EDGEWOOD ARSENAL
TECHNICAL REPORT

EATR 4646

THE DISTRIBUTION, ABUNDANCE, AND DIVERSITY OF BIRDS ON EDGEWOOD ARSENAL'S CHEMICAL AGENT TEST AREA

by

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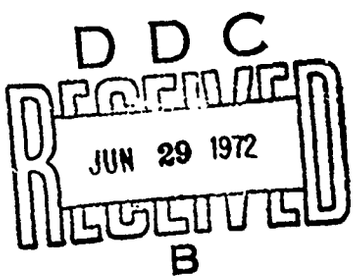
June 1972



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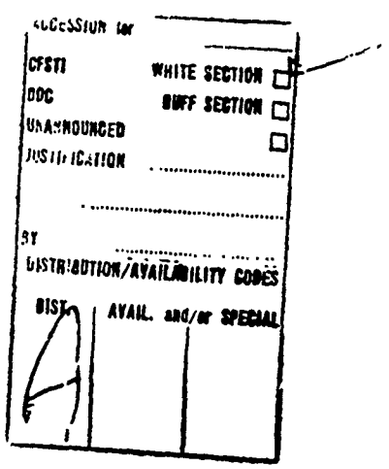

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13. ABSTRACT

Populations of songbirds and gamebirds were studied from January 1970 to July 1971 on Edgewood Arsenal's outdoor test area for chemical agents. Special emphasis was placed on censuses during the breeding seasons. During the study period, 178 species of birds (more than half the number on the official Maryland list) were identified on the test area. During the 1970 and 1971 breeding seasons, more singing (nesting) males were counted at stations adjacent to agent test facilities than at stations remote from the area. The pheasant population increased significantly from 1970 to 1971, and densities were higher in potentially contaminated areas. A woodlot directly downwind from agent test grid 1 had the same density of nesting birds as a woodlot upwind from the grid. Diversity indices were calculated for populations of birds in test areas versus control areas. Indices were similar for both areas except during winter months when diversity was much lower in test areas; this was probably a result of habitat differences. An annotated species list and graphs depicting seasonal abundance and occurrence of the 178 species of birds are included.

14. KEYWORDS

Chemical agent	Populations
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Medical Research Division

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Task 1W662710AD6302

DEPARTMENT OF THE ARMY
EDGEWOOD ARSENAL
Biomedical Laboratory
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FOREWORD

The work described in this report was authorized under Task 1W662710AD6302, Chemical Safety Investigations, Test Area Ecology. This work was started in January 1970 and completed in December 1971.

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DIGEST

Populations of songbirds and gamebirds were studied from January 1970 to July 1971 on Edgewood Arsenal's outdoor test area for chemical agents. Special emphasis was placed on censuses during the breeding seasons.

During the study period, 178 species of birds (more than half the number on the official Maryland list) were identified on the test area. During the 1970 and 1971 breeding seasons, more singing (nesting) males were counted at stations adjacent to agent test facilities than at stations remote from the area. The pheasant population increased significantly from 1970 to 1971, and densities were higher in potentially contaminated areas. A woodlot directly downwind from agent test grid 1 had the same density of nesting birds as a woodlot upwind from the grid.

Diversity indices were calculated for populations of birds in test areas versus control areas. Indices were similar for both areas except during winter months, when diversity was much lower in test areas; this was probably a result of habitat differences. An annotated species list and graphs depicting seasonal abundance and occurrence of the 178 species of birds are included.

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THE DISTRIBUTION, ABUNDANCE, AND DIVERSITY OF BIRDS ON EDGEWOOD ARSENAL'S CHEMICAL AGENT TEST AREA

I. INTRODUCTION.

Carroll Island, Maryland, has been Edgewood Arsenal's principal outdoor test area for chemical agents for more than 20 years Lethal agent testing was suspended on 14 July 1969. In August 1969 in response to rising public concern over possible environmental hazards of outdoor testing, the Director of Research Laboratories initiated a program entitled "Test Area Ecology" designed to evaluate the effects of agent testing on the environment. This paper reports the results of the avian population studies conducted on Carroll Island as a part of this comprehensive program.

