Field Study of the Environmental Factors Which Affect Bird Activity

G. A. Hesterberg

1947

Field Study of the Environmental Factors Which Affect Bird Activity

by

G. A. Hesterberg

1947

A Thesis

Submitted in partial fulfillment

of the requirements for the Degree of

Master of Forestry

In the University of Michigan

CONTENTS

Field Study of the Environmental Factors Which Affect Bird Activity[1]

By G. A. Hesterberg

Meteorological factors play an important role in the life of all organisms. They determine, in combination with other environmental conditions, their geographic and local distribution and exert influences that may regulate the rate of development of animals and plants. Cold-blooded animals are especially susceptible to meteorological effects, but even such warm-blooded animals as birds and mammals are profoundly affected by changes in environmental factors.

A good, fair or poor pheasant hunting season in Michigan may be determined by amounts and distribution of spring and early summer rainfall. The northern distribution of the Bobwhite quail may be limited by snowfall and low winter temperatures in the Lake States. Observations reported by Emlen and Glading (1945) indicate the value of loafing cover for the California Valley quail as protection from hot summer sun. These examples illustrate the importance of environmental factors in the management of wildlife resources. The results of investigations reported in this paper contribute information on certain of these physical effects.

Description of Study Area

With but few exceptions, all data for this study were gathered on the Rad-rick Farm, approximately 5 miles east of Ann Arbor, Washtenaw County,

---

[1]The author wishes to express thanks to Dr. S. A. Graham for his supervision and constructive views towards the completion of this paper; to Dr. Warren W. Chase for his interest in and guidance of the summer's field work; and to Mr. F. C. Matthaei for permission to use the Rad-rick Farm as a field study area.

Michigan. This area was chosen as representative of certain land practices in the locality, contained a good population of summer resident birds, and was well fenced to prevent damage or molestation of instruments.

The study area centered around a 30 acre, ungrazed, mature oak-hickory woodlot, growing on sandy to gravelly soil, most of which would be classified as Bellfountaine sandy loam. Black and red oak with lesser amounts of white oak and hickory were the chief species and occasional trees reached 26 inches D. B. H. The lower story of the woods consisted of reproduction of these predominant trees with some Basswood, Black Cherry, Choke Cherry, Hawthorn and several kinds of shrubs. Fence rows in the area contained similar species of plant growth. Some grasses, mainly bluegrass, grew along the edges of the woodlot and in the fence rows. Plant associations adjacent to the study area were clover in cultivation on the south side, a large bluegrass pasture on the north and east sides and sub-climax sumach-poplar growth west of the woods. The area was generally flat to gently rolling with exception of the steep slope formed by an abandoned gravel pit west of the woodlot. In appearance, the fence row cover was rather dense, especially when compared with similar cover on intensively managed lands adjacent to the Rad-rick Farm.

Method of Procedure

The purpose of this project was to study the effect of summer temperature upon tne behavior of birds in their natural environment. The study was limited to a single area where daily observations were made of meteorological conditions and the reactions of birds to them. Temperature, light, evaporating power of the air, relative humidity and precipitation were measured at four different stations and observations of bird activity were made under these known physical conditions.

Plate 1. Station #1. This illustrates the method of placing black and white atmometers and maximum-minimum thermometers. Atmometers are 4.5 feet above ground in oak-hickory woodlot.

At the permanent stations, daily observations were made using standardized Livingston atmometers and maximum-minimum thermometers. One station was in the open where the instruments were placed on an orange crate and three stations were along the east edge of the woodlot previously described. One was in a draw, one on a slight rise of ground and a third midway down a slope. Data from the three stations were averaged. Atmometers were taped to the south side of trees at breast height and the maximum-minimum thermometer was placed below them. (See Plate 1.)

Along with these meteorological records, field observations were made on various species of birds to associate their activity with existing physical conditions. During the summer, over eight hundred observations were made. This field work was done between noon and late afternoon because this was the time temperature would reach a maximum. Figure 1 shows the number of observations that were made at different temperatures.

When a bird was first observed, its reaction to temperature was noted. The species, number of individuals and place where activity occurred were then recorded. The time of day was noted and the habitat temperature was measured and recorded along with a brief description of the activity.

To simplify compilation of data, a form was used on which was recorded:

1. Species and number of individuals.
2. Specific activity noted.
3. Place of activity (woods, fence row, brush area or in open).
4. Temperature at the point of action.
5. Time of day.
6. Whether the birds observed gave evidence of high air temperature reaction.

