

SUCCESION OF FIRST MORNING SONG IN COMMON BIRD SPECIES NEAR
THE UNIVERSITY OF MICHIGAN BIOLOGICAL STATION

By

Grace Blanchard
Ann Arbor, Michigan

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Introduction

This paper is based on studies of the beginning time of morning song in some of the commoner birds in the vicinity of the University of Michigan Biological Station during the summer of 1949.

Records were made on 14 mornings over a period of 27 days (June 24 to July 21) in an attempt to determine whether there is a consistent order in which the birds begin to vocalize, whether there is a change in the time a species begins as the summer progresses, whether day to day variations in time can be correlated with changes in weather, and any other observations of morning song which could be made. Observations were almost entirely of song rather than calls or chips, except in cases such as the crow, where the species has no real song. Listening points were located within two miles of the Biological Station, in Munro and Burt Townships, Cheboygan County, in the northeastern part of the lower peninsula of Michigan, $48^{\circ}45'$ degrees east longitude and $45^{\circ}35'$ degrees north latitude. About 22 hours were spent listening and recording song beginnings. Some of the earlier records on several mornings were made enroute to the listening post, but most were taken from one position in each of the areas studied.

I am gratefully indebted to Dr. Olin Sewall Pettingill Jr. for suggestion of the study and direction in carrying it out. I am also indebted to Miss Kathryn Ann Grave for the records of the morning song beginning of birds on the Biological Station campus, which have been used in this paper. Data on sunrise and twilight times were secured from the U. S. Weather Stations at Alcona, Michigan and at Sault Ste. Marie, Michigan. Temperature, pressure and precipitation data is that recorded by Professor Frank C. Gates.

Habitat

For this study, listening places near many kinds of habitats were chosen in an attempt to be within hearing distance of as many species of birds as possible. The Biological Station region is one of hilly glacial deposits. It is in the transition area between the central hardwoods, dominated by Beech (Fagus grandifolia), Sugar Maple (Acer saccharum), and Hemlock (Tsuga canadensis), and the north-east coniferous province where Red Pine (Pinus resinosa), White Pine (Pinus strobus), and White Cedar (Thuja occidentalis) are the characteristic trees. The vegetation is a checkerboard of local areas of coniferous and deciduous trees. The areas where bird song was recorded are near bog, aspen, hardwood, field, meadow, and shore habitats.

Habitat I is at North Fishtail Bay, along the east shore of Douglas Lake, about two miles north of the Biological Station. The listening position was on the beach. A small meadow about 50 feet across and bordered with shrubs is just inland from the beach. About a hundred feet east along the beach, the mixed White Cedar and Trembling Aspen (Populus tremuloides) type of woods comes down to the shore. Eastward the woods grades into White Cedar bog, and westward into Sugar Maple-Trembling Aspen deciduous woods. Across the bay within hearing distance is a small camp, which adds another habitat from which bird song can be heard.

Habitat II is at Grapevine Point, about a mile north of the Station along the west shore of Douglas Lake. The habitat is a narrow beach abruptly backed up by deciduous Beech-Maple-Large-toothed Aspen (Populus grandidentata) woods. This place was visited only once, as very few species of birds could be heard there then.

Habitat III is at the edge of Reese's Bog, about a mile and a half south of the Biological Station. Reese's Bog is an extensive White Cedar bog which is now fairly dry at this point. Near the edge of the road the woods has been cleared somewhat in the recent past and is now thin White Pine, Spruce (Picea), and White Cedar, with a few

scattered ground plants, several brush heaps of lumbering waste, and a number of small Trembling Aspens about four feet high. Back from the cleared part is White Cedar woods with a sprinkling of Red Maple (Acer rubrum), birch (Betula), and Trembling Aspen. There is very little ground cover.

Habitat IV is a fairly flat, open, cultivated grain field, with scattered groups of shrubs and trees along the wheel-track road going by it. Birds with a loud song could be heard in the coniferous and mixed woods beyond the field.

Habitat V is the Biological Station campus, along the south shore of Douglas Lake. Vegetation here is largely deciduous trees which border the gravel road and surround the cabins along the road.

Methods

The carrying out of this study involved several problems in method. One was to decide whether each record was really the first morning song. Where the birds were known to be close by, records are assumed to be good, but where a species might have moved into hearing range after beginning to sing, especially late records of a species were usually considered to be in error. Such data are indicated by an asterisk on the data sheets.

Some other problems in the study were with the weather data. Temperature was that recorded on the Biological Station campus as the minimum night temperature. Since this temperature is reached shortly before sunrise, the record probably is very close to the temperature when observations were taken. Humidity was not considered because of the difficulties involved in recording it. An attempt was made to get light intensity readings, but these were a failure, as more than half of the birds had started to sing by the time the light meter began to indicate light. As a substitute for light intensity data recorded on the spot, Civil Twilight, beginning when the sun is 6° below the horizon, and time of sunrise have been plotted along with the time of song beginning. Weather data are given in Table IV.

Finding the exact time proved also to be a problem. The watch used to record song beginning time was corrected to Eastern Standard Time by the radio within three or four days of taking data. Though there may still be errors of a minute or two in the figures, these probably are not significant, because of the variance in time a species begins to sing.

Discussion

It is usually assumed that song beginning indicates awakening time. It may be true among the passerine birds that vocalization comes very quickly after awakening. For some birds, however, activity may begin before song. On July 8, a nighthawk (Chordeides minor) flew close to me three times within five minutes (3:50-3:55), but was not heard until 3:57. Since other records during the summer show the latest nighthawk beginning to be 3:54, this observation may not indicate normal behavior. On several occasions a gull was seen flying over the lake before it was heard calling.

Allard (1930) believes that song does not indicate awakening time, because in sleep position with the head under the wing, birds are not visually aware of changes in weak early morning light. He even found that in a caged canary, and a starling (Molothrus ater) sleep was not disturbed at night by the bright light of a lantern.

If song does usually indicate awakening, my records show only the time the male wakes, since in this study nearly all records are of actual song, rather than chips. When the call of male and female is similar, I do not know which began first. In the case of the Song Sparrow (Melospiza melodia), Nice (1943) finds that the male Song Sparrow

is generally thought to rise earlier than the female. How general this relationship may be, I do not know.