The objectives of this study were twofold: (1) to describe quantitatively and qualitatively the avian populations of the test area at all seasons of the year, and (2) to evaluate the effects of chemical agent testing on these populations.

II. STUDY AREA.

A map showing the three major types of vegetation, principal agent test sites, and various physical features of the island is presented in figure 1. A brief description of the vegetation of the area was given by Slack, Roelle, and Ward.[1] Ward also presented a comprehensive review of the history of agent testing on Carroll Island, patterns and quantities of agent dispersal, physiographic and climatologic features, and related research.[2]

Chemical agents are tested at four locations on the island: agent test grid 1, spray grid, wind tunnel, and agent test grid 2 (figure 1). Meteorological conditions determine when tests are permitted; no tests are run when winds would move an agent cloud toward the west. Although the exact division between test and control areas is obscure (a comprehensive residue study would be necessary to map these areas exactly), we believe that the western sector of the island (control area) remains uncontaminated by chemical agents. Thus, despite obvious differences in habitat, populations in the control and test areas can be conveniently compared.

III. METHODS.

Although data were collected during all seasons, the breeding season perhaps represents the best time of the year to evaluate possible effects of agent testing on avian populations. During the reproductive period, the activity of a pair of birds is restricted to a well-defined territory. For the small passerines, these territories are limited in size, often on the order of 2 or 3 acres. Therefore, a pair that nests in the test area is restricted to that area for an extended period and has a greater opportunity for exposure to both residual and direct contamination than during other seasons. Furthermore, the territorial boundaries are advertised by intense song activity, usually on the part of the males. This auditory conspicuousness makes it quite easy to obtain accurate indices or censuses of the number of pairs of various species breeding in an area.

In addition to this extended period of potential exposure, birds may be more susceptible to inimical effects of agents during the breeding season because of the physiological stress of reproduction. Indirect effects, such as reductions in the food supply for insectivorous birds, might

[1]Slack, R. S., Roelle, J. E., Ward, F. P., and Pinkham, C. F. EATR 4593. Reptiles and Amphibians on Edgewood Arsenal's Chemical Agent Test Area. February 1972. UNCLASSIFIED Report.

[2]Ward, F. P. EASP 100-101. A Summary of Ecological Investigations at Edgewood Arsenal, Maryland: Fiscal Year 1970. June 1971. UNCLASSIFIED Report.