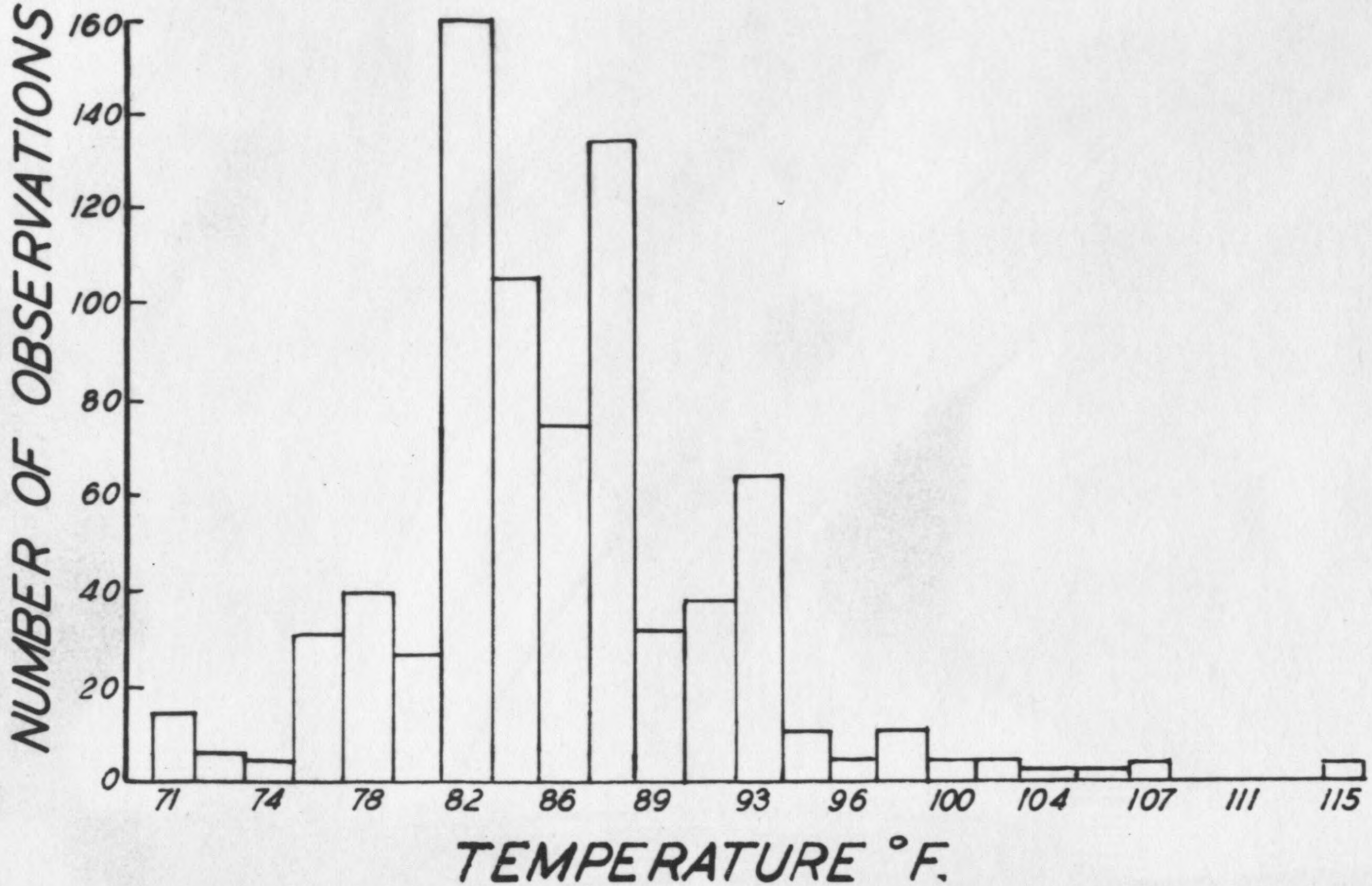

Figure 1. Number of observations at each temperature. A relatively cool summer resulted in fewer observations in high temperature ranges.

Field Techniques

Every effort was made to avoid disturbing the birds so they could be observed in their natural environment. To accomplish this, the study area was cruised each afternoon with the path of travel parallel to woods edge and fence rows. In general, the greatest number of birds were observed along these wooded margins. Movement was slow enough to allow the observer ample time to watch ahead and seek out birds before they flushed. It was an advantage to sit down and watch from time to time, so as to avoid too much disturbance.

When a bird was first seen, it was immediately viewed through binoculars. The 7 x 50 binoculars used had coated lenses which increased both light gathering power and reduced glare. These glasses aided the observer by making the temperature reaction of the birds clearly and easily recognizable.

In all observations, first consideration was given to whether or not there was visible evidence of high temperature reaction; for example, a bird opening its mouth in respiration or compressing the contour feathers tightly against the body in contrast with a more loose and fluffy appearance. Sometimes the wings, when at rest were drooped or held slightly away from the body when birds showed reaction to heat.

The temperature to which the bird was subjected at the time of observation was determined by placing a centigrade thermometer where the bird was observed.

Weather data and instrument readings were recorded daily during the period June 20 to August 20, 1946. These records, kept in a field journal separate from the observations on bird activity, were made every afternoon after the daily maximum temperature had been reached.

