WEIGHT AND SIZE VARIATION IN THE GRAY CATBIRD

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INTRODUCTION

Weights of wild birds fluctuate because of various activity patterns governed by either internal or external stimuli. Important short time-scale activities include locomotion, feeding, and defecation; those on a longer time-scale include migration, reproduction, and molt. Stimuli controlling these activities include day length, temperature, hunger, fright, and many others, some operating directly and others indirectly. Weight changes in living birds provide clues to other aspects of their biology, to environmental stresses, and to the longer-period activities in which the species or individual is engaged.

Because of the many variables determining the instantaneous weight of a bird and the limited number of times a wild bird can be captured and weighed (particularly without inadvertently influencing the weight), useful information on cyclical or systematic changes can best be obtained from statistical analyses of large numbers of weights taken throughout the duration of the cycle of interest. This paper presents an analysis of weight variation in the Gray Catbird (*Dumetella carolinensis*) and relates these variations to time of day and year, activity patterns, age, and sex.

In contrast to weight, linear measurements of individual birds are relatively constant after full growth is attained. Some change takes place in wing and tail length by wear between molts but this is typically slow and gradual (Blake, 1971). Thus, size of the Catbird is documented by age and sex but related only to season.

Many authors have reported bird weights and several (Baldwin and Kendeigh, 1938; Becker and Stack, 1944; Wiseman, 1975) have analyzed their data by age, sex, time of day or season. Most data were taken from living birds but some from tower kills (Graber and Graber, 1962; Tordoff and Mengel, 1956). Causes of weight changes and their significance have been discussed previously (Nice, 1938; Blake, 1956). General patterns of weight change are well known but have been documented by adequate data for only a few species such as the American Goldfinch (Wiseman, 1975). Other authors studied weight change in relationship to fat deposition and potential flight distance (Drury and Keith, 1962; Mueller and Berger, 1966; Rogers and Odum, 1966).

An attempt was made to locate all previous Gray Catbird weights reported in the literature so that comparisons could be made with data from other seasons and other locations. In addition to the authors cited above, Catbird weights were given by Stewart (1937), Poole (1938), Johnston and Haines (1957), Murray and Jehl (1964), and Stewart and Skinner (1967). Only one series of Catbird measurements was found (Wetherbee, 1934). Those measurements are compared below to data from this study.

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ACTIVITY CYCLES

At the study location (Manorville, Long Island, N.Y.), Gray Catbirds of both sexes normally arrive from the south in the first week of May. Spring migration is poorly marked and most birds appear to be returning residents rather than transients. Territorial activity begins soon thereafter. Pair formation is completed during May while first nest construction and egg laying typically occur near the end of the month. Young of the first brood are largely fledged by early July. An unknown percentage of the population attempts a second brood and young have been found in the nest in August. Thus, fledging may extend over a two-month period. Much greater detail on nesting biology was given by Nickell (1965).

Adults undergo a complete second prebasic (postnuptial) molt in August and September, the onset apparently governed by termination of reproductive activity. Birds of the year have a partial first prebasic (postjuvenal) molt at the same season, its onset apparently influenced by the date of fledging. By mid- to late-September, this molt is largely complete in most individuals and immatures are indistinguishable by plumage from adults except possibly by wear of the flight feathers. However, the two age classes can be separated by mouth color until they leave in the fall.

During the molting period, territoriality breaks down and considerable wandering takes place. This continues into the fall and apparently overlaps the period of true migration. Peak of fall migration takes place in September and the first half of October. Some Catbirds linger into November and a few winter on Long Island although seldom at the banding station.

The daily activity pattern usually includes a period of intense feeding soon after sunrise, sporadic feeding during the bulk of the day, and perhaps a short period of more intense feeding before sunset. This pattern may be modified by inclement weather. Other daily activities depend on the stage of the reproductive, molt or migration cycle.

METHODS

Data included in this study were obtained from Catbirds captured between September 1939 and August 1975. The banding station includes a rural yard, large garden area, cultivated and overgrown fields and deciduous woods plus a wide band of wooded swamp bordering the Peconic River, a slow-moving stream that runs through the area. Prior to 1959, all captures were by traps and relatively few Catbirds were taken. Starting in 1959, both traps and mist nets were used and many more Catbirds were captured annually.

Banding was conducted on a time-available basis and the data are somewhat biased towards captures late in the day in contrast to the early morning bias at many coastal banding stations during the fall migration. During the spring, banding was regular although captures were few. During the early summer, banding was conducted frequently enough to capture most of the residents but not daily. From late July or August through October, banding was conducted almost daily, if possible, particularly during the years of Operation Recovery (Baird et al., 1958) and the subsequent Atlantic Flyway Review Program. Due to the presence of more Catbirds in late summer and fall and the time of the banding effort, most captures were made at that time.

All birds captured were aged, sexed if possible, weighed, and measured. Traps and nets were examined frequently. Most weights were taken within 10 min after capture to the nearest 0.1 g on an OHaus triple-beam balance. Time of weighing was recorded to the nearest five min using Eastern Standard time throughout the year. Measurements were taken in standard fashion using a steel rule calibrated in millimeters. Bill length was measured to the nearest 0.5 mm and the chord of the wing and the tail to the nearest 1 mm. Lengths of primaries and rectrices in sheaths and obviously still growing were not included in the data base and the few tail lengths <78 mm were excluded from the analyses below because they were not considered fully grown. Weights were taken at every capture, including repeats. Measurements were taken of all new birds and returns and occasionally of repeats if some time had elapsed since the previous capture. Otherwise, measurements of repeats were assumed to be the same as when last taken. Fat class was not normally recorded but notations were made of extremely fat or thin birds to verify that the weights were not in error. Nisbet et al. (1970) showed that the mean of wing lengths measured by four observers differed slightly. This source of variability is absent in this study because all measurements were made by the author. However, random errors are likely in any large set of data.

Catbirds could only be sexed during the breeding season: brood patch in females and cloacal protuberance in males. Sex determined at any capture was assigned to all prior or subsequent captures of the same bird. Immature (HY) birds were separated from adults (AHY) by plumage or mouth color.

Data were obtained from 2,592 captures, 1,835 new, 106 returns, and 651 repeats. Weights are missing from only four of the captures and measurements from only a small number of new and return birds. Of

TABLE 1.
Age and sex distribution of captures.

Sex	Age			
	Adult	Immature	Unknown	Total
Male	126	3	2	131
Female	79	2	2	83
Unknown	461	1,768	149	2,378
Total	666	1,773	153	2,592

the captures 6.9% were made in May and June, 15.4% in July and August, and 77.5% in September and October. A listing by age and sex is given in Table 1. Individuals of unknown age were taken largely in the early years before aging and sexing were considered important in the banding program.

ANALYTICAL METHODS

All data were transferred from the banding notebook to punch cards and copied on magnetic tape. A separate card was punched for each capture of each bird and included the following information: band number, AOU number, date, third of the month, time (EST), solar hour (Raynor, 1975), age, sex, bill length, wing length, tail length, weight, method of capture, status (new, return or repeat), capture number and capture location. Code numbers were used for the variables underlined.

