report came from X-10 guard, Justice, whose parents saw a black bear cross the road in front of them as they were traveling through the Sugar Grove area northwest of our K-25 (ORGDP) facility. The bear was reportedly as big as any the Justices had seen in the Smoky Mountains.

I appreciate your interest in the cougar reports and will be glad to supply these and other animal observations to you on a routine basis if you find them useful.

Sincerely,

Jay D. Story
Science Technologist
Environmental Sciences Division
Building 1505

JDS:sgl

Enclosure

THREATENED WILDLIFE OF THE UNITED STATES

1973 EDITION

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

THREATENED WILDLIFE OF THE UNITED STATES

Compiled by

Office of Endangered Species and International Activities
Bureau of Sport Fisheries and Wildlife
U.S. Department of the Interior

RESOURCE PUBLICATION 114, March 1973
(Revised Resource Publication 34)

Published by the Bureau of Sport Fisheries and Wildlife
Printed at the U.S. Government Printing Office
Washington, D.C., March 1973

SOUTHERN BALD EAGLE — Haliaeetus l. leucocephalus (Linnaeus)

Order: FALCONIFORMES — Family: ACCIPITRIDAE

Distinguishing characteristics: Large, hawk-like, soaring bird, plumage mainly dark brown with pure white head and tail when adult. Brown blotched with white all over when immature. Distinuished from the other race of the species, the northern bald eagle, only by smaller size.

Present distribution: Nests primarily in estuarine areas of Atlantic and Gulf coasts, locally from New Jersey to Texas, and lower Mississippi Valley southward from eastern Arkansas and western Tennessee, and through southern States west to California and Baja California. Some birds wander northward in summer after nesting season to northern United States and southeastern Canada. Adult population of southern Florida essentially resident.

Former distribution: More extensive, but locally, in the southern United States the same as at present.

Status: Generally decreasing. Reproduction apparently less successful than formerly except in Everglades National Park, where about 52 pairs nested in 1965 with a success of 50 percent and a production of 1.46 young per successful nest.

Estimated numbers: About 235 active nests in 1965, 99 of which were successful.

Breeding rate in the wild: Normally, about 1.5 young per successful nest.

Reasons for decline: Increase in human population in primary nesting areas. Disturbance of nesting birds, illegal shooting, loss of nest trees, and possible reduced reproduction as a result of pesticides ingested with food by adults.

Protective measures already taken: Federal laws in the United States protect both the bald and golden eagles. The Bureau of Sport Fisheries and Wildlife and the State game departments enforce these laws. The Bureau is also studying the effects of pesticides on bald eagles. Eight National Wildlife Refuges in the southeastern United States have bald eagles nesting on them. The National Audubon Society is conducting intensive investigations of bald eagle distribution, status, breeding biology, and limiting factors. Florida Audubon Society has obtained agreements with landowners for 2,300,000 acres where nests are located to be treated as bald eagle sanctuaries. The Society makes annual inspections of these nesting sites. Access to eagle nesting areas on National Wildlife Refuges is restricted. Timber cutting, road traffic, and pesticide use have been reduced or eliminated. Cooperation of the public is being sought in reducing human activity in areas adjacent to refuges in vicinity of eagle nests. Potential nest sites (trees) are being preserved in existing and promising nesting areas. The Patuxent Wildlife Research Center has developed facilities where propagation of the northern and southern races is underway. The Center is studying pesticidal contaminants in the environment of the bald eagle and is developing captive propagation methods to produce birds to bolster wild populations or restore breeding pairs to depleted habitat.

Measures proposed: Continued surveillance of nest sites to determine success of production and to learn reasons for failures. Continued research on effects of pesticides and other presumed limiting factors. Educational programs and personal contacts with local residents and landowners in bald eagle nesting areas to obtain maximum interest and cooperation in protecting these birds and their nests. Secure cooperation of other agencies in reducing and eliminating spraying of DDT.

Number in captivity: At least 50.