Two crepuscular birds enter my records all summer, the Whip-poor-will (Caprimulgus vociferus) and the Nighthawk. Table III and Chart II show the times of song beginning and ending, and the time during which the birds were heard. It has been reported to me that on a moonlight night whip-poor-wills were singing at 2:00 A.M., so that under some conditions, at least, this bird may be nocturnal rather than strictly crepuscular. However, on several occasions, I was in the field where I could hear a bird if it were singing within quite a wide area, more than half an hour before a call was heard. Following the first recorded call, these birds usually sang for several minutes, then paused for a while, and began calling again. The Nighthawk begins after the Whip-poor-will and continues later. It sings during a period of dawn overlapping the Whip-poor-will's period but lasting later. The Nighthawk's stopping times seem to average very close to sunrise time, and as with sunrise, came later as the summer progressed. The Whip-poor-will is more consistent in its stopping time, and never sang as late as sunrise. Temperature seems to have an effect on the day to day starting and stopping of song, both birds singing earlier on colder mornings. At lower

temperatures song also stopped earlier, especially the Nighthawk's call which shows much more variation in stopping time than does the Whip-poor-will's. More data would be necessary to discover whether cloudiness effects starting time. From my information, I think that temperature influences these birds more in their singing than does cloudiness, though it does happen that on the cloudy days when records were made, song beginning was later.

One of the main objectives of this study was to discover something about the relationships between song beginning times of different species of birds in this area. In regard to the whole group of birds recorded, it is interesting to note that about mid-way between the earlier and later records of each morning there is a time when very few birds begin to sing. Towards the beginning of the summer this time came between 4:00 and 4:10, becoming later during the summer at about the same rate which sunrise and twilight starting times changed. Chart I shows this pause in song beginning at about the middle of the left-hand half of the graph. It also shows that on the last seven days, (July 12-21), when most of the data were recorded at Reese's Bog, there does not seem to be a pause like that in the earlier records from other habitats. Instead there is a less wide range of starting times of

the various singers on one day, and most of the species begin at about this time. Perhaps this is partly because different species are found in the bog habitat. It may also be due to change in starting time of some birds later in the summer. Allard (1930) says that the widest divergence in song beginning times of various species is near the summer solstice. Towards the end of the summer there is a rapid closing in towards the time of sunrise.

Another interesting generalization which becomes evident from Chart I is that many birds respond to environmental conditions in the same way from day to day. For example: on July 1 the Least Flycatcher (Empidonax minimus), Scarlet Tanager (Piranga olivacea), Red-eyed Vireo (Vireo olivaceus), and others began to sing later than they had on June 30. It is the external conditions acting in the same way upon the physiology of these birds which cause the variations in song beginning time. It seems strange, then, that the same environmental conditions (those of one morning) cause the birds of the earlier and later beginning groups described above to react quite consistently in opposite manner with regard to song beginning time, one group starting earlier when the other starts later. There are some birds in each group such as the Oriole (Icterus gularis) and the Tree Swallow (Iridoprocne bicolor) in the later group, which react as though in the opposite group, but the ten-

endency ~~is~~ for birds of each group ~~is~~ to react together, the two groups to react oppositely to changes in the external environment. This does not seem to be related to the light intensity in the habitat, ^{of different birds} nor does it appear to be a family characteristic to respond in a certain way. I cannot explain it at present.

The factors of the external environment which might cause variation in song beginning time are numerous. Temperature, cloud cover, moonlight, wind, and atmospheric pressure were recorded, in the hope that one or more might be related to song beginning time. Pressure does not appear to be related to day to day variations in song beginning time. Nor does moonlight seem to have effected the birds for which I have data, but I do not have records for the Whip-poor-will and Nighthawk on moonlight mornings. Wright (1913) says that some of the earlier birds which might have been effected by moonlight started earlier when the moon was bright; others were not influenced. Wind was only once sufficient to be noticeable; more data might show that it has some effect. Alexander (1931) ^(Nice 1943) states that wind has a disturbing effect on bird activity, song being later when the wind is strong. This may be true for some birds, but in my records, birds have never all reacted to a change by response in the same direction. Correlations with tem-

perature and cloud cover seem to be more significant, though sometimes such correlation seems false. On three mornings, June 24, 30, and July 5, singing was generally later in the later group, and earlier in the earlier group. Two of these mornings were cloudy, which would seem to correlate cloudiness with later singing, but the third, June 30, was clear. Temperature does not seem to explain these changes either. About half of the data for June 30 were taken in the cultivated field habitat, but this different location does not seem to have been responsible for the shift in time of song beginning, for where two records for the same species are available for that day, one taken in the field and one in Camp, the field time is earlier about as often as it is later than the other. Possibly humidity, which is related to cloudiness and temperature, may be more directly responsible for the variations from day to day. If this is the case, partial correlation with cloudiness and temperature may be valid. I have not found any literature dealing with humidity as a factor in day to day variation in time of first vocalization of birds. Several investigators report probable relationship between day to day song beginning time and temperature or cloudiness. Kendeigh (1934) says: "Cloudy weather, since it effects temperature by lowering it, is favorable to song. (Saunders 1929)." In the case of my data, the effect of

cloudiness was probably not through temperature as temperature as temperature was almost constant. Wright (1913) also indicates a belief that temperature is an important factor, for he says that on warm cloudy mornings birds begin to sing earlier than on cold cloudy mornings. Kendeigh (1934) reports that Lutz (1913) found a house wren in Panama which during 24 mornings began to sing at nearly the same time, slightly earlier if mornings were especially bright, and later if cloudy, although never varying more than 15 minutes. From the information given, there is no way to tell whether this change in time was due directly to the light conditions or was due to a change in temperature accompanying the change in cloud cover. In all probability there are several factors which are responsible for day to day variation in song beginning time. However, I think that the number of factors is not large, because so many birds respond similarly. This would be less likely if many important stimulating factors were responsible for initiation of morning song in birds.