Data were classified into selected groupings and analyzed statistically. Most analyses were performed on a CDC 6600 computer. Extensive use was made of the preprogrammed software package SPSS (Statistical Package for the Social Sciences) (Nie et al., 1975). Groups were selected by age, sex, time of year, and time of day. Possible differences between all captures and new captures only were investigated as were possible differences due to capture method and status. Data were analyzed by the variables separately and in various combinations. Attempts were made to perform the analyses in ways that would give biologically significant information.

In planning the analyses, the possibility was considered that an annual pattern of weight change might be influenced by birds of different average size being present at different seasons, so a normalized weight was computed for each capture. The actual weight was divided by the wing length on the assumption that the latter is a conservative indicator of the overall size of the bird. However, computation of the Pearson correlation coefficients between the various measures of size showed that they were only poorly related to each other (Table 2). Thus, analyses of normalized weight are not presented. However, the method may prove useful for other species.

TABLE 2.
Pearson correlation coefficients (r) between measured variables.

Variables	n	r
Wing-tail	2,529	0.583
Wing-mandible	2,577	0.315
Tail-mandible	2,527	0.264
Wing-weight	2,574	0.253
Tail-weight	2,522	0.257
Mandible-weight	2,577	0.091

RESULTS

Sample Statistics

The basic statistics for the entire sample and for subsets by age and sex are given in Table 3. The mean weight of immatures was only slightly less than that of adults but both minimum and maximum weights were less. In sexed adults, females were much heavier than males. During most of the breeding season, differences were even greater. Males were light due to their constant territorial activities and feeding of young. Females were particularly heavy while laying and retained much of their weight through incubation. While feeding young, however, females weighed approximately the same as males.

Adult bill length averaged nearly a millimeter more than that of immatures but sex differences between adults were slight. Wing and tail lengths were also much greater in adults than in immatures but sexual differences were probably not significant.

Wetherbee (1934) found a mean culmen length of 16.0 mm (13.3–17.8) in 11 adults and 15.8 mm (11.8–19.8) in 43 immatures in a sample from New England. The mean values are somewhat smaller than those found in this study. Wing lengths given by Wetherbee (1934) averaged 91.6 mm for adults and 90.8 mm for immatures, values close to those shown in Table 3. Mean tail lengths from the same sample were 95.5 mm for adults and 95.6 mm for immatures. Both values are larger than those presented here. This is surprising because the minima given, 66.8 and 67.8 for the two age groups, suggest that tails not fully grown were included in the sample.

Because 29% of this sample consists of returns and repeats, the effect of including their data in the statistics was examined. No bias was caused because the mean measurements of birds caught for the first time do not differ significantly from those of all captures.

TABLE 3.
Weights and measurements of all birds.

Age	Sex	n[1]	Mean ± SD (Range)	% CV	S	K	95% CI
			Weight (g)				
All	—	2,584	39.9 ± 3.15 (27.4–54.5)	7.88	−0.02	+0.52	39.8–40.0
Im.	—	1,767	39.9 ± 2.99 (27.4–50.1)	7.50	−0.23	+0.60	39.7–40.0
Ad.	—	665	40.1 ± 3.57 (31.6–54.5)	8.92	+0.32	+0.08	39.8–40.3
Ad.	M	126	38.3 ± 3.52 (31.9–48.7)	9.19	+0.79	+0.55	37.7–39.0
Ad.	F	79	40.9 ± 4.38 (31.6–54.5)	10.70	+0.31	+0.09	40.0–41.9

TABLE 3.
Continued.

Age	Sex	n[1]	Mean ± SD (Range)	% CV	S	K	95% CI
			Bill length (mm)				
All	—	2,585	16.7 ± 0.95 (13.5–20.0)	5.70	−0.05	−0.03	16.6–16.7
Im.	—	1,768	16.4 ± 0.87 (13.5–19.0)	5.32	−0.15	+0.05	16.4–16.5
Ad.	—	666	17.3 ± 0.86 (14.5–20.0)	4.96	−0.13	+0.02	17.3–17.4
Ad.	M	126	17.5 ± 0.81 (16.0–20.0)	4.59	+0.14	−0.18	17.4–17.7
Ad.	F	79	17.7 ± 0.78 (16.0–19.0)	4.41	−0.58	−0.35	17.5–17.8
			Wing length (mm)				
All	—	2,582	91.0 ± 2.91 (80.0–102.0)	3.20	−0.03	−0.06	90.9–91.1
Im.	—	1,767	90.4 ± 2.72 (80.0–98.0)	3.01	−0.11	−0.23	90.3–90.6
Ad.	—	662	92.3 ± 2.99 (83.0–102.0)	3.24	−0.08	−0.01	92.1–92.5
Ad.	M	125	92.1 ± 3.01 (86.0–99.0)	3.27	+0.16	−0.32	91.6–92.7
Ad.	F	78	91.4 ± 2.73 (86.0–97.0)	2.99	+0.16	−0.71	90.8–92.0
			Tail length (mm)				
All	—	2,530	91.5 ± 3.75 (78.0–110.0)	4.10	−0.03	+0.79	91.4–91.7
Im.	—	1,736	90.9 ± 3.50 (78.0–108.0)	3.85	−0.16	+0.76	90.7–91.1
Ad.	—	642	93.3 ± 3.80 (81.0–110.0)	4.07	−0.02	+1.14	93.0–93.6
Ad.	M	120	93.5 ± 4.09 (84.0–110.0)	4.37	+1.10	+3.29	92.8–94.3
Ad.	F	74	93.1 ± 2.67 (87.0–100.0)	2.86	−0.36	+0.13	92.5–93.7

[1] n = number of cases, SD = standard deviation, S = skewness, K = kurtosis, CI = confidence interval.

The effect of handling on weights of repeats taken shortly after a previous capture is noticeable but the number of cases is too small to affect any results. As shown earlier by Mueller (1964), handling usually causes a weight loss. These data suggest that this may be regained within hours or may persist for several days. However, it is difficult to isolate this factor from the many other causes of weight change.

Repeats weigh slightly less and have slightly shorter wings and tails than new birds whereas returns are appreciably larger in all measurements. This is believed due to inclusion of immatures in the new category whereas all returns are at least in their second year. In addition, returns average larger in all measurements than all adults. This could be interpreted in several ways but perhaps the larger, heavier birds are more likely to return successfully than smaller and presumably weaker individuals.

Previous investigators have suggested that trapped birds weigh more than netted birds due to food consumed at the trap or at nearby feeders. This may well apply to granivorous species, particularly in the colder months when food is scarce in the natural environment. However, trapped Catbirds weighed less (39.2 g) than netted individuals (40.0 g) although they averaged larger in all body dimensions. All data were examined first. Then, to remove any possible bias from breeding season birds that are predominantly light males, data for the months of August through October were also examined. Data were similar. These findings might be interpreted to mean that larger, dominant individuals are more likely to preempt available food first as suggested by observations at feeders but that they utilize food in a trap only if hungry and below normal weight at the time.

Sample Frequencies

Although the statistics given above describe weight and size variation in the samples studied, frequency distributions were prepared to facilitate visual comparisons. A frequency of all weights is shown in Figure 1 wherein the near normal distribution is evident. The maximum weight is twice the minimum. The smooth decrease from the median to the extreme weights indicates that the latter are an integral part of the distribution. However, data for the four birds weighing less than 30 g and the four weighing 50 or more g were critically examined and found to be valid.