Breeding potential in captivity: Limited.

References:

Broley, C. L. 1958. The plight of the American Bald Eagle. Audubon Magazine, 60:162-163, 171.

Cunningham, R. L. 1960. The status of the bald eagle in Florida. Audubon Magazine, 62:24-26, 41, 43.

Imler, R. H. and E. R. Kalmbach. 1955. The bald eagle and its economic status. U.S. Fish and Wildlife Service Circular, 30:1-51.

Robbins, C. S. 1960. Status of the bald eagle summer of 1959. U.S. Fish and Wildlife Service Leaflet, 418:1-8.

Robertson, W. B. Park Naturalist, Everglades National Park, Homestead, Florida. (in lit. 1964).

AMERICAN PEREGRINE FALCON — Falco peregrinus anatum (Bonaparte)

Order: FALCONIFORMES — Family: FALCONIDAE

Distinguishing characteristics: Medium-sized hawk with long, pointed wings and long tail. Rapid, shallow wing beats. Adult is slate gray above, wing and tail feathers and flanks barred with black. Moustache marks on side face black. Throat white. Below white and reddish buffy, extensively spotted and barred with black. Legs and feet yellow. Immature brown above, streaked below. Larger, darker, and black markings on face more extensive than Arctic peregrine (F. p. tundrius); paler and more reddish, less grayish below than Peale's peregrine.

Present distribution: Breeds from non-Arctic portions of Alaska and Canada south to Baja California (except coast of southern Alaska and British Columbia), central Arizona and Mexico (locally); eastern limits presently follow eastern front of the Rocky Mountains in the United States; distribution local in the southern boreal forests of Canada and a few pairs still breed in Labrador. Winters chiefly in breeding range, but more northern birds move to south. Other races occur on Pacific coast of British Columbia and southern Alaska in Arctic North America and other parts of the world.

Former distribution: Same, but breeding distribution also included Eastern United States south to Georgia; also Ontario, southern Quebec and the Maritime Provinces of Canada.

Status: Extirpated as a breeding bird east of the Rocky Mountains in the United States, in Ontario, southern Quebec, and the Maritimes. Local declines reported from the western United States also taiga in Yukon Territory, Mackenzie District, and interior Alaska (Cade and Fyfe). Eggshell thickness reduced 15 to 20 percent since 1947 (Hickey and Anderson, Cade and Fyfe, Cade et al.), and taiga eggs average more than 600 ppm DDE (lipid basis); there is a highly significant negative correlation between shell thickness and DDE concentration in eggs (Cade et al.).

Estimated numbers: Number of known aeries with adults present in 1969-70, but not all producing young: British Columbia, 19 (J. Simonyi); Alberta, 3 (R. Fyfe); southern Labrador, 2 (R. Fyfe); California, 2 (H. L. Leach); Oregon, 2 (D. B. Marshall); western Mexico, 14 (M. Kirven); Arizona, 2 (J. Enderson); New Mexico, 2 (J. Enderson); Utah, 0 (C. M. White); Colorado, 6-8; Wyoming, 1; Montana, 1 (J. Enderson); Texas, 3-5 (C. M. White). Recent information lacking for Washington, Idaho, and Nevada but Nelson (in Hickey, 1969) estimated only 10 to 20 percent of pairs remaining in 1965. A few hundred pairs still breed in interior Alaska and taiga of Northwestern Canada principally along major rivers. Status in eastern Canadian boreal forest unclear but evidently not numerous.

Breeding rate in the wild: 3 or 4 eggs per set. Number of pairs laying eggs and hatching success low in southern part of range (Herman et al.); reproductive rate and number of breeding pairs also decreasing in taiga populations (Cade and Fyfe).

Reasons for decline: All field and laboratory evidence points to cumulative effects of chlorinated pesticides and their breakdown products obtained from its prey, especially DDT and DDE, which have increased adult mortality and reduced production of young by affecting reproductive mechanisms and causing eggs to become thin-shelled or otherwise nonviable. Habitat destruction and collection of young and adults for falconry have also been factors.