Through the summer, some tendencies in the change of time a species begins to sing are noticeable, (though in most cases data are insufficient). The ovenbird is the most striking example. Chart I shows that the bird is fairly regular in time of song beginning, but that later in the summer song gradually begins later. It is pro-

bably not a matter of slightly different habitat (records are from near the bog during the last part of the time), because even in the bog habitat the trend continues. The Robin, (Turdus migratorius), Wood Thrush (Hylocichla mustelina) Red-eyed Vireo, and to some extent, the Kingbird (Tyrannus tyrannus), also show a tendency to begin singing later as summer progresses. The Northern Yellow-throat (Geothlypis trichas) and Cuckoo (Coccyzus) seem, from the data available, to show the opposite tendency, though this may be due to records of song after the beginning time, earlier in the summer. The most obvious guess as to the cause of later song beginning as the summer progresses is the change in light intensity, which is indicated on the chart by the beginning of twilight line. In the case of the Vireo and thrushes this may be the cause, but the change is too rapid in the Ovenbird to be a simple correlation with light. Perhaps here it is related more to stage of the nesting cycle. Allard (1930) is concerned mainly with the seasonal rather than the day to day changes in time of morning song beginning. He feels that light is the most important factor effecting time of song beginning, but that the state of reproductive activity makes a bird sensitive to weaker light during the nesting season than at other times of the year. The extent of this change in sensativity is probably different in different birds, and accounts for the Ovenbird suddenly beginning at later and later times towards the end

of the summer. Some birds whose times of beginning bore the same relationship to the time of sunrise at the end of this study which they did at the beginning may not have finished reproductive activity.

As a matter of curiosity, I have graphed the average time of song beginning for families of birds, Chart IV and Table II. The results are not significant, for in many cases but one species represents the family, and in some cases only one record for that species was taken. As might be expected, there is no relationship between phylogenetic position and song beginning time. Chart III shows the wide range in song beginning times within a family, a situation which shows again that the family averages are not of value. It must be remembered here that some of these graphs are based on one record. If more data were available, it might be found that the one record did not represent the normal beginning time.

There seems, as Allard (1930) says, to be a gradation of light appreciation by various species. He believes that the intensity of light of the visible spectrum operates in the visual organization of the bird to cause it to begin to sing at the time for which its physiological mechanism is set. This results in the fairly regular order in which bird species begin to sing. H. W. Wright (1912 and 1913) lists the birds for which he has records

in the order of their song beginning. Comparing my list as given in Table I with Wright's list, I find that my averages, where there are over five records, vary from his, some being earlier, others later, and differing widely in some cases. (I have included data where there are less than five observations only as an indication of possible position in the order of morning song beginning, realizing fully that where one or a few observations have been made, the position given the bird may well be in error.) Even with an equal number of observations, where there is a seemingly^a sufficient amount of information to establish a fairly accurate starting time, there is often a wide variance. The difference may be due to different habitat and exposure of roosting sites in the two studies. Allard (1930) says that averages over different periods of time vary, and feels that this is the reason for the variance in data of Wright (1912 and 1913) and Allen (1913). Whether a species had begun to change its reaction to low light intensities with the stage of reproductive cycle would certainly effect the relation to other species in the order of song beginning. This may account for some of the disagreement of this study with the published work in regard to order of song beginning.

In two cases, I would suggest a change in the order of Wright's listing where he has few observations. My five observations of the Winter Wren (Troglodytes troglodytes)

were at very close range, and averaged 42 minutes before sunrise, with three between 4:20 and 4:22. Wright finds the average time to be 25 minutes before sunrise. I would therefore place the Winter Wren between the Chestnut-sided Warbler (Dendroica pensylvanicā) and the Bluebird (Sialia sialis) on his list, about midway in the list. On the basis of 16 records of the Belted Kingfisher (Megaceryle alcyon), I would place it earlier in the list also. I find its average starting time to be 28 minutes before sunrise, with several records between 4:20 and 4:35. I would put the Kingfisher near the Black-throated Green Warbler (Dendroica virens) on his list, about one third of the way from the bottom of the list, instead of its present position at two minutes after sunrise. Allen (1913) thinks that the Kingbird (Tyrannus tyrannus) should be placed very early in the list. My observations, though also seven in number, as are Wrights, support this suggestion of change, and put the Kingbird 62 minutes before sunrise; Wright (1913) finds it to be 51 minutes before. I believe that the Kingbird should be just before the Robin in Wright's list.

From my observations, I can not agree with Allen (1913) and Nice (1943) in giving the Song Sparrow's morning song beginning as late as 30 minutes before sunrise. The Song Sparrow which I recorded averaged beginning of song at 68 minutes before sunrise. Usually chirping or song continued

after it started, making it seem more like a morning than like a night song. Wright and Allard (Nice 1943) believe this singing to be a morning song. I must also disagree with Allen (1913) in his suggestion that the Tree Swallow (~~Iridoprocne bicolor~~) belongs among the very earliest singers. I find that it begins singing about 35 minutes before sunrise. Perhaps the variance is due to date of observations, as several of Allen's observations were made in the last part of May, while mine were made in late June. Allen (1913) suggests further that the Chipping Sparrow (Spizella passerina) belongs below the Robin in the list. My observations agree with this for my Chipping Sparrow averages beginning song 50 minutes before sunrise, while the Robin averages 60 minutes before sunrise.

My records include several species not recorded by Wright (1913) or Allen (1913). These are: Whip-poor-will (Caprimulgus vociferus), Nighthawk (Chordeiles minor), Spotted Sandpiper (Actitis macularia), Mourning Dove (Zenaidura macroura), Northern Yellow-throat (Geothlypis trichas), Purple Martin (Progne subis), Crested Flycatcher (Myiarchus crinitus), Blue Jay (Cyanocitta cristata), and Baltimore Oriole (Icterus galbula). My data and averages for these birds are given in Table I.

It has been mentioned that the Song Sparrow may sing at night. While walking to my listening point at North

Fishtail Bay, I found that quite often, if near the shore, I disturbed a Spotted Sandpiper which gave a few calls, and then quieted down again. Apparently the Spotted Sandpiper is more easily disturbed than other birds, and may also call at night. Other birds were not disturbed by my walking by.

Summary

1. Listening positions were located near enough to the following kinds of habitat so that birds living in these habitats could be heard: bog, aspens, hardwoods, fields, meadow, and shore.
2. Data on birds regularly singing close by is considered to be good; records of more distant song have been discarded when they differ widely from other figures for the same species.
3. Temperatures, pressure, and precipitation were recorded on the Biological Station campus; sunrise and twilight data are from a U.S. Weather Station; other weather notes were taken at the listening place. Time is EST.
4. Some birds, such as the Nighthawk and gull, may become active in the morning before they call.
5. The Whip-poor-will and Nighthawk have song periods which overlap each other, the Whip-poor-will being the

earlier and more regular of the two, and both apparently being effected by temperature in their time of beginning to vocalize.