Weights of adults and immatures are compared in Figure 2. Adults have a less peaked distribution due, in part, to the large difference between the sexes in the breeding season. This is shown in Figure 3 where males predominate below 39 g and most birds weighing above 40 g are females. The departure from normality here is attributed largely to the smaller number of cases but the difference in weight between breeding and nonbreeding adults probably contributes to the scatter.

Bill length is shown in Figure 4 where the distribution is near normal. Data were also graphed by age and sex but are not shown. Adults predominate in the >17 mm class and immatures <16 mm. Bills of females average somewhat longer than those of males but the number of cases is small and overlap is extensive (Table 3).

The distribution of all wing lengths is shown in Figure 5 and again approximates a normal distribution. Data were also examined by age and sex. Wings of adults are appreciably longer than those of immatures

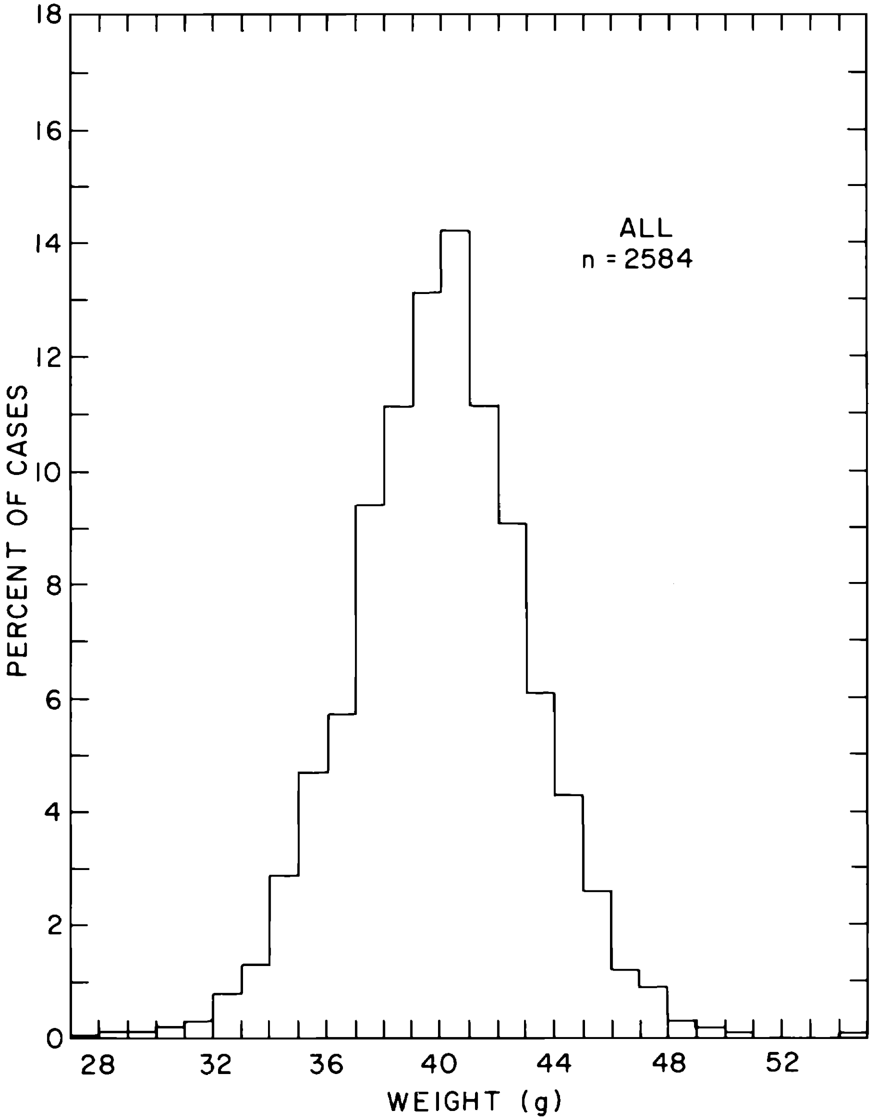

FIGURE 1. Percentage frequency distribution of all Gray Catbird weights.

and show a tendency towards a bimodal distribution whereas immatures have a more peaked unimodal distribution. No adults had wings <83 mm and no immatures >98 mm. Adult males peak about 1 mm longer than adult females. The latter have a bimodal distribution which may be caused by the small sample size.

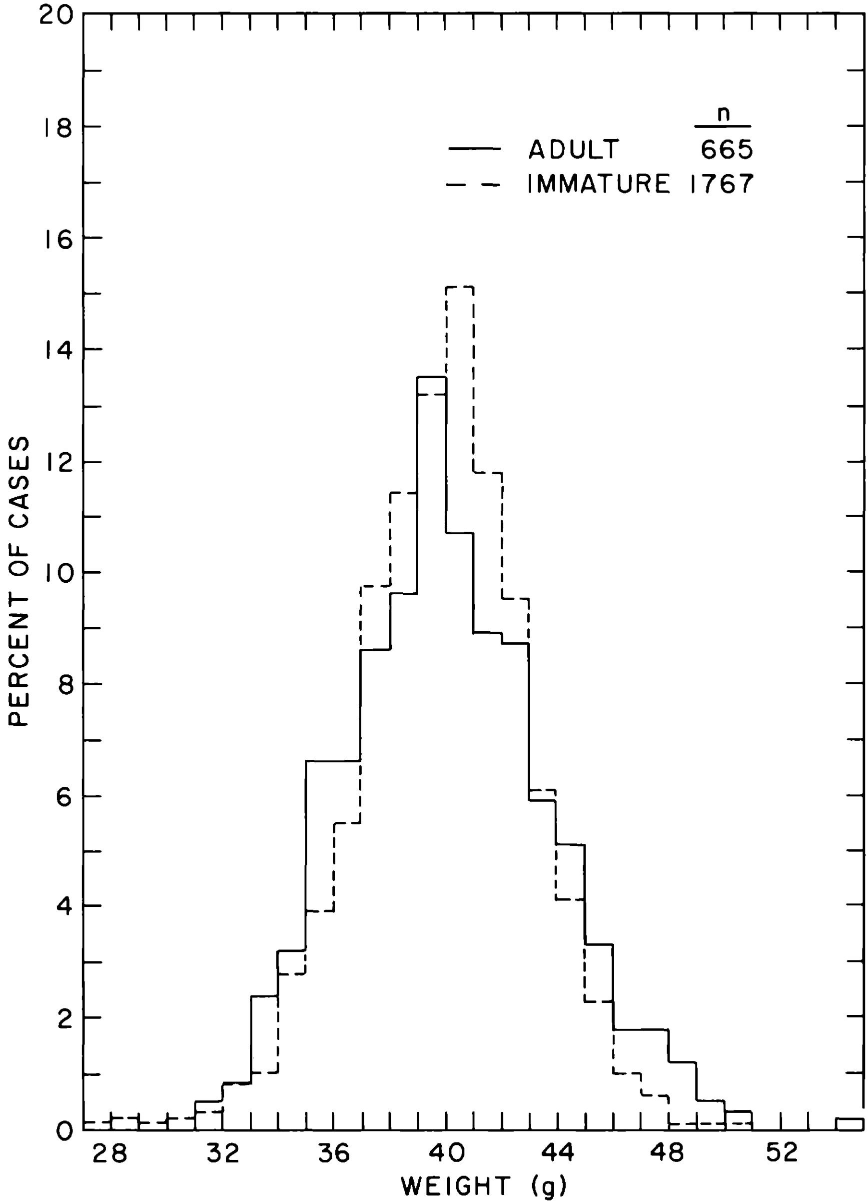

FIGURE 2. Percentage frequency distribution of Gray Catbird weights by age.