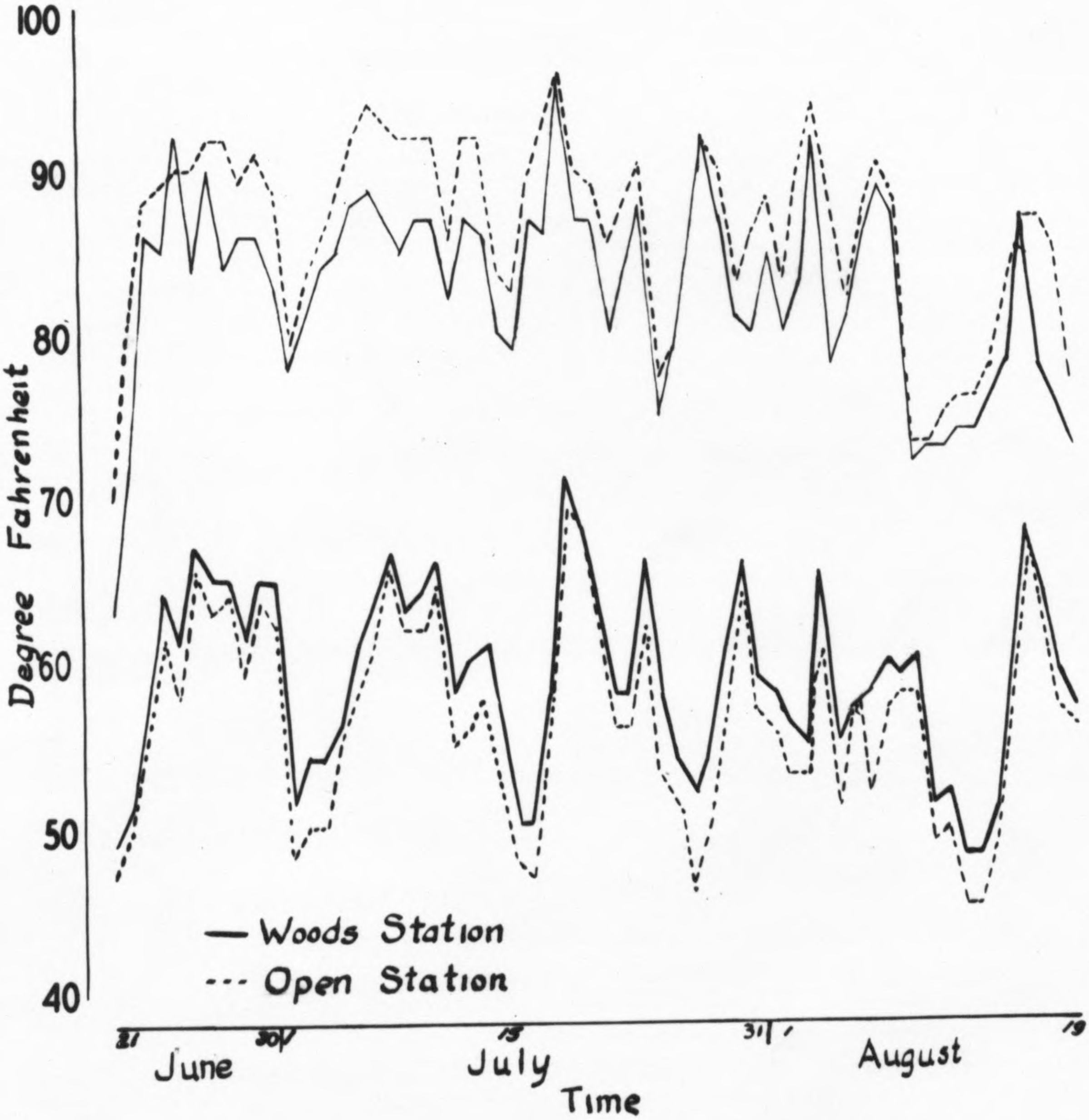

Figure 2. Distribution of maximum-minimum temperatures throughtout the period June 21-August 19, 1946. No correlation is apparent between these maximum temperatures as they effected bird activity.

The following meteorological data were recorded:

1. Date and hour of record.
2. Maximum-minimum temperatures for the twenty-four hour period.
3. Differences in Livingston atmometer cups (black minus white reading).
4. Relative humidity using sling psychrometer.
5. Rainfall for the twenty-four hour period.

Analysis of Meteorological Data

By measuring meteorological factors, it was hoped to determine their effect on bird activity in the natural habitat. Temperature was given important consideration; nevertheless, other measurements were made to determine if they, too, affected bird movement or could be correlated with any noted change in activity.

Rainfall: Very little rain fell on the study area during the summer (see Figure 2); therefore, it was impossible to observe the effects of rainfall on bird activity.

Relative Humidity: Relative humidity seemed to exercise little, if any, influence on the birds observed. Therefore, the effects of temperature are given primary consideration in this paper.