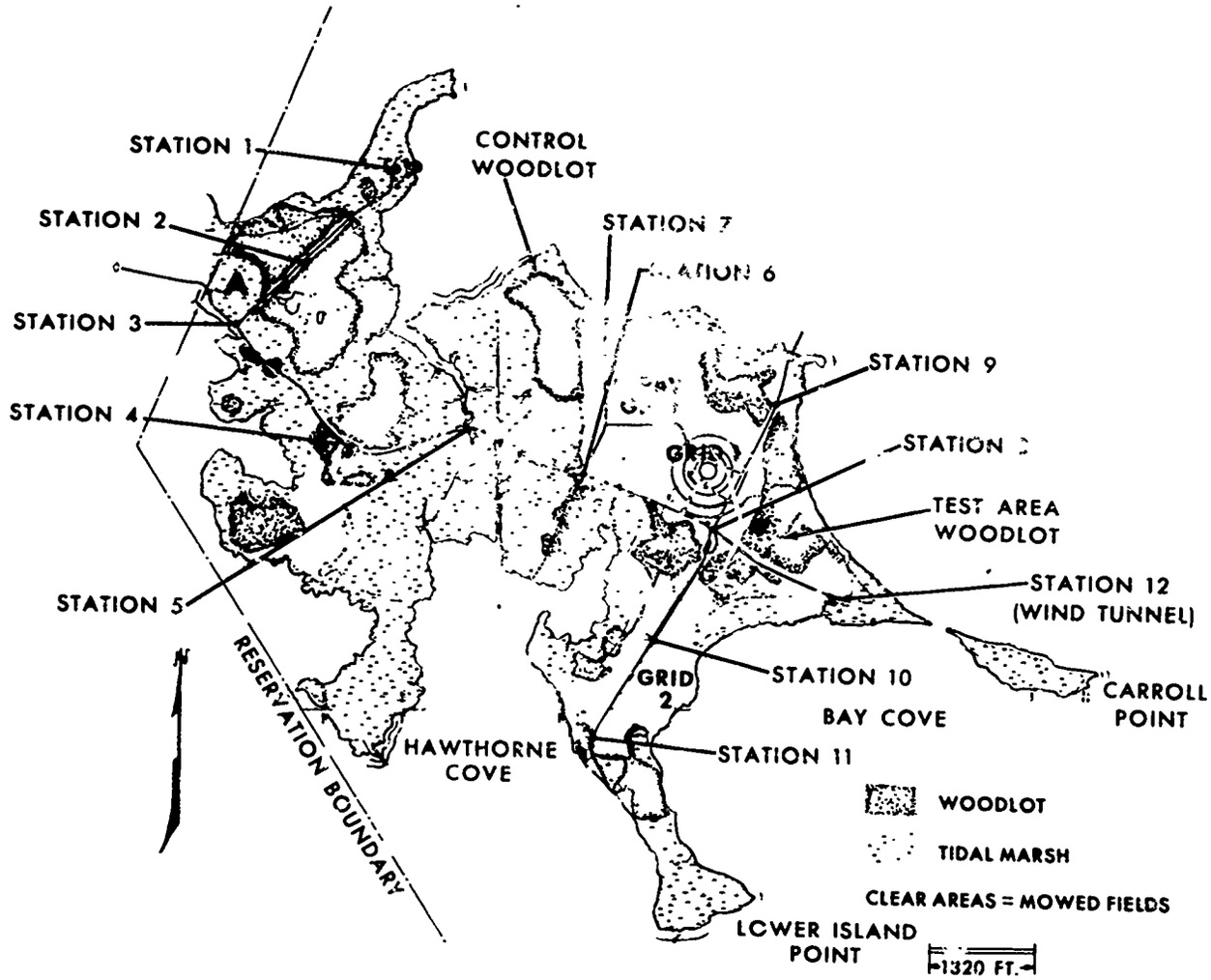

Figure 1. A Map of the Carroll Island Study Area

Stations 1 through 12 were used for roadside counts in May of 1970 and 1971. The road between stations, e.g., 1-2 or 2-3, was the basis for the roadside count. A marsh referenced in the annotated species list is designated by the letter A.

also be more important during the reproductive season when adults must feed themselves and their offspring. The potential for exposure of herbivorous species also might be more significant in spring when plants could be actively translocating material from the soil to various tissues. Therefore, many of the bird censuses were conducted during spring and early summer. Two basic methods for reproductive indices were used: (1) roadside count and (2) territorial male mapping.

A. Roadside Count.

Twelve stations, between 1/4 and 1/2 mile apart, were selected on the roads in the study area (figure 1). Stations 1 through 6 were considered to be uncontaminated, and stations 7 through 12 were in the test area. These stations were chosen because they were fairly evenly distributed with respect to both location and habitat type, and all were distinguished by a conspicuous landmark (road intersection, building, etc.). On 8 days in May of 1970 and 1971, beginning 1/2 hour before sunrise, two observers stopped at each of the 12 stations and got out of the car. One observer recorded the number of pheasant calls heard in a 2-minute interval and the number of bobwhites (both male and female) heard whistling in a 3-minute interval. The second observer recorded the number of males of 17 songbird species heard singing in the same 3-minute interval.* These 17 species (see table 1) were selected because they are fairly common on Carroll Island, occupy a variety of habitats, and have characteristic territorial songs that are easily distinguishable from other notes and calls. Census trips normally lasted about 2 hours. Data from days with rain or winds greater than 12 mph were not included. The results for the eight trips in each year were averaged and were considered as indices of the breeding bird population.

B. Territorial Male Mapping.

A 29.6-acre control woodlot (figure 1) and a potentially contaminated woodlot (21.8 acres) were chosen for this census. Each woodlot was surveyed and marked with a system of iron stakes at 100-foot intervals. On 3 days during the spring of 1971, two observers (one in each woodlot) walked the lines between stakes and plotted the locations of all birds seen or heard on maps of the two areas. Trips began 1/2 hour before sunrise and lasted about 2½ hours.