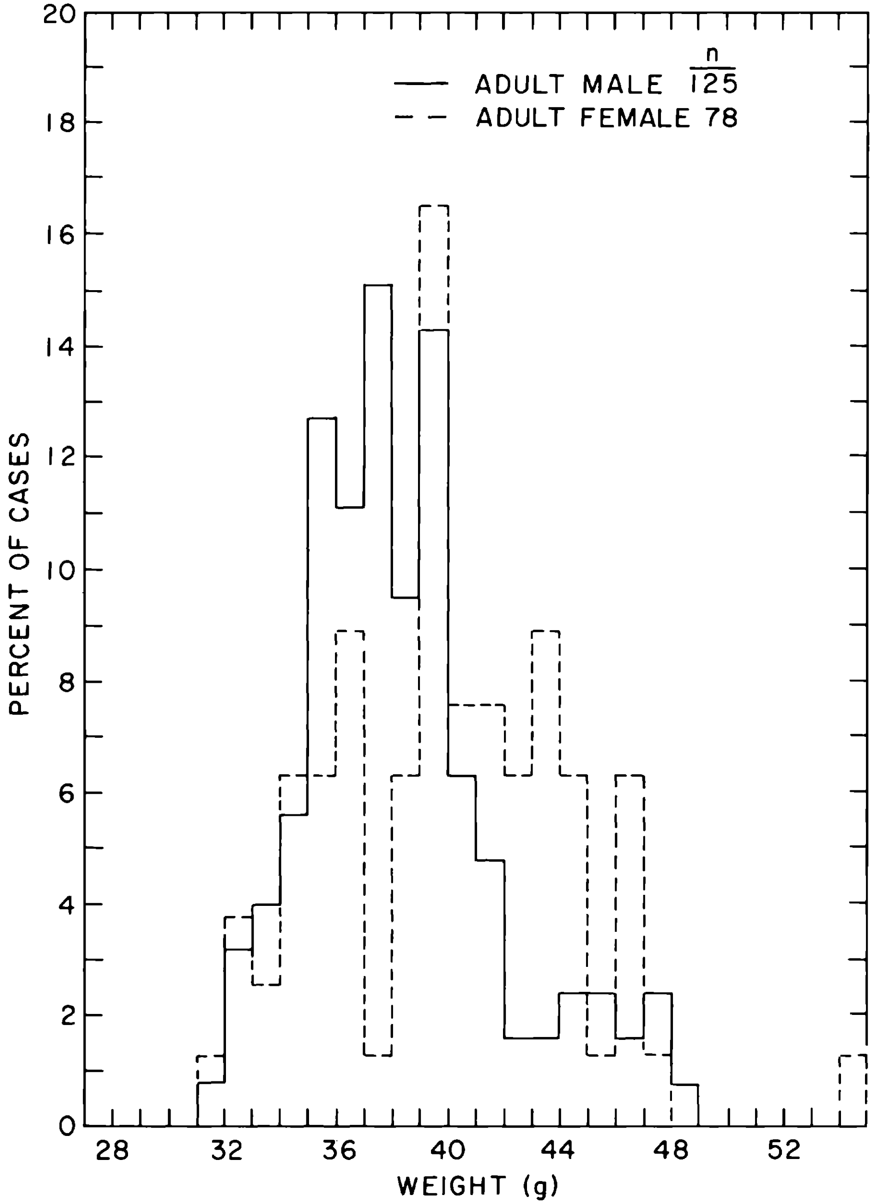

FIGURE 3. Percentage frequency distribution of Gray Catbird weights by sex.

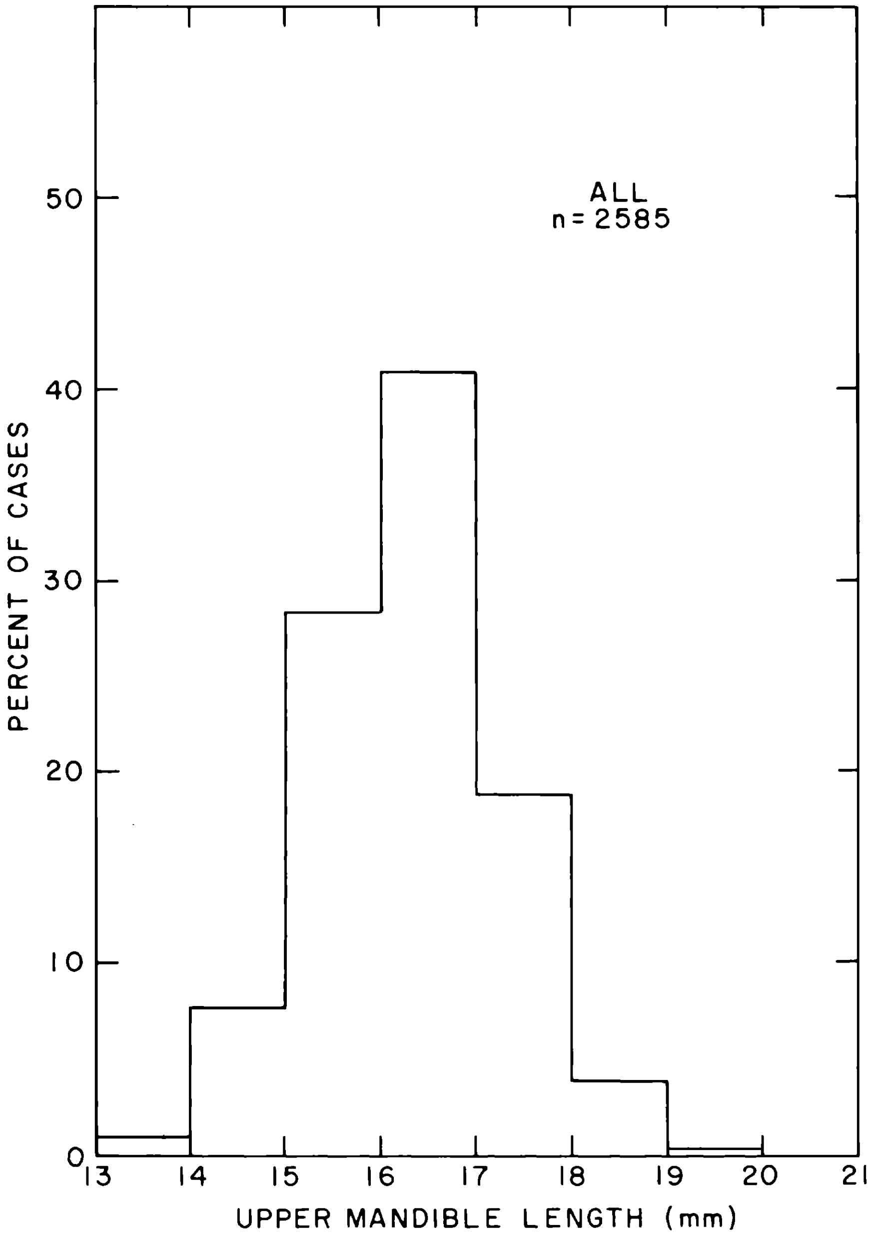

FIGURE 4. Percentage frequency distribution of all Gray Catbird bill lengths.