Maximum-Minimum Temperature: Maximum-minimum temperatures, recorded at a station in the open and one in the woodlot, are presented in Figure 3. In general, the station in the woodlot remained about 3 degrees (2.9° F.) cooler during the day than did the station in the open. The woods air temperature was about 2 degrees (2.3° F.) warmer during the night hours.

Evaporation rates of atmometers at the woodlot station compared with those of the open station (see Figure 3), indicated that during the average twenty-four hour period, only 28 per cent of the available light

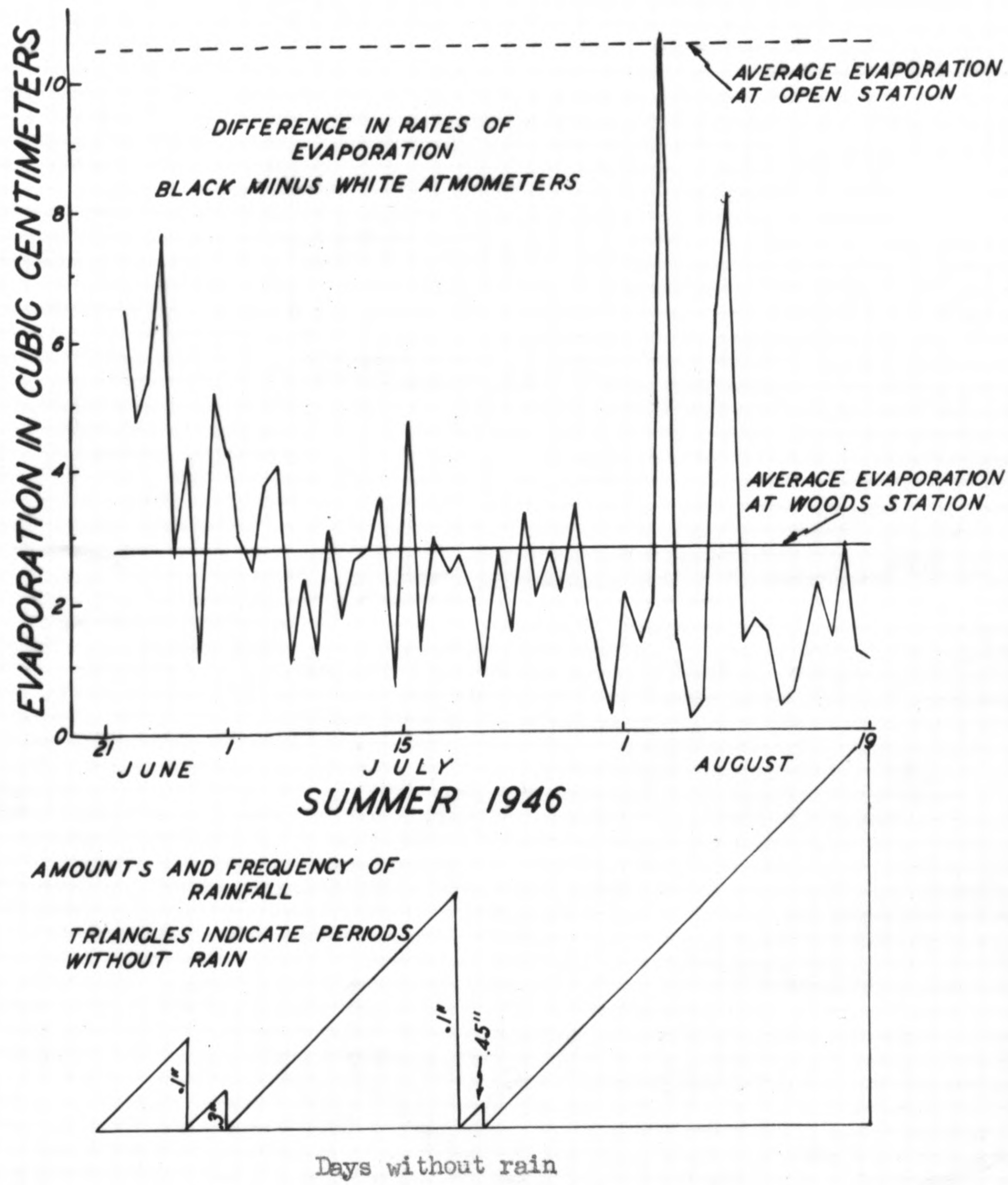

Figure 3. Data gathered to illustrate the variation in rates of atmometer cup evaporation from stations located in the edge of woodlot and in the open. Rainfall frequency is indicated so that the greater triangle indicates the greater period without measureable rainfall.