Under normal circumstances, 10 such trips are recommended for determining the breeding songbird population of a given area.[4] Observations are plotted on individual maps for each species, and clusters of observations are considered to represent established territories. Migrant and nonbreeding individuals are thus eliminated because they usually are not observed repeatedly in the same location. Because of other duties and inclement weather, however, only three trips were made, and territories could not be determined. The total number of observations of singing males of 24 species that are believed to breed on the study area and have distinct territorial songs was therefore considered as an index to the breeding songbird populations of the two woodlots.

In addition to these breeding-season indices, fluctuations in seasonal populations and the effects of possible agent contamination on birds during the remainder of the year were estimated using a strip counting technique. Approximately once a week from July 1970 to June 1971, two observers (occasionally one) walked along the roads on Carroll Island and made independent counts of all birds seen or heard within an estimated 50 yards on either side of the road. The two observers conferred when the identity of the bird seen by both was in question, but did not point out birds to each other. Birds were identified as to species whenever possible. When complete identification could not be made, birds were placed in the best classification possible, e.g., unidentified sparrow, unidentified flycatcher. For convenience in recordkeeping and for comparing populations in test

*Both male and female cardinals sing.[3]

[3]Welty, J. C. The Life of Birds. pp 189-190. W. B. Saunders Company, Philadelphia, Pennsylvania. 1962. 546 pp.

[4]Robbins, C. S. Recommendations for an International Standard for a Mapping Method in Bird Census Work. Audubon Field Notes *24*(6), 723-726 (1970).

Table I. Average Number of Singing Males of 17 Indicator Species Heard Per Roadside Count in 1970 and 1971

Sample size = 8 trips in each year.

Species	Mean ± standard error	
	1970	1971
Yellowthroat	24.0 ±1.35[a]	29.8 ±1.79[a]
Carolina Wren	10.8 ±1.29	10.9 ±0.90
Rufous-Sided Towhee	6.9 ±0.85	6.9 ±0.93
Long-Billed Marsh Wren	6.8 ±1.16	6.0 ±0.65
Bobwhite	6.6 ±0.96	4.4 ±0.56
Yellow Warbler	6.5 ±1.21	3.8 ±0.56
Red-Eyed Vireo	2.9 ±0.72	3.0 ±0.80
Wood Thrush	2.0 ±0.53	2.3 ±0.45
Indigo Bunting	1.4 ±0.73	0.3 ±0.16
Eastern Meadowlark	3.8 ±0.65	4.9 ±0.48
Yellow-Breasted Chat	3.9 ±0.48	3.9 ±0.67
Cardinal	3.3 ±0.65	3.5 ±0.57
Brown Thrasher	0.8 ±0.25	1.0 ±0.38
Tufted Titmouse	0.8 ±0.25[b]	3.3 ±0.31[b]
Song Sparrow	0.6 ±0.26[b]	2.0 ±0.27[b]
Mockingbird	0.3 ±0.16[b]	2.5 ±0.27[b]
Carolina Chickadee	0.3 ±0.16	1.3 ±0.62

[a]Difference between means significant at 95% level as determined by Student's *t* test.

[b]Difference between means significant at 99% level as determined by Student's *t* test.

and control areas, counts were kept in sections (the sections being those areas between stations used on the roadside count). Sections 1-2, 2-3, 3-4, 4-5, and 5-6 were in control areas, while sections 6-8, 8-12, 9-8, 8-10, and 10-11 were in test areas. Birds observed in one section while the observers were walking in another section were tabulated in the section in which they were located. The sections on lines between stations 1 and 3 and 3 and 12 were counted first, followed by the sections on a line between stations 9 and 11. The grid 1 intersection (station 8) was traversed twice. Birds observed on both trips through this area were counted twice. Results for the test area are thus slightly biased by this duplication, but the duplications were probably few relative to the total number of birds observed in the test area. Elsewhere efforts were made to exclude duplications. On days when two observers were present, the results for all sections were averaged, and these values were used in all statistical calculations. Trips during July and August 1970 were begun about 0900 hours; other trips were begun 1/2 hour after sunrise. Trips lasted 2 to 4 hours. Days with rainfall or heavy winds were avoided.