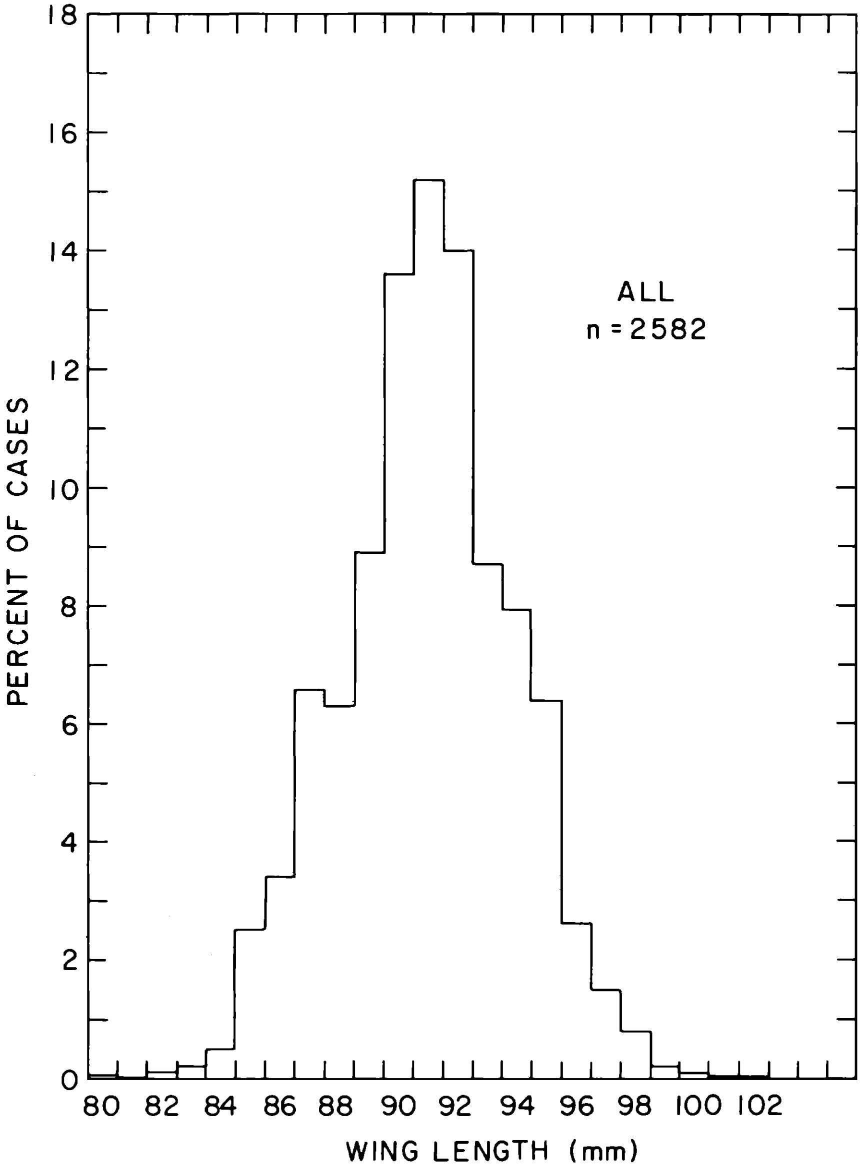

FIGURE 5. Percentage frequency distribution of all Gray Catbird wing lengths.

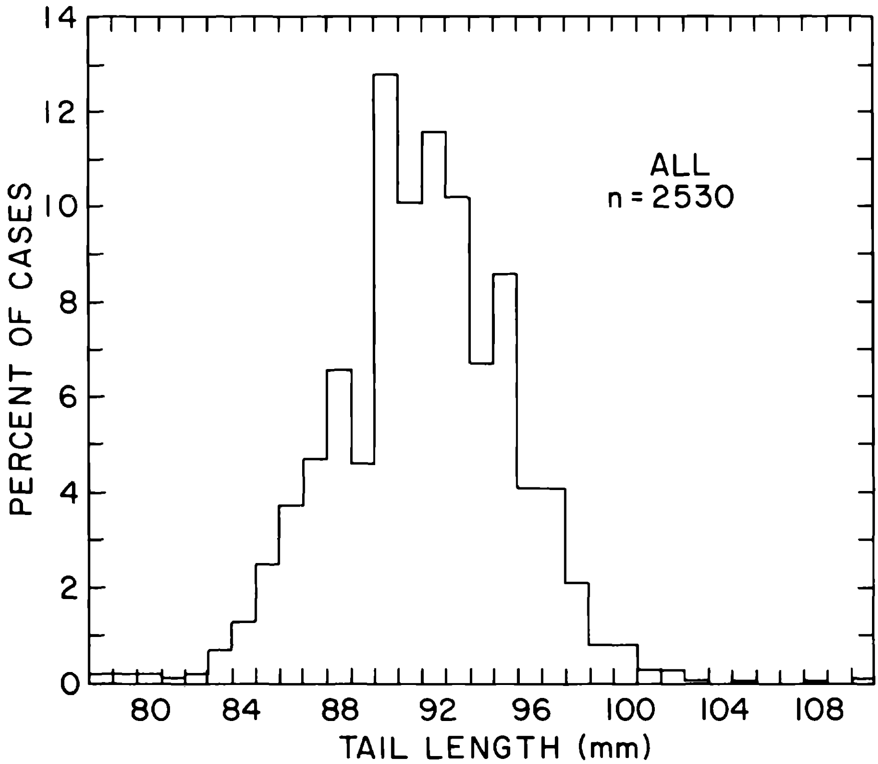

FIGURE 6. Percentage frequency distribution of all Gray Catbird tail lengths.

Tail lengths of all birds (Figure 6) have a more irregular distribution than wing lengths but reasons for this are not evident. When data were examined by age and sex, it was found that tails of adults have a wider distribution than those of immatures and peak appreciably higher. Females have a narrower, more peaked distribution than males which have greater extremes. All tails <87 mm and >100 mm were of males.

Diurnal Cycle in Weight

Because day length varies from about 10 to 15 hr between May and October and since feeding and other activities are governed by the times of sunrise and sunset, data were classified by a solar time system (Raynor, 1975) rather than conventional time. The system was designed for classification of variables that undergo systematic diurnal changes. Hours are numbered with reference to sunrise and sunset, for example, the third hour after sunrise or the fourth hour before sunset. At this latitude, 30 solar hours occur throughout the year but only 24 on any given day.