Table 1

Bird Species Observed During Summer

Field Study on Rad-rick Farm

Ring-necked Pheasant (Phasianus colchicus torquatus)

Mourning Dove (Zenaidura macroura)

Ruby-throated Hummingbird (Archilochus colubris)

Flicker (Colaptes auratus)

Red-headed Woodpecker (Melanerpes erythrocephalus)

Downy Woodpecker (Dryobates pubescens)

Eastern Kingbird (Tyrannus tyrannus)

Northern Crested Flycatcher (Myiarchus crinitus boreus)

Eastern Phoebe (Sayornis phoebe)

Eastern Wood Pewee (Myiochanes virens)

Horned Lark (Otocoris alpestris)

Blue Jay (Cyanocitta cristata)

Eastern Crow (Corvus b. brachyrhynchos)

Tufted Titmouse (Baeolophus bicolor)

House Wren (Troglodytes Aedon)

Catbird (Dumetella carolinensis)

Eastern Robin (Turdus m. migratorius)

Wood Thrush (Hylocichla mustelina)

Eastern Bluebird (Sialia s. sialis)

Cedar Waxwing (Bombycilla cedrorum)

Starling (Sturnus v. vulgaris)

Red-eyed Vireo (Vireo olivaceus)

Oven-bird (Seiurus aurocapillus)

Table 1 (Cont'd.)

Northern Yellow-Throat (*Geothlypis trichas brachidactyla*)

English Sparrow (*Passer d. domesticus*)

Eastern Meadowlark (*Sturnella m. magna*)

Red-wing (*Agelaius phoeniceus*)

Baltimore Oriole (*Icterus galbula*)

Cowbird (*Molothrus ater*)

Scarlet Tanager (*Piranga erythromelas*)

Cardinal (*Richmondena cardinalis*)

Indigo Bunting (*Passerina cyanea*)

Eastern Goldfinch (*Spinus t. tristis*)

Red-eyed Towhee (*Pipilo e. erythrophthalmus*)

Grasshopper Sparrow (*Ammodramus savannarum*)

Henslow's Sparrow (*Passerherbulus henslowi*)

Vesper Sparrow (*Pooecetes gramineus*)

Eastern Chipping Sparrow (*Spizella p. passerina*)

Field Sparrow (*Spizella pusilla*)

Eastern Song Sparrow (*Melospiza m. melodia*) reached the instruments through the overhead plant cover. Thus, trees reduced the radiant energy by about three-fourths.

Figure 4 presents data showing the relationship between air temperature and the reaction of birds in their natural environment. Due to the cool summer, only 14 per cent of the 772 observations on forty species of birds (see Table 1) were at sufficiently high temperatures so that visible reactions to heat were evident.

At 90° F., some birds showed reactions (panting, compressed feathers, etc.) to temperatures but most did not. This may be due to individual variation within a species or to differences between species. It is possible that some of these responses were only apparent and were actually the result of recent flight under border line temperature conditions, but whenever possible, the birds were observed long enough to avoid such error.

Although a few birds responded to temperature at 90° F. (32° C.), 79 per cent observed reacted at 93 to 95° F. (34 to 35° C.). The highest recorded temperature observed during the study was 115° F. (32° C.), whereas the lowest was 71° F. (22° C.).

The results obtained from field observation agree with laboratory work by Kendeigh (1934), who experimented with English Sparrows (Passer d. domesticus). He reported that 93° F. (33.9° C.) was the critical temperature for that species. Using Ringed Doves (Streptopelia risoria), Riddle, et al (1930) showed that even at a temperature of 86° F. (30° C.), their metabolism was so depressed that the birds were in an abnormal physiological condition. Although the critical point for most birds lies in the neighborhood of 93° F.; nevertheless, this study indicates variations exist between species.

Table 2

List by Species of Observations

Made at 98° F.

Temperature Reaction Noted		Temperature Reaction Not Apparent	
E. Crow	2	Henslow's Sparrow	2
E. Kingbird	1	Grasshopper Sparrow	2
Song Sparrow	2		
English Sparrow	1		
Totals:	6		4

These variations are illustrated in Figure 4 where the number of birds reacting to heat is compared with habitat temperature. At 98° F., two Grasshopper Sparrows (Ammodramus savannarum) and two Henslow's Sparrows (Passerherbulus henslowi) failed to exhibit visible temperature effects. All other birds at this same temperature, showed reactions to heat (Table 2). The two species not affected are birds of the open meadow; therefore, it appears that these two species are better physiologically adapted to withstand high air temperature than are the others. Fifty-six Field Sparrows (Spizella pusilla) were observed at temperatures from 90° to 93° F. Eight of every ten of these birds indicated a response to high temperature. Of eleven observations on the Eastern Crow (Corvus b. brachyrhynchos), all birds showed visible signs of temperature reaction in this same temperature range. Again at 90 to 93° F., twenty-two Vesper Sparrows (Poecetes g. gramineus) were observed, and of these, three of every four birds exhibited reactions to heat.