Protective measures already taken: Peregrine falcons are protected by Federal law and by States in the United States. Propagation techniques are being studied by Government and private investigators and at Cornell University.

Measures proposed: Eliminate use of food chain pesticides where possible. Responsible agencies should set appropriate regulations for the protection of this species. Include in international conservation agreements. Develop methods for captive propagation to bolster wild population. Initiate management-oriented research and investigate the establishment of refuges around known eyries.

Number in captivity: Not precisely known, but number of peregrines from south of the taiga in possession of falconers, zoos, and captive breeding projects believed to be less than 20 (Cade).

Breeding potential in captivity: Probably poor.

References:

Berger, D. D., D. W. Anderson, and R. W. Risebrough. 1970. Shell thinning in eggs of Ungava peregrines. Canadian Field-Nat. 84:265-267.

Bond, R. M. 1946. The peregrine population of western North America.

Cade, T. J. 1960. Ecology of the peregrine and gyrfalcon populations in Alaska. Univ. Cal. Pub. Zool. 63:151-290.

_____, C. M. White, and J. R. Haugh. 1968. Peregrine and pesticides in Alaska. Condor 70:170-178.

_____, and R. Fyfe. 1970. The North American peregrine survey, 1970. Canadian Field-Nat. 84:231-245.

_____, J. L. Lincer, C. M. White, D. G. Roseneau, and L. G. Swartz. 1971. DDE residues and eggshell changes in Alaskan falcons and hawks. Science (in press).

Henderson, J. H. and D. D. Berger. 1968. Chlorinated hydrocarbon residues in peregrines and their prey species from northern Canada. Condor 70:149-153.

Herman, S. G., M. N. Kirven, and R. W. Risebrough. 1970. The peregrine falcon decline in California I. A preliminary review. Audubon Field Notes 24(4):609-613.

Herman, S. G. 1971. The peregrine falcon decline in California; breeding status in 1970. Calif. Fish & Game Spec. Wildlife Investigations Report.

Hickey, J. J. (editor). 1969. Peregrine falcon populations, their biology and decline. University of Wisconsin Press, Madison, 596 pp.

_____ and D. W. Anderson. 1968. Chlorinated hydrocarbons and eggshell changes in raptorial and fish-eating birds. Science 162:271-273.

Leach, H. R. and L. D. Fisk. 1972. At the crossroads--a report on California's endangered and rare fish and wildlife. California Dept. of Fish & Game.

Marshall, D. B. 1969. Rare and endangered plants and animals of Oregon, Part 3. Birds. Extension Division, Oregon State University.

White, C. M. 1968. Diagnosis and relationships of the North American tundra inhabiting peregrine falcons. Auk 85:179-191.

RED-COCKADED WOODPECKER — Dendrocopos borcalis (Vicillot)

Order: PICIFORMES — Family: PICIDAE

Distinguishing characteristics: Small woodpecker with black and white horizontal stripes on back, white cheeks and under parts, flanks black streaked. Cap and stripe on side of throat and neck black. Male has a small red spot on each side of black cap.

Present distribution: Resident in open, old age pine woodlands from Southeastern Oklahoma, Arkansas, Western Kentucky, Southeastern Virginia south to Gulf Coast and southern Florida.

Former distribution: Southern Missouri, Western Kentucky, and southeastern Virginia, south to Gulf Coast and Southern Florida.

Status: Vulnerable, because of limited number of specialized nesting sites in old, living pines infected with red-heart disease, and current trend in forestry practice to eliminate such trees.

Estimated numbers: Estimate 3,000 to 10,000 but uncommon and very local.

Protective measures already taken: Federal and some State forestry agencies have policies of saving some large pine trees infected with red-heart disease in limited areas where red-cockaded woodpeckers are known to occur.

Measures proposed: Managing blocks of land to provide all necessary habitat requirements.