6. Records of song beginning between June 24 and July 7 show a pause during the morning twilight when very few birds begin to sing, about half beginning before, and half after it. This pause comes about 4:00-4:15 earlier in the summer and as the summer progresses, grows later at about the same rate that the beginning of Civil Twilight changes.

7. The pause in song beginning noticed during the first part of the summer does not show up in the records obtained at Reese's Bog.

8. External environmental conditions seem to be the stimulus causing day to day variations in the time a species of bird begins to sing, but they apparently effect the group of birds beginning to sing earlier differently from those beginning later, for they respond oppositely in the time of song beginning under the same conditions.

9. Atmospheric pressure, wind, and moonlight are not, from these data, obviously correlated with time of bird song beginning; temperature and cloudyness, and perhaps humidity are more closely related to song beginning time.

10. The Ovenbird, Robin, Wood Thrush, and Red-eyed Vireo begin to sing later as the summer progresses; data for the

Northern Yellowthroat and Cuckoo make them seem to sing earlier later on in the summer; for most birds, sufficient ^{to determine such a tendency} data is not available.

11. Within a bird family there is wide variation in the time different species begin to sing in the morning, so that family averages are probably only of cursity value.

12. Results of this investigation agree and disagree with the results of similar studies by Wright (1913) and Allen (1913), on the order in which different species of birds begin to sing in the morning. The disagreement is not only where little data was available, but also where a number of records are on hand. Habitat and exoosure of roosting places, as well as period of observation from which averages were taken, may account for the latter disagreement. My records include nine species not listed by Wright (1913).

13. Spotted Sandpipers seem to be more easily disturbed at night than do other birds of this area, and give several calls when disturbed.

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	June 24	June 26	June 30	July 1	July 5	July 7	July 8
Crested Flycatcher <u>Myiarchus cineritus</u>	p 4:46	c 4:54	f 4:30		p. 4:26		
Blue Jay <u>Cyanocitta cristata</u>	p. 4:30	p. 4:26	f 4:56*	p 4:36			
Western Meadowlark <u>Sturnella neglecta</u>			f 4:40				
Crow <u>Corvus brachyrhynchos</u>	p. 4:41	p. 4:26	f 4:40 c 4:45	p. 4:50 c 4:43	p. 4:42 c 5:02	p. 4:40 c 5:02	g 4:49
Redstart <u>Setophaga ruticilla</u>	p. 4:55	p. 4:27		p. 4:31	p. 5:17*	p 5:09*	g 4:34
Oriole <u>Icterus galbula</u>		c 4:54	c 4:32	c 4:37		c 5:07	
Wood Pewee <u>Contopus virens</u>	p. 5:00	c 4:54	c 4:24	p. 5:22* c 4:33	p. 5:08		
Black-capped Chickadee <u>Parus atricapillus</u>	p. 4:54	c 4:12	f 4:53 c 4:41	p. 5:26* c 4:45	p. 5:05		
Cedar Waxwing <u>Bombycilla cedrorum</u>		c 4:41	c 4:50	c 4:44	c 5:08	c 5:15	g 4:46
Cuckoo (yellow-billed?) <u>Coccyzus sp.</u>	p 5:06		f 3:57* c 4:48	p 5:20 c 4:50	p. 5:13 c 5:11	c 5:12	g 5:04
Savannah Sparrow <u>Passerculus sandwichensis</u>			f 4:55				
Black and White Warbler <u>Mniotilta varia</u>	p. 4:57				p 5:17	p. 5:04	

I (continued)

	July 12	July 13	July 14	July 15	July 19	July 20	July 21	Average EST 4:39 (23)	No. of records on which av. is based 4	Average as Suntime 4:01
					r 4:45	r 4:46	r 4:37	4:39 (23)	7	4:01
								4:40 (22)	1	4:02
7	r 4:55			r 4:52				4:47 (15)	3	4:09
4								4:47 (15)	6	4:09
								4:47 (15)	4	4:09
								4:53 (9)	6	4:15
					r 5:03	r 5:10	r 4:33	4:53 (9)	9	4:15
6								4:54 (8)	6	4:16
4	r 4:42			r 4:25	r 4:36			4:55 (7)	11	4:17
								4:55 (7)	1	4:17
	r 4:47			r 4:20	r 4:49	r 4:57	r 4:55	5:06 (yatter)	2	4:28

June 24 June 26 June 30 July 1 July 5 July 7 July 8

Mourning Dove
Zenaidura macroura

p. 5:13*

Winter Wren
Troglodytes troglodytes

f 4:55*

Northern Yellowthroat
Geothlypis trichas

p. 4:57* p. 4:17 f 4:54* p. 5:37* p. 4:26 p. 4:27

Phoebe
Sayornis phoebe

p. 4:23 p. 4:14 f 4:35 p. 4:26 p. 4:23 p. 4:25
c 4:14 c 4:22 c 4:27 c 4:30

Veery (song)
(chip)
Hyllocichla fuscescens

p. 4:26 p. 4:23 p. 4:25 p. 4:25 p. 4:20 g 4:18

Gull (not graphed)
Larus delawarensis (probably)