Effect of High Temperature on Bird Movements

Birds exposed to unfavorable temperature conditions usually seek a more comfortable location. Shade provides obvious relief from the heat of the sun and most birds seek plant cover that provides shade when air temperatures reach 93° F. For instance, on July 19 when forty-nine observations were made on seventeen species, habitat temperatures at breast height were 91 to 94° F. in the shade and 98° F. in the sun. In 78 per cent of these records, birds exhibited visible temperature reaction either by planting or by compressing the contour feathers. In only six of these forty-nine observations were birds seen to be active in the sun. In the remaining forty-three records, all birds sought relief from high air temperature.

The presence of shade provided by plant cover becomes an important factor in the life of many birds. Kendeigh (1934) explains the reason behind

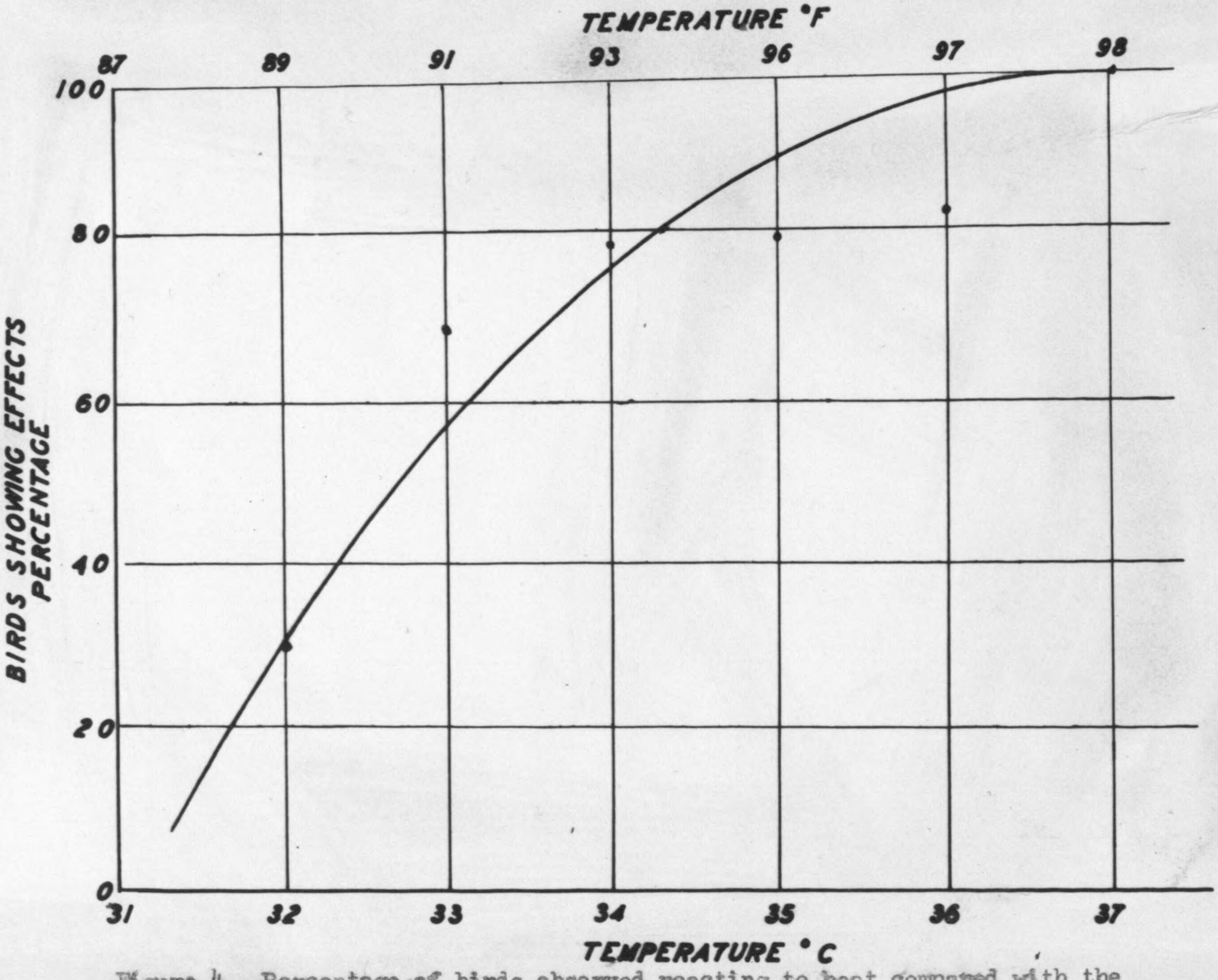

Figure 4. Percentage of birds observed reacting to heat compared with the habitat temperature.

Table 3

Variation in Sun and Shade Temperatures (° F.)

Date	Shade Temperature	Sun Temperature
July 6	86	96
7	86	102
8	86	96
13	83	90
15	81	80
16	75	88
17	80	90
18	82	93
19	93	98
20	82	90
28	84	93
29	86	95
August 1	80	88
5	82	84
5	82	88
6	76	82
7	84	93

Average Sun Temperature: 91° F.