Number in captivity: None known.

Breeding potential in captivity: Probably poor.

References:

Bent, A. C. 1939. Life histories of North American woodpeckers. U.S. Nat. Mus. Bull. 174: 72-79.

Czuhai, E. 1971. Synoptic review of forest resource and use within the range of the red-cockaded woodpecker. In the Ecology and Management of the Red-cockaded Woodpecker, Proc. Symposium at Okefenokee Nat. Wildlife Refuge, Folkston, Ga. May 26-27, 1971, sponsored by Bureau of Sport Fisheries and Wildlife and Tall Timbers Research Station.

Dennis, J. V. 1972. Red-cockaded woodpecker. National Parks and Conservation Magazine. 46(4): 24-27.

Jackson, J. A. 1971. The evolution, taxonomy, distribution, past populations and current status of the Red-cockaded woodpecker. In The Ecology and Management of the Red-cockaded Woodpecker, Proc. Symposium at Okefenokee Nat. Wildlife Refuge, Folkston, Ga. May 26-27, 1971, sponsored by Bureau of Sport Fisheries and Wildlife and Tall Timbers Research Station.

Lay, D. W., and D. N. Russell. 1970. Notes on the Red-cockaded woodpecker in Texas. Auk 87: 781-786.

Morse, D. 1972. Habitat utilization of the red-cockaded woodpecker during the winter. Auk 89:429-434.

Thompson, R. L. and W. W. Baker. 1971. A survey of red-cockaded woodpecker habitat requirements. In The Ecology and management of the red-cockaded woodpecker, Proc. Symposium at Okefenokee Nat. Wildlife Refuge, Folkston, Ga. May 26-27, 1971, sponsored by Bureau of Sport Fisheries and Wildlife and Tall Timbers Research Station.

STATUS-UNDETERMINED BIRDS

A status-undetermined species or subspecies is one that has been suggested as possibly threatened with extinction, but about which there is not enough information to determine its status. More information is needed.

Wood, Ibis, Mycteria americana
Resident from Florida and Gulf Coast south on both coasts of Mexico and central America to southern South America.

White-Faced Ibis, Plegadis chihi
Breeds from eastern Oregon, southern Idaho, northern Utah, Colorado, and Nebraska south locally to southern South America.

Red-Bellied Red-Shouldered Hawk, Butei lineatus elegans
Resident in Sacramento and San Joaquin Valleys and southern coastal lowlands of California south to northern Baja California.

Puerto Rican Broad-Winged Hawk, Buteo platypterus brunnescens
Resident locally in small numbers in Puerto Rico chiefly in El Yunque but also at Utuado and Maricao.

Ferruginous Hawk, Buteo regalis
Breeds from eastern Washington and southwestern Manitoba south to Nevada and western Oklahoma. Winters chiefly from southwestern United States south to northern Mexico.

American Osprey, Pandion haliaetus carolinensis
Breeds from northern Alaska south to Baja California and Sonora, east to southern Labrador, Newfoundland, and southern Florida. Winters from southern United States south to South America.

Audubon's Caracara, Caracara cheriway audubonii
Resident from southern Arizona, southern Texas, and central Florida south to western Panama and Cuba.

Northern Aplomado Falcon, Falco fermoalis septentrionalis
Bred formerly from southern Arizona, southwestern New Mexico, and southern Texas south to southern Mexico.

Prairie Pigeon Hawk, Falco columbarius richardsonii
Breeds from southern Alberta, southern Saskatchewan, and southwestern Manitoba south to northern Montana and northern North Dakota. Winters from Wyoming and California south to northern Mexico.

Eastern Pigeon Hawk, Falco c. columbarius
Breeds from northern Manitoba east to Labrador and Newfoundland south to northeastern North Dakota, northern Minnesota, northern Michigan, northern New York, Maine, and Nova Scotia. Winters from southern Texas east to South Carolina and south to the West Indies and northern South America.