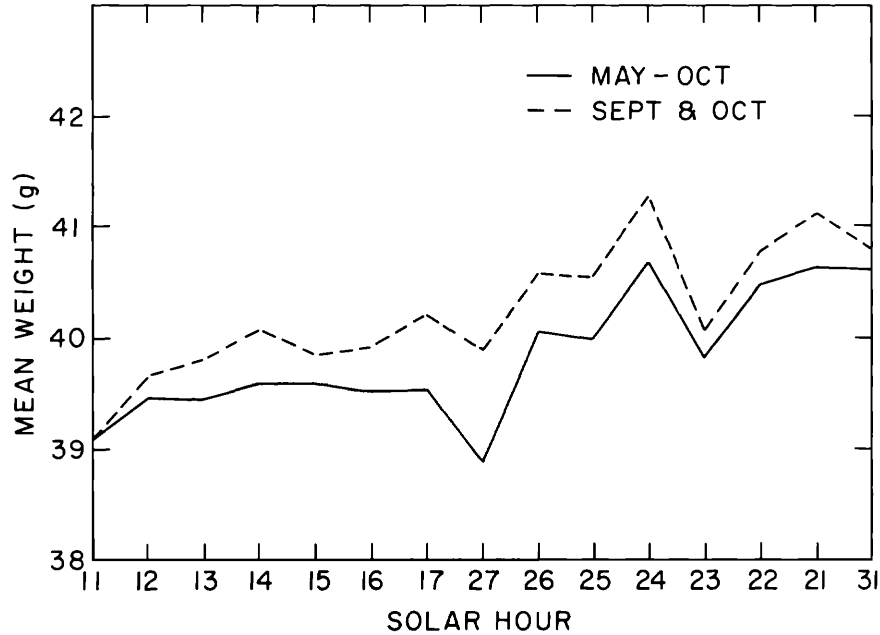

FIGURE 7. Diurnal cycle in weight of all Gray Catbirds and of September and October captures by solar hour.

Most important changes in bird weights take place soon after sunrise and before sunset while little change normally occurs during the midday period. This is illustrated by the solid line in Figure 7 which shows the mean weight of all captures as a function of solar hour. The value of 39.1 g during solar hour 11 is undoubtedly well above the minimum early morning weight because many birds had fed before being captured. Thus, the full extent of the early morning weight increase is not shown here.

Weight reaches a plateau by midmorning but increases again after midday to a peak at sunset (between hours 21 and 31). Solar hours 17 and 27 do not occur after late September so the heavier late fall birds are not represented in these hours. Also, the number of captures is less in these hours than in hours occurring throughout the season. Thus, no significance is attached to the minimum at hour 27. The peak at hour 24 and the dip at hour 23 are unexplainable but the reasons are probably statistical rather than biological.

The data show an average weight gain of about 1.6 g throughout the day or about 4% of the mean weight of all birds. The actual increase from the minimum weight is certainly greater. Overnight weight loss was sampled from 16 birds caught near dark, held overnight in the house, and reweighed before release early the next morning. Original weights varied from 33.0 to 46.0 and averaged 40.1 g, close to the mean weight for the species. Weight loss ranged from 1.8 to 6.0 and averaged 3.9 g. Percentage loss varied from 5.9 to 13.7% of the evening weight and averaged 9.6%. A group of seven similar captures in 1977 had an average loss of 3.7 g or 9.2% of their evening weight. It is not known if these losses are greater or less than losses in undisturbed birds but a few birds released late in the day and recaptured early the next morning showed similar losses. If this rate of weight loss applies to noncaptives, mean prefeeding weight would be about 36.7 g and the value of 39.1 g for the first hour after sunrise implies an average gain of 2.4 g within the first half hour after sunrise.

Considering the possibility that birds might have a different diurnal cycle in the breeding and molting seasons, hourly values for September and October only were computed and are shown as a dashed line in Figure 7. Because this sample includes 77% of the total captures, the similarity in the curves is not unexpected.

Seasonal Cycle in Weight

Weights were averaged for each one-third month period from May through October. Results are shown in Figure 8. Despite some irregularities during June and July when few captures were made, the seasonal pattern is clear. In early May, weights are slightly less than the mean for the year. They decrease to a minimum near the end of June, rise after the breeding season to a relatively constant level during most of the molt period and rise to above average levels in the fall. A few birds were captured frequently enough to permit determination of weight changes. Most show a reasonable similarity to the seasonal curve for all birds but changes are often more extreme than would be expected from the mean curve and exceeded 10 g for several birds.

Combined Diurnal-seasonal Weight Pattern

Ideally, the mean weight of a population could be specified for any time of day and any time of year. Weights of individual birds would deviate widely from the mean but the pattern would provide a reference against which to evaluate these deviations. A combined pattern for the Catbird was prepared by classifying the data by both solar hour and third-month intervals. Because the number of cases in many classes was small, considerable smoothing guided by the mean diurnal curve of Figure 7 and the mean seasonal curve of Figure 8 was necessary in drawing the lines of equal weight shown in Figure 9. However, the resulting pattern is probably a reasonable representation of population weight changes throughout the day for the six-month period.

Relation of Weight to Reproduction

Weights of sexed adults captured during June and the first half of July were examined to document any effect of reproductive activities. Weights of 52 males averaged 37.4 g and of 21 females, 41.0 g. Some