Average Shade " : 81° F.

Difference: 10° F.

this response when he shows the rate of metabolism in small birds reaches a minimum at an air temperature of 93° F. Higher air temperature causes an increase in moisture loss through the lungs and air sacs, and may also raise the metabolic rate too rapidly. These effects would obviously be detrimental to the bird, and seem sufficient to compel other birds to seek the cooler habitat which plant cover affords.

Table 3 shows the difference between sun and shade temperatures to be 10° F. The average sun temperature was 91° F., while the average temperature in the shade was 81° F. In every case, shade temperature was enough lower than the sun temperature to provide relief from the heat. In almost every instance, shade temperature was below the critical point even though sun temperature was excessive. Still greater differences exist between temperatures taken at the ground surface.

On hot days, numerous observations were recorded of birds feeding or otherwise active on the ground at the edge of shade offered by trees and shrubs, to which they could retire from time to time for relief. For instance, on July 28 a Field Sparrow (Spizella pusilla) was seen on the ground feeding in the sun. After two minutes, it opened its mouth and panted. One and a half minutes later it returned to the shade of a nearby Haw tree. There it remained for a minute before closing its mouth. The temperature where this bird fed was 93° F., whereas the shade temperature was 87° F. This Field Sparrow had cooled sufficiently to cease panting in about a minute.

On July 31, Robins (Turdus m. migratorius) were numerous in an open pasture when the sun was hidden by clouds but on August 1, they were in the adjacent woods and absent from the open when soil surface temperature reached 113° F. ~~(Plate 2)~~ Air temperature at breast height was 89° and in the shade only 82° F.

Another observation on August 7 further illustrates the value of shade afforded by vegetative cover. In an oats field, within 10 feet of lush vegetation, fourteen Song Sparrows (Melospiza m. melodia) and two Field Sparrows (Spizella pusilla) were observed for twenty minutes. The temperature in the oats stubble, where these birds were active, was 115° F., whereas that of the shaded border was 84° F. The birds moved back and forth from the oats stubble to the shade of the bordering shrubs, grasses and weeds remaining in the stubble forty-five to seventy-five seconds before returning to the shade for relief. Panting and compression of the feathers were observed while birds were in the sun feeding. Shortly after these symptoms developed, the birds departed for cover. Presumably attracted by some preferred food, they would flit to the hot stubble, feed for a short time, then return to the cool, shady vegetation near at hand.

These and still other observations demonstrate that most birds avoid unfavorable high temperature conditions by seeking shade. Although birds do frequently use plants for escape cover from mammals or birds of prey, movement to cover afforded by vegetation in summer is frequently a response to extremes of high temperature.

Conclusion

During the summer of 1946 on the Rad-rick Farm, temperature was the meteorological factor that exhibited the greatest influence on bird activity. The immediate temperature to which birds were exposed caused them to alter their activity and frequently directed their selection of habitat. Light, evaporating power of the air, relative humidity, rainfall and average daily air temperature, seemed to exercise minimum effects on bird movement. At other times of the year or during other seasons, these factors might perhaps be more important but in this study their effects were not evident.

From these field records it seems that shade becomes an essential part of the habitat for many birds that are usually regarded as being birds of the open. Grazing, mowing of fields or clearing of fence rows and other activities that remove shade-producing cover from fields may compel birds virtually to abandon such lands in hot weather, except where adjacent shade permits transient marginal use.

Therefore, it seems clear that scattered plantings of trees or shrubs will provide shade along field margins and in odd corners about the farm will add materially to the comfort of the bird inhabitants, and will probably increase the number of birds that can find suitable habitat on the land. On the other hand, cleared fence rows combined with cultivated and closely cropped fields or pasture lands may reduce the capacity of that land to produce birds.

Summary

1. A study was made during the summer of 1946 near Ann Arbor, Michigan to determine the influence which temperature, light, evaporating power of the air, relative humidity and rainfall have on bird activity. Meteorological measurements of these elements with parallel field observations on bird activity were made.

2. These meteorological data indicate that temperature is the most important influence on bird activity and selection of their habitat during the summer season, whereas light, evaporating power of the air, relative humidity and rainfall induce minimal effects under conditions observed.

3. Extensive observations on bird species encountered during the study indicate that the immediate temperature to which the bird is exposed differs greatly from temperatures recorded in an instrument shelter, and that this habitat temperature has a greater effect on bird activity than does the maximum daily temperature.

4. Temperature reactions by birds were indicated by respiration through the mouth and flattening of the contour feathers. These responses were evident at 90° F. (32° C.) for some birds; but, at 93 to 95° (34 to 35° C.), they were exhibited by three of every four birds recorded.

5. Evidence is presented which strongly suggests that birds of the open meadows, such as the Grasshopper Sparrow or Henslow's Sparrow, are not as readily affected by high air temperature as are species such as the English Sparrow or Song Sparrow.