p. 4:11 p. 3:58
c 4:47

Bobolink
Dolichonyx oryzivorus

f 4:26

Red-eyed Vireo
Vireo olivaceus

c 4:16 c 4:19 p. 5:11* c 4:27 p. 4:57* g 4:24
c 4:24

Tree Swallow
Iridoprocne bicolor

c 4:24 c 4:30 c 4:31 c 4:22

Scarlet Tanager
Piranga olivacea

p. 5:07* f 4:16 p. 4:11 p. 4:10 p. 4:37*

Loon (sleep at distance)
Gavia immer

p. 4:11 p. 5:00 p. 4:49 p. 4:16

Kingfisher
Megasceryle alcyon alcyon

p. 4:28 p. 4:18 c 4:49 p. 4:30 p. 4:34 p. 4:24
c 4:20 c 4:38 c 5:01 c 4:35

Chestnut-sided Warbler
Dendroica pennsylvanica

p. 4:47 p. 4:22 g 4:33

Purple Martin
Progne subis

c 4:31 c 4:38 c 4:35 c 4:35

Black-throated Green Warbler
Dendroica virens

f 5:00*

July 12	July 13	July 14	July 15	July 19	July 20	July 21	Average EST	No. of records	Average as sur. time	
			r 4:35	r 4:08	r 4:18	r 4:19	4:20	(42)	4	3:42
r 4:12			r 4:26	r 4:20	r 4:22	r 4:20	4:20	(42)	5	3:42
							4:23	(39)	3	3:45
							4:23	(39)	10	3:45
r 4:23							4:23	(39)	7	3:45
r 4:14			r 4:20	r 4:37	r 4:36	r 4:25	4:26	(36)	5	3:48
				r 4:48			4:26	(36)	4	3:48
							4:26	(36)	1	3:48
	o 4:33	c 4:39	c 4:35				4:27	(35)	9	3:49
							4:27	(35)	4	3:49
							4:28	(34)	5	3:50
							4:29	(33)	3	3:51
							4:34	(25)	10	3:56
							4:34	(25)	2	3:56
							4:35	(27)	4	3:57
r 4:46			r 4:32	r 4:35	r 4:32	r 4:39	4:36	(26)	5	3:58

TABLE

	June 24	June 26	June 30	July 1	July 5	July 7	July 8	July
	Overcast calm Min. Nite Temp. 60°	clear calm 62°	clear calm 61°-	clear light wind 63°	foggy calm 63°	clear fair wind 58°		
Whip-poor-will <u>Caprimulgus vociferus</u>	p. 3:36	p. 3:46 c 3:36	p. 3:23 c 3:28	p. 3:45 c 3:55	p. 3:07 c 3:38	p. 3:23 c 3:40	g. 3:25	
Grasshopper Sparrow <u>Ammodramus savannarum</u>			f 3:41					
Horned Lark <u>Eremophila alpestris</u>			f 3:42					
Killdeer <u>Charadrius vociferus vociferus</u>			f. 3:43					
Nighthawk <u>Chordeiles minor</u>	p. 3:51	p. 3:54 c 3:44	f 3:45 c 3:47	p. 4:05 c 3:49	p. 3:42 c 3:46	p. 3:40 c 3:55	g 4:15	
Ovenbird <u>Seiurus aurocapillus</u>	p. 3:56	p. 3:52 c 3:44	f 3:52	p. 3:53	p. 3:36 c 3:48	p. 3:54 c 3:57		r. 4:1
Spotted Sandpiper <u>Actitis macularia</u>	p. 3:48	p. 3:56 c 3:51	c 3:55	p. 4:11 c 3:59	p. 3:54 c 3:42	p. 4:23 c 3:42	g 4:07	
Song Sparrow <u>Melospiza melodia</u>	p. 3:58	p. 3:48	f 3:49	p. 3:43	p. 3:59	p. 4:08		
Vesper Sparrow <u>Pooecetes gramineus</u>			f 3:57					
Great Blue Heron <u>Ardea herodias</u>				p. 3:57				
Kingbird <u>Tyrannus tyrannus</u>		c 3:56	f 3:55 c 3:50	p. 5:27* c 3:52	c 4:06	c 4:14		
Robin <u>Turdus migratorius</u>	p. 4:51*	p. 3:55 c 3:53	f 3:53 c 3:36	p. 4:05 c. 3:56	c 4:01	p. 4:05 c 4:14		r. 4:1
Chipping Sparrow <u>Spizella passerina</u>		p. 4:16 c 4:02	f 5:16* c 4:14	c 4:00	p. 4:24 c 4:01	p. 4:27 c 4:11		
Least Flycatcher <u>Empidonax minimus</u>		c 4:05	f 5:00* c 4:04	c 4:15	c 4:14	c 4:03		
Wood Thrush <u>Hylocichla mustelina</u>		p 3:55		p 4:12	p 4:07	p. 4:06		r 4:1
White-throated Sparrow <u>Zenotrichia albicollis</u>			f 4:16					

July 12	July 13	July 14	July 15	July 19	July 20	July 21	Average EST	No. of records on which ov. is based	Average as Suntime
Moon bright sprinkling calm 59°	Moon bright clear calm 58°	Moon bright thin clouds calm 55°	Moon bright thin clouds calm 53°	Moon bright clear calm 63°	Moon thin clouds calm 55°	Moon clear calm 49°	3:33 (89)	11	2:55
							3:41 (81)	1	3:03
							3:42 (80)	1	3:04
							3:43 (79)	1	3:05
							3:49 (73)	10	3:11
r 4:08			r 4:23	r 4:53	r 4:56		3:50 (72)	9	3:12
							3:50 (72)	10	3:12
							3:54 (68)	6	3:16
							3:57 (65)	1	3:19
							3:57 (65)	1	3:19
	c 4:09						4:00 (62)	7	3:22
r 4:07	c 4:08	r 4:07	r 4:10				4:02 (60)	14	3:24
							4:12 (50)	8	3:28
							4:08 (54)	5	3:30
r 4:16		r 4:08	r 4:20				4:09 (53)	7	3:31
						r 4:51*	4:16 (46)	1	3:38

Min. before Median Sunrise

TABLE II

AVERAGE TIME OF SONG BEGINNING
FOR BIRD FAMILIES(average based on records of birds in the Biological Station Area
during the summer of 1949)

Alaudidae	3:42
Charadriidae	3:43
Caprimulgidae	3:49
Scolopacidae	3:50
Ardeidae	3:57
Fringillidae	4:08
Troglodytidae	4:20
Columbidae	4:20
Tyrannidae	4:25
Laridae	4:26
Virionidae	4:27
Thraupidae	4:28
Gaviidae	4:29
Hirundinidae	4:31
Alcedinidae	4:34
Turdidae	4:43
Icteridae	4:38
Parulidae	4:40
Corvidae	4:43
Paridae	4:53
Bombycillidae	4:54
Cuculidae	4:55