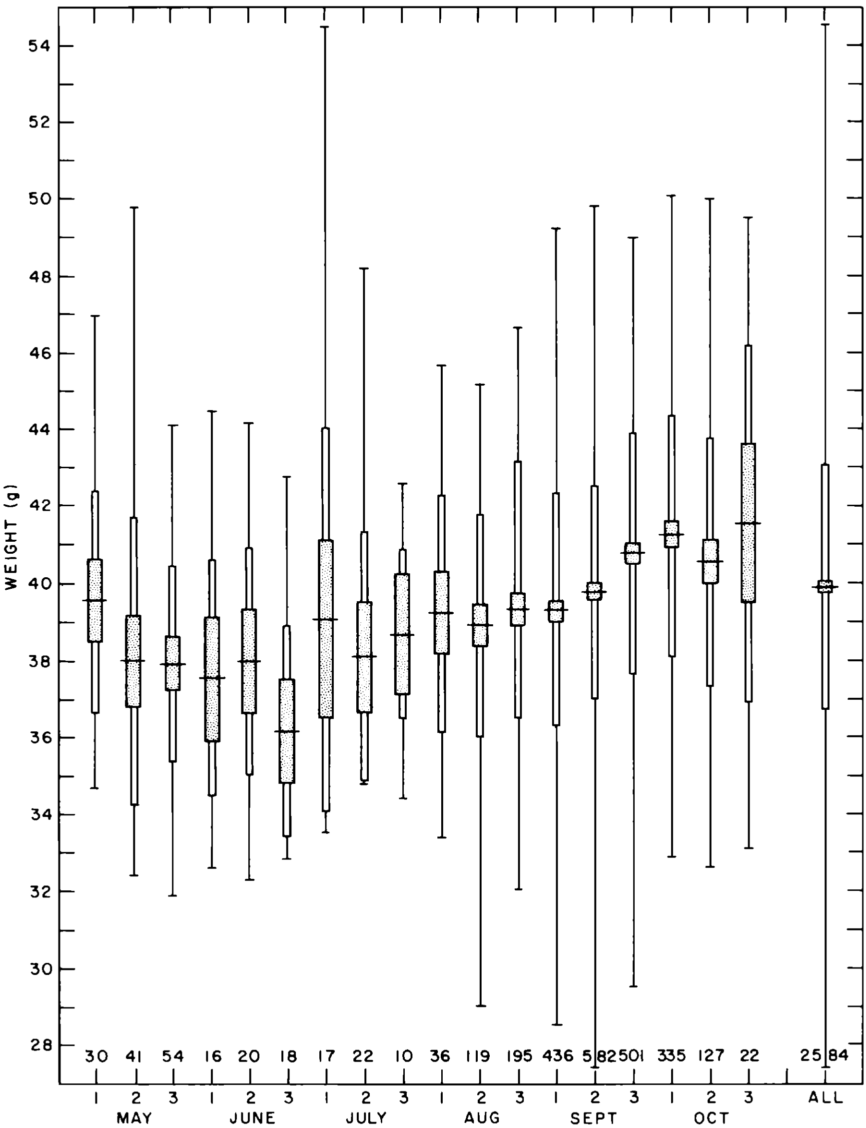

FIGURE 8. Mean (horizontal bar), 95% confidence interval (stippled vertical bar), mean plus and minus one standard deviation (open vertical bar) and extremes (vertical line) of all Gray Catbird weights with number of cases for each one-third month period and for all data.

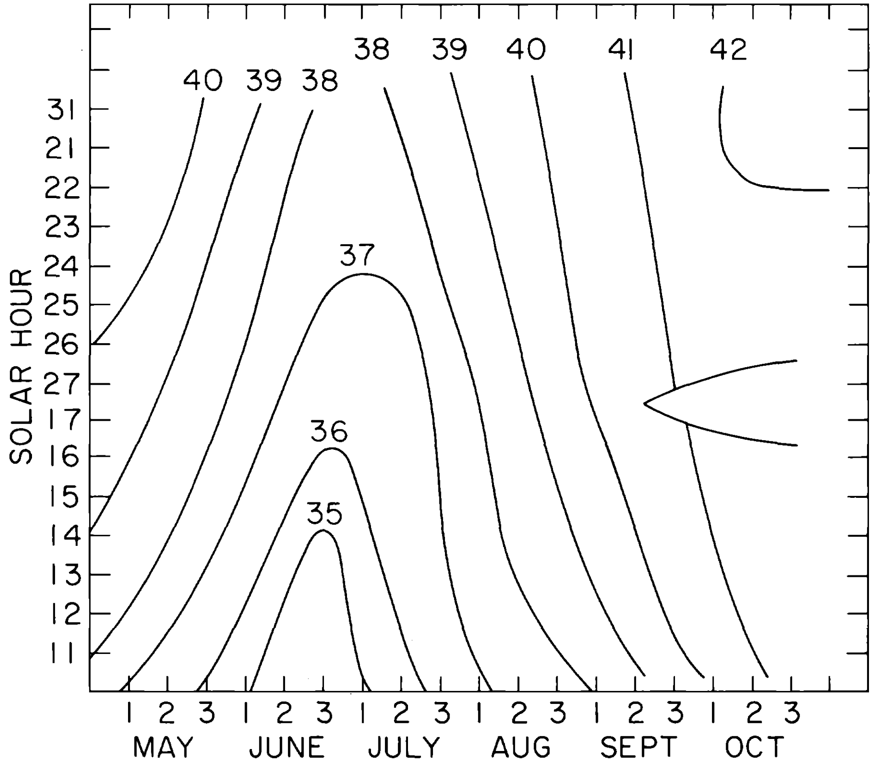

FIGURE 9. Combined seasonal-diurnal pattern of weight change in the Gray Catbird by solar hour and one-third month interval.

females were as light as males and a significant weight loss probably occurs when young are being fed. Unfortunately, no female was captured often enough to follow weight change of a single individual through the breeding season. A number of males were captured periodically during a single season and their weight showed no trend with time. It appears that energy expended in the feeding of young differs little from that used during territorial defense.

Relation of Weight to Molt

Since the Catbird is often double-brooded, young fledge over an appreciable period of time, and the timing of the partial first prebasic molt seems to be similarly distributed. Experience in handling large numbers of late summer and fall birds led to the belief that significant weight gain at that season did not occur until the molt was largely completed. To test this hypothesis, all immature birds first captured within a restricted time period, 15–20 September, were classified into five groups by the stage of molt and the mean weight of each group computed with the following results: (1) 14 birds in complete immature plumage with little or no molt showing averaged 39.2 g; (2) 9 birds in active molt but with predominantly immature plumage averaged 40.1 g; (3) 17 birds in active molt and with about half of the plumage replaced averaged 40.4 g; (4) 36 birds still in molt but with most of the contour feathers replaced averaged 40.8 g; (5) 95 birds that had replaced essentially all body feathers averaged 41.1 g. The pattern is clear: when the variables of season and age are eliminated, a gradual increase in weight occurs with progressive stages of molt. Unfortunately, not enough adults were captured during their complete prebasic molt to warrant a similar analysis. However, inspection of the data available suggests that their pattern is similar.

Relation of Weight to Migration

As pointed out earlier, birds arriving in the spring were near the average weight of the sample indicating that spring migration causes less energy expenditure than reproduction and molt. This is not surprising if one assumes that this species migrates over land in short "hops." An alternative explanation is that any weight loss is regained almost immediately upon arrival. As shown above, the population as a whole increases weight in the fall but this may be more related to the completion of molt and the advent of cooler weather than to premigratory fat deposition.

The data on individual birds recaptured several times during the fall were examined for evidence of weight increase up to the time of last capture. In some individuals, a systematic increase took place with time but other birds showed no trend. Obviously, failure to recapture an individual does not indicate a migratory departure so it is not known which, if any, weights were immediately premigratory. From the data available, however, it seems that some, but not excessive, weight increase typically takes place.

Data from the literature suggest that weight loss is considerable during migratory flights. For example, birds captured at Island Beach, New Jersey in fall averaged only about 35 g (Murray and Jehl, 1964). Birds at this locality are mostly captured in the morning soon after completing a migratory flight although some residents are undoubtedly included in the sample. Birds killed in migration at a Kansas TV tower averaged appreciably heavier (37.5–39.1 g; Tordoff and Mengel, 1956) but many of these birds were probably killed near the beginning or in the middle of a flight rather than at its end. Birds killed at the Tallahassee, Florida TV tower averaged only 31.8 g and individuals arriving in Panama in fall only 31.3 g (Rogers and Odum, 1966). This is near the southern limit of the wintering range so these weights are probably representative of birds that had just completed their migration. A sample of spring birds in Louisiana (Rogers and Odum, 1966) averaged somewhat greater (35.7 g) but considerably less than spring arrivals on Long Island.

Relation of Weight to Weather

A systematic study of weight changes in relationship to weather conditions is beyond the scope of this investigation since weather data were not included in the original banding records or added later to the data base. Experience with other species during the colder months of the year suggests that weight does increase with decreasing temperature as long as ample food is available and inclement weather does not restrict feeding. Limited observations of Catbird behavior indicate that feeding may be curtailed during lengthy periods of heavy rain with resultant temporary weight loss. However, temperatures are high enough and day lengths long enough at this latitude during the period when Catbirds are normally present that significant response of weight to temperature changes probably does not occur.