6. Average shade temperatures were 10° F. cooler than average sun habitat temperatures at breast height.

7. Considerable evidence from field records was compiled and sufficient references to these are given to indicate when most birds are subjected to temperatures of 93° F. (34° C.), and above they will seek shade of plant growth if such exists within their home range.

Literature Cited

1. Emlen, John T. and Ben Glading, 1945. "Increasing Valley Quail in California," University of California, Berkeley; Bulletin No. 695.

2. Kendeigh, S. Charles, 1934. "The Role of Environment in the Life of Birds," Ecological Monographs, Volume 4, No. 3.

3. Riddle, Oscar, Francis G. Bennedict and Guinevere Christman, 1930. "Differential Response of Male and Female Ringed Doves to Metabolism Measurement at Higher and Lower Temperatures," A. J., Physiology, Volume 95, No. 1.

Bibliography of Pertinent Literature*

1. Baldwin, S. P. and S. Charles Kendeigh. 1932. Physiology of the Temperature of Birds, Clev. Mus. Nat. History, Vol. III.

2. Barbour, H. G. 1921. The Heat Regulating Mechanism of the Body. Phys. Rev. Vol. I, #2.

3. Bazett, Henry C. 1927. Physiological Responses to Heat. Phys. Rev. Vol. VII, #4.

4. Berney, F. L. 1928. Birds and Drought in Central-Western Queensland. Mem. Queensland, Mus. #9.

5. Brody, Samuel. 1941. Temperature Factors in Animal Production. Am. Inst. of Physics, New York.

6. Chandler, A. C. 1916. Structure of Feathers. Univ. of Calif. Publ. Zool., Vol. 13, #11.

7. Chapman, R. N. 1931. Temperatures in Widely Different Environments of the Same Climatic Area. Ecology, Vol. 12.

8. Clark, Janet H. 1922. The Physiological Action of Light. Phys. Rev. Vol. 2.

9. Dexter, Edwin G. 1899. Conduct and Weather. Phys. Review, Vol. 2, #6.

10. Edwards, W. F. 1839. Animal Heat. Todd's Cyclopaedia Anat. & Physiol. Vol. 2.

11. Emlen, John T. and Ben Glading. 1945. Increasing Valley Quail in California. Univ. of Calif., Berkeley, Bull. #695.

---

* This bibliography has been assembled for the convenience of the student with special interest in this particular study.

12. Griffith, B. G. 1928. Effect of Local Changes in Topography on the Temperature and Relative Humidity of the Atmosphere. For. Chronicle Vol. 4, #4.

13. Hickey, J. J. 1943. A Guide to Bird Watching. Oxford Univ. Press, London

14. Howard, H. E. 1920. Territory in Bird Life. J. Murray, Ltd., London

15. Huggins, R. A. 1941. Egg Temperatures of Wild Birds under Natural Conditions. Ecology Vol. 22, #1.

16. Kendeigh, S. Charles. 1934. The role of Environment in the life of Birds. Ecol. Monographs. Vol. 4, #3.

17. Lehmann, Valgene W. 1946. Bob-White Quail Reproduction in Southwestern Texas. J. of Wildlife Management Mgt., Vol. 10, No. 2.

18. MacDougal, D. T. 1903. Soil Temperatures and Vegetation. Monthly Weather Rev. Aug., 1903.

19. MacKinney, A. L. 1929. Effects of Forest litter on soil temperature and soil freezing in Autumn and Winter. Ecology Vol. 10.

20. Odum, Eugene P. 1941. Variations in the Heart Rate of Birds. Ecol. Monographs Vol. 11, #3.

21. Pearse, A. S. 1926. Animal Ecology. McGraw-Hill Co., New York.

a. ____________ 1928. The Origin of Warm-Blooded Vertebrates. J. Wiley and Sons, New York.

22. Roberts, Tilden W. 1942. Behavior of Organisms Ecol. Monographs. Vol. 12, #4.

23. Riddle, Oscar, Guinevere Christman, and Francis G. Bennedict. 1930. Differential Response of Male and Female Ringed Doves to Metabolism Measurement at Higher and lower Temperatures. Am. J. Physiology Vol. 95, #1.

24. Shelford, V. E. 1914. The Use of Atmometers to Measure evaporation in the study of Insects. J. of Econ. Ent. 7:249.

25. Taverner, Percy A. 1947. Birds of Canada, Musson Co., Ltd., Toronto.

26. Thornwaite, C. Warren 1942. The Importance of Knowledge of Micro-climates. Climate in the Science of Agriculture.

27. Wetmore, A. 1921. A study of the Body Temperatures of Birds. Smithsonian Misc. Pub. Vol. LXXII, #12.

28. Willford, A. H. 1925. The Effects of Hot Sun on Young Birds. British Birds. 18 (10)