TABLE III

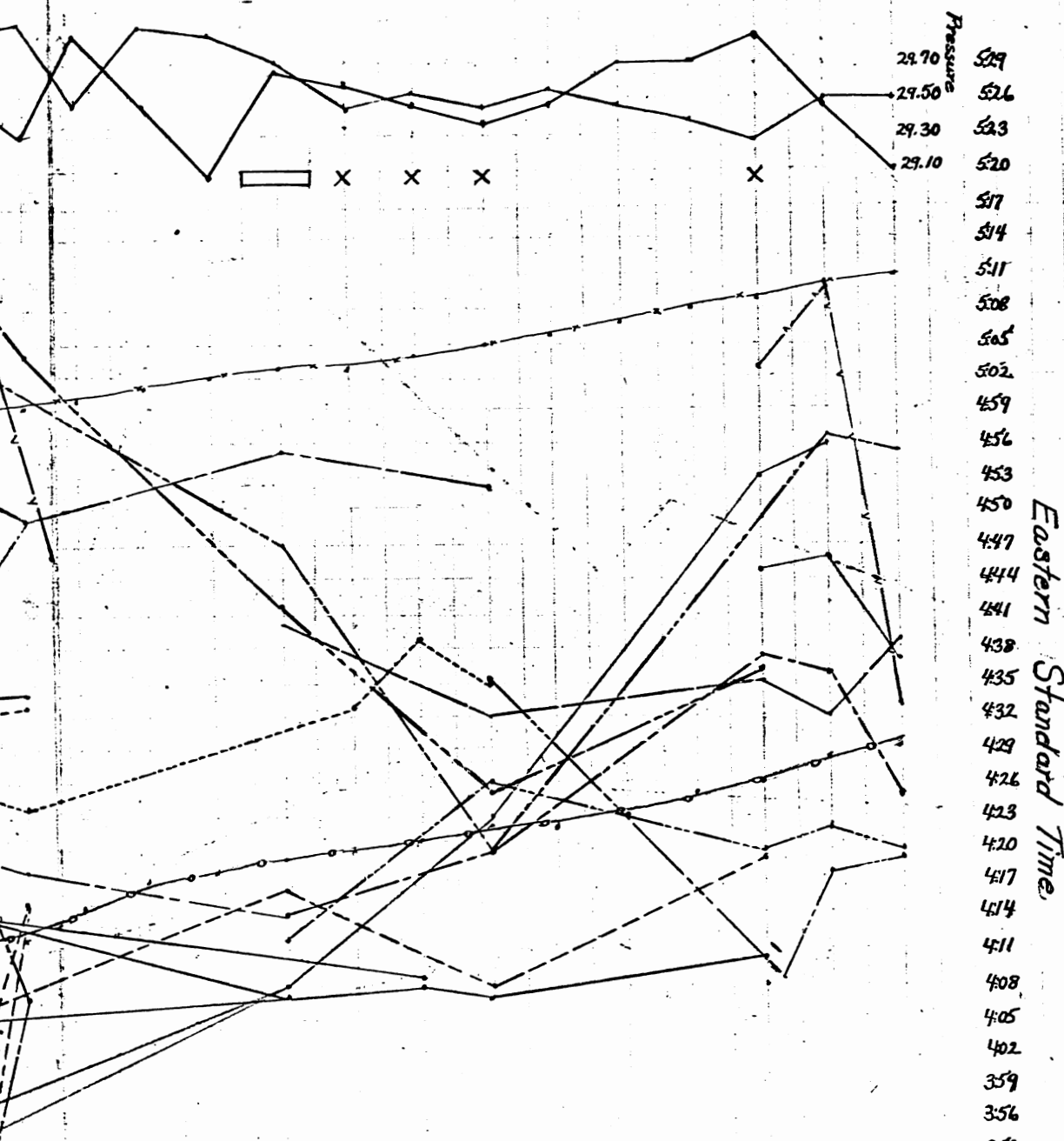
BEGINNING AND END OF Nighthawk AND Whip-poor-will CALLS

	<i>Whip-poor-will</i>		<i>Nighthawk</i>	
	<i>Begin</i>	<i>End</i>	<i>Begin</i>	<i>End</i>
June 24	3:36	4:26	3:57	4:36
26	3:46 - 3:36	4:12	3:45 - 3:44	4:31
30	3:23 - 3:27		3:45 - 3:46	
July 1	3:45 - 3:55	4:27	4:05 - 3:49	5:49
5	3:07 - 3:38	4:29	3:42 - 3:46	4:44
7	3:23	4:25	3:40	4:39
12	3:25	4:21	4:15	5:21
15		NONE HEARD		4:50
19		" "		4:57
20		4:32		4:53
21		4:20		4:48

TABLE IV
WEATHER DATA

	Min. Night Temp.	Pressure	Night Precipitation	Sunrise EST	Beginning of Civil Twilight
June 24	60°	29.19	.02	4:52	4:06
25	64°	29.17		4:52	4:06
26	62°	29.20		4:52	4:06
27	58°	29.43		4:53	4:07
28	60°	29.44		4:53	4:07
29	60°	29.61		4:54	4:08
30	61°	29.60		4:54	4:08
July 1	63°	29.63		4:55	4:09
2	61°	29.75		4:55	4:09
3	62°	29.63		4:56	4:10
4	65°	29.45		4:57	4:11
5	63°	29.62		4:57	4:11
6	60°	29.58		4:58	4:12
7	58°	29.67		4:59	4:13
8	52°	29.71		4:59	4:13
9	63°	29.48		5:00	4:15
10	55°	29.70		5:01	4:17
11	48°	29.68		5:02	4:18
12	59°	29.50	.03	5:03	4:19
13	58°	29.48		5:03	4:20
14	55°	29.51		5:04	4:21
15	53°	29.47		5:05	4:22
16	55°	29.53		5:06	4:22
17	60°	29.48		5:07	4:23
18	60°	29.34		5:08	4:25
19	63°	29.27		5:09	4:26
20	55°	29.47		5:10	4:28
21	49°	29.48		5:11	4:29