Seasonal Changes in Measurements

Measurements of bill, wing, and tail were examined to detect possible seasonal changes. Mean bill length showed no systematic change until after the breeding season when the addition of young birds to the population decreased the mean by about 1 mm. Wing lengths were high in the spring because all birds were adults and showed a tendency to decrease prior to the midsummer molt, probably as a result of wear. After late summer, they leveled off near the seasonal mean. Tail lengths showed a similar pattern.

DISCUSSION

In order to complete the annual cycle of weight change, data from birds on their normal wintering grounds are needed. Hopefully banders in the south who have weight data will analyze them in similar fashion. If weights are not presently available, some interested bander should initiate the necessary study. An investigation of the diurnal cycle in a relatively sedentary winter population unaffected by the stresses of reproduction and molt would also be valuable.

CONCLUSIONS

Weights and measurements of summering and migrant Gray Catbirds are approximately normally distributed in the population as a whole and in most subsets classified by age and sex. Adults average larger in all dimensions and are somewhat heavier than immature birds. Differences in size between the sexes are small but females average heavier in the sample due largely to the high percentage of breeding season birds among the sexed adults. Although the data are inadequate, the sexes are probably similar in weight outside of the breeding season.

Weight is at a minimum early in the morning, reaches a plateau by midmorning and increases further before sunset. Overnight weight loss in captive birds averaged from 9 to 10% of the evening weight. Weight is near the population mean on spring arrival. Males decrease in weight during the reproductive period. Females increase during egg laying and incubation but apparently decrease when they are feeding young. Weight reaches a minimum in July and increases little during the summer. As molt nears completion in the early fall, weight increases and reaches a maximum prior to migration. However, a large premigratory weight gain was not found.

Weight of Catbirds is governed primarily by seasonal activity patterns such as migration, reproduction, and molt, and secondarily by diurnal feeding and other activities. Thus, in the population as a whole, a predictable diurnal cycle is superimposed on a predictable seasonal cycle. However, individual variation in body size and in activity produces appreciable variation about the population mean.

SUMMARY

Weight and size variation in a sample of 2,592 Gray Catbird captures over a 36-year period on Long Island, New York were analyzed statistically and are described for the population as a whole and for subsets classified by age and sex. Weights and measurements of bill, wing and tail are approximately normally distributed. For all captures, mean weight was 39.9 g (SD = 3.15). Comparable values for bill length were 16.7 mm and 1.0 mm, for wing length 91.0 mm and 2.9 mm, and for tail length 91.5 mm and 3.8 mm. Adults averaged somewhat larger and heavier than immatures but differences between the sexes were minor except during laying and incubation when females were much heavier than males.

Weight changes were studied as a function of time of day, season, reproduction, molt, and migration and appear to be largely governed by seasonal activity patterns modified by daily activities. In the diurnal cycle, weights were lowest early in the morning, reached a plateau by midmorning and increased further before sunset. Overnight weight loss was from 9 to 10% of the evening weight. In the seasonal cycle, weights were near the sample mean upon spring arrival, decreased to a minimum near the end of the reproductive period, remained nearly as low during molt and increased prior to fall migration. A marked premigratory weight increase was not found. Birds netted had approximately the same mean weight as those trapped and the total sample which included repeats and returns did not differ in any significant way from new birds only.

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LITERATURE CITED

AMADON, D. 1943. Bird weights and egg weights. *Auk,* **60:** 221–234.

BAIRD, J., C. S. ROBBINS, A. M. BAGG, AND J. V. DENNIS. 1958. Operation Recovery: the Atlantic coastal netting project. *Bird-Banding,* **29:** 137–168.

BALDWIN, S. P., AND S. C. KENDEIGH. 1938. Variations in the weights of birds. *Auk,* **55:** 416–467.

BECKER, G. B., AND J. W. STACK. 1944. Weights and temperatures of some Michigan birds. *Bird-Banding,* **15:** 45–68.

BLAKE, C. H. 1956. Weight changes in birds. *Bird-Banding,* **27:** 16–22.

———. 1971. Wear and wing length in the Cardinal. *Bird-Banding,* **42:** 295.

DRURY, W. H., AND J. A. KEITH. 1962. Radar studies of songbird migration in coastal New England. *Ibis,* **104:** 449–489.

GRABER, R. A., AND J. W. GRABER. 1962. Weight characteristics of birds killed in nocturnal migration. *Wilson Bull.,* **74:** 74–88.

JOHNSTON, D. W., AND T. P. HAINES. 1957. Analyses of mass bird mortality in October, 1964. *Auk,* **74:** 447–458.

MUELLER, H. C. 1964. Effects of handling on the weights of migrant Swainson's Thrushes. Presented at 82nd Annual Meeting of AOU, Lawrence, KS, 30 Aug.–3 Sept.

MUELLER, H. C., AND D. D. BERGER. 1966. Analyses of weight and fat variations in transient Swainson's Thrushes. *Bird-Banding,* **37:** 83–112.

MURRAY, B. G., JR., AND J. R. JEHL, JR. 1964. Weights of autumn migrants from coastal New Jersey. *Bird-Banding,* **35:** 253–263.

NICE, M. M. 1938. The biological significance of bird weights. *Bird-Banding,* **9:** 1–11.

NICKELL, W. P. 1965. Habitats, territory and nesting of the Catbird. *Amer. Midl. Nat.,* **73:** 433–478.

NIE, N. H., C. H. HULL, J. G. JENKINS, K. STEINBRENNER, AND D. H. BENT. 1975. Statistical package for the social sciences (SPSS). McGraw-Hill, New York.

NISBET, I. C. T., J. BAIRD, D. V. HOWARD, AND K. S. ANDERSON. 1970. Statistical comparison of wing-lengths measured by four observers. *Bird-Banding,* **41:** 307–308.

POOLE, E. L. 1938. Weights and wing areas in North American birds. *Auk,* **55:** 511–517.

RAYNOR, G. S. 1975. A solar time classification for data with diurnal variability. *Bird-Banding,* **46:** 28–32.

ROGERS, D. T., JR., AND E. P. ODUM. 1966. A study of autumnal postmigrant weights and vernal fattening of North American migrants in the tropics. *Wilson Bull.,* **78:** 415–433.

STEWART, P. A. 1937. A preliminary list of bird weights. *Auk,* **54:** 324–332.

STEWART, P. A., AND R. W. SKINNER. 1967. Weights of birds from Alabama and North Carolina. *Wilson Bull.,* **79:** 37–42.

TORDOFF, H. B., AND R. M. MENGEL. 1956. Studies of birds killed in nocturnal migration. *Univ. Kans. Publ. Mus. Nat. Hist.,* **10:** 1–44.

WETHERBEE, K. B. 1934. Some measurements and weights of live birds. *Bird-Banding,* **5:** 55–64.

WISEMAN, A. J. 1975. Changes in body weight of American Goldfinches. *Wilson Bull.,* **87:** 390–411.

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