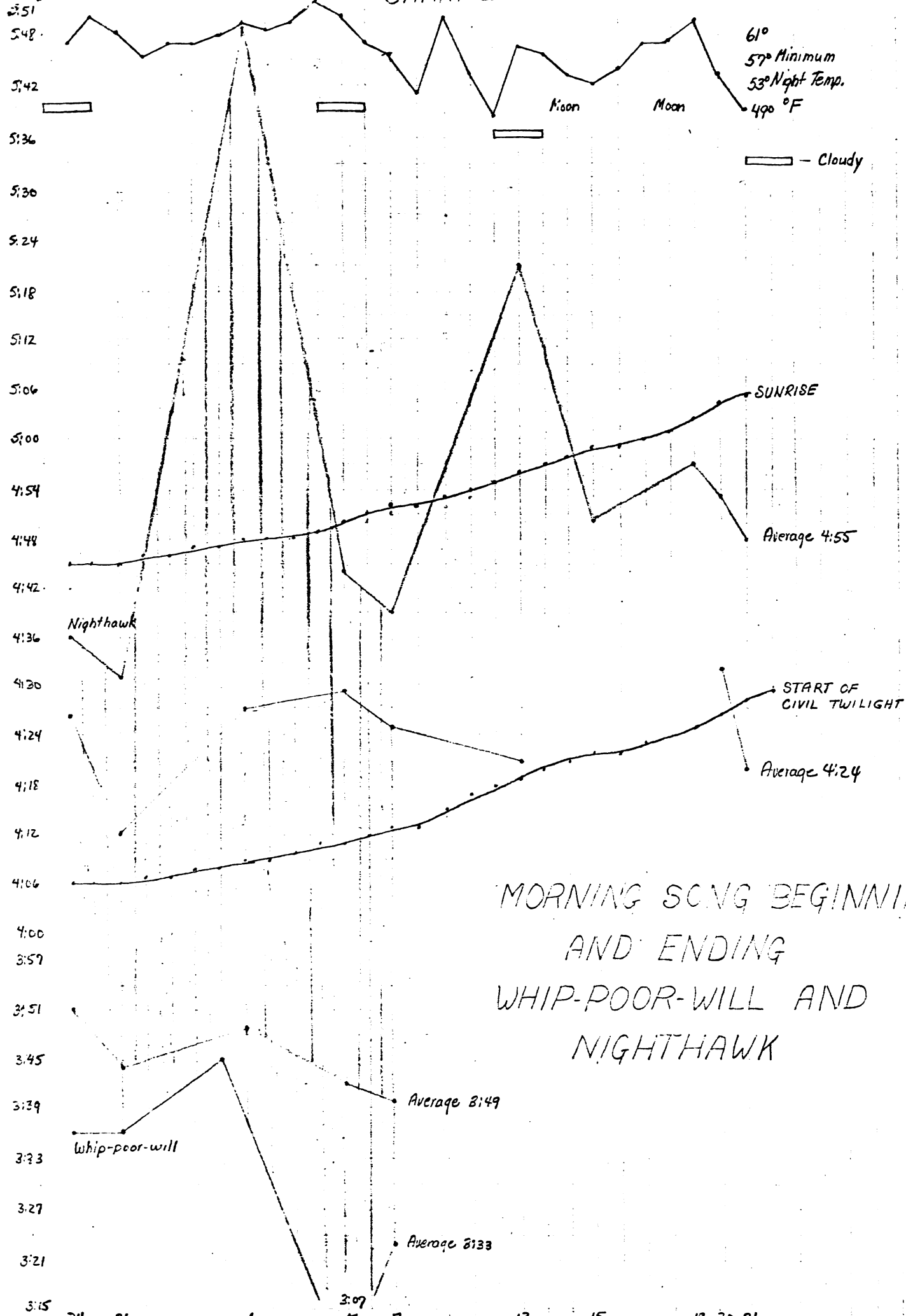
Median 5:02



RECORDS OF MORNING
SONG BEGINNING

Pressure
 30.70
 30.50
 30.30
 30.10
 30.7
 30.4
 30.1
 30.8
 30.5
 30.2
 29.9
 29.6
 29.3
 29.0
 28.7
 28.4
 28.1
 27.8
 27.5
 27.2
 26.9
 26.6
 26.3
 26.0
 25.7
 25.4
 25.1
 24.8
 24.5
 24.2
 23.9
 23.6
 23.3
 23.0
 22.7
 22.4
 22.1
 21.8
 21.5
 21.2
 20.9
 20.6
 20.3
 20.0
 19.7
 19.4
 19.1
 18.8
 18.5
 18.2
 17.9
 17.6
 17.3
 17.0
 16.7
 16.4
 16.1
 15.8
 15.5
 15.2
 14.9
 14.6
 14.3
 14.0
 13.7
 13.4
 13.1
 12.8
 12.5
 12.2
 11.9
 11.6
 11.3
 11.0
 10.7
 10.4
 10.1
 9.8
 9.5
 9.2
 8.9
 8.6
 8.3
 8.0
 7.7
 7.4
 7.1
 6.8
 6.5
 6.2
 5.9
 5.6
 5.3
 5.0
 4.7
 4.4
 4.1
 3.8
 3.5
 3.2
 2.9
 2.6
 2.3
 2.0
 1.7
 1.4
 1.1
 0.8
 0.5
 0.2
 0.0

CHART II



MORNING SONG BEGINNING
AND ENDING
WHIP-POOR-WILL AND
NIGHTHAWK

AVERAGE TIME OF SONG BEGINNING

Time is EST

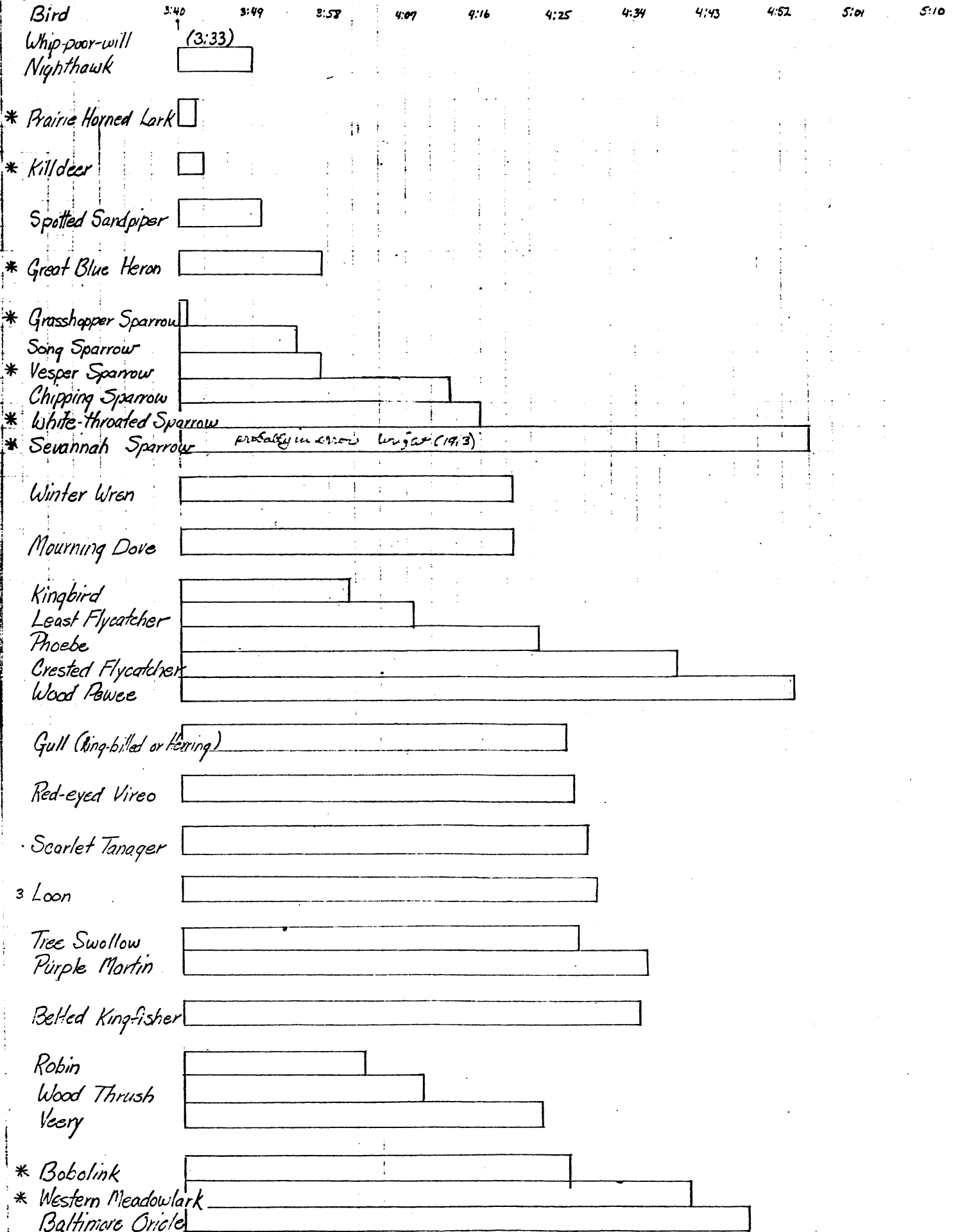
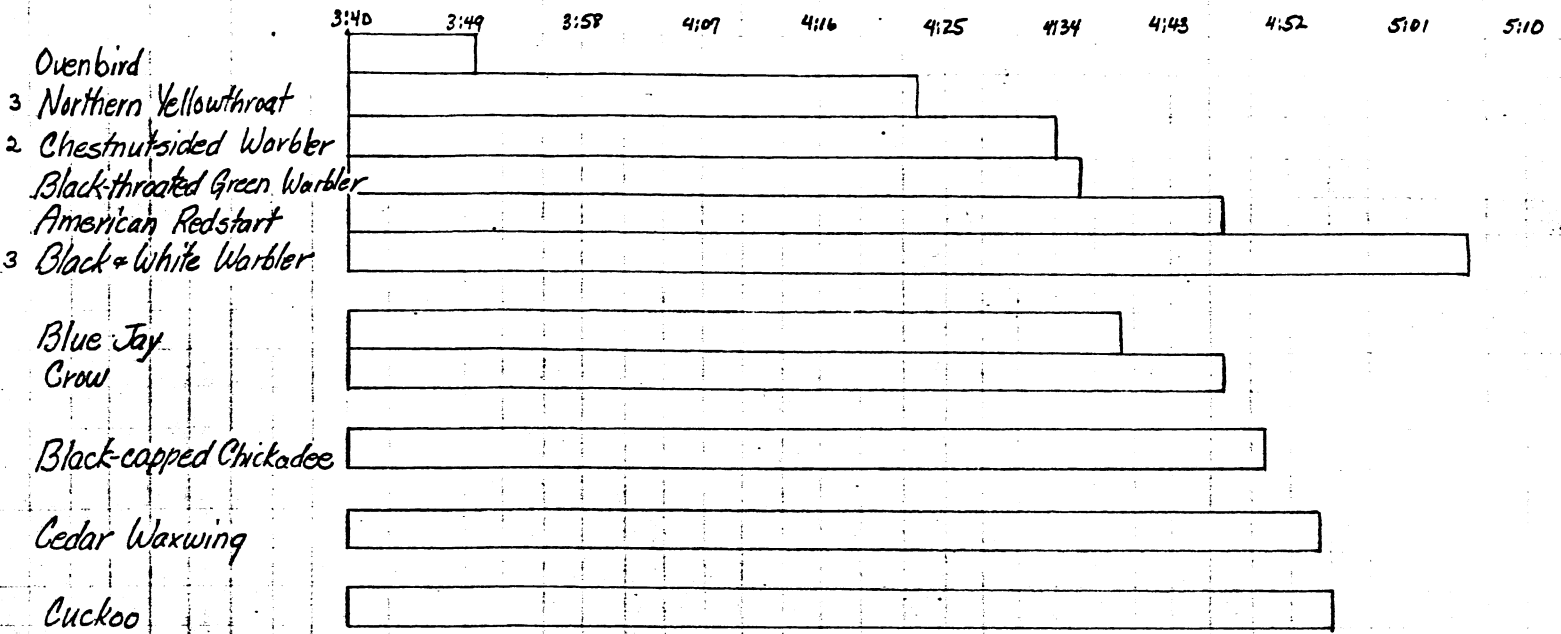


CHART III
(continued)



- * Only one observation
- 2 Two observations
- 3 Three observations
- More than three observations

3:40 3:50 4:00 4:10 4:20 4:30 4:40 4:50

AVERAGE TIME OF MORNING SONG BEGINNING

(average only of birds whose morning song beginning was recorded this summer.)

Bird Families