In an attempt to reduce the variance in strip count results, data were divided into four seasonal categories according to whether the majority of the avifauna at a particular time were

winter residents, summer residents, or migratory species. These seasons were Spring (March, April, and May), Summer (June, July, and August), Fall (September, October, and November), and Winter (December, January, and February).

Species-numbers diversity is probably a more sensitive indicator of the condition of an environment than total number of organisms present.[5] Diversities in the control and test areas, based on results of weekly strip counts from July 1970 to June 1971, were compared using the Shannon-Wiener function.[5] This index increases as both the number of species and the evenness of their distribution increase. All calculations were based on logarithms to the base 10.

A list of all species of birds observed on trips to the study area was compiled. The locations of pheasants and quail, as well as age and sex when possible, were marked on maps daily. Other observations of interest were recorded in field notebooks.

IV. RESULTS AND DISCUSSION.

During the period January 1970 to July 1971, 178 species of birds (just over half of the 355 species on the official Maryland list[6]) were identified on Carroll Island. In view of the limited variety of habitats on the study area and the relatively short time span of the study, 178 species is a substantial avian population. An annotated species list and graphs depicting the seasonal abundance of these species are presented in the appendix. Common and scientific names follow those of Robbins et al.[7] Seasonal abundance shown on the graphs was assessed on the basis of data from strip counts and other field notes. These are estimates of abundance for a relatively small area over a short period of time, and therefore may differ markedly from results obtained either in different areas or on our study area in succeeding years.

Results from the two annual roadside counts were consistent from year to year (table I), indicating that the technique provides a valid and useful index to the breeding songbird population. Significant increases in the number of singing males from 1970 to 1971 occurred in 4 of the 17 species. Because there were no significant decreases, the changes might be a result of better observations on the part of the investigators. A comparison of the results from the six control and six test stops indicates that populations were higher in the test area in both years, but the difference was significant only in 1971 (table II).

The pheasant population on the study area increased substantially from 1970 to 1971 (tables III and IV). Table V indicates that this increase occurred in both the test and control areas, and that the pheasant population in the test area was larger than the population in the control area in both years. The increase therefore is not attributable to either a reduction in testing activities[2] or the gradual degradation of toxic residues. It is more likely that the pheasant population increase resulted from a reduction in illegal shooting because of the frequent presence of researchers.

Results from the three territorial male censuses indicate that the breeding bird populations of the test area and control woodlots are not substantially different (table VI). Although large differences exist for certain species (e.g., 16 versus 31 Rufous-Sided Towhees tabulated in the control and test area woodlots, respectively), these probably can be attributed to differences in habitat. Overall, the indices for the two areas are quite similar, and the total numbers

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[5]Dahlberg, M. D., and Odum, E. P. Annual Cycles of Species Occurrence, Abundance, and Diversity in Georgia Estuarine Fish Populations. Amer. Midl. Nat. *83*(2), 382-392(1970).

[6]Robbins, C. S., and Van Velzen, W. T. Field List of the Birds of Maryland. Maryland Avifauna Number 2. Maryland Ornithological Society, 1963. 44 pp.

[7]Robbins, C. S., Bruun, B., Zim, H. S., and Singer, A. Birds of North America. Golden Press, New York 1966 340 pp.

Table II. Total Number of Singing Males of 17 Indicator Species Heard on Roadside Counts at Six Control and Six Test Area Stops

1970			1971		
Date	Control area	Test area	Date	Control area	Test area
13 May	28	24	12 May	38	44
14 May	37	35	14 May	43	48
18 May	32	39	18 May	40	50
19 May	45	49	20 May	43	41
21 May	43	48	24 May	38	51
25 May	40	48	26 May	43	49
26 May	42	49	27 May	47	48
27 May	32	56	28 May	42	51
Mean	37.4	43.5	Mean	41.8*	47.8*

*Difference between means from test and control areas significant at 99% level as determined by Student's *t* test.

Table III. Total Number of Pheasant Calls Heard Per Roadside Count in 1970 and 1971

1970		1971	
Date	Number of calls	Date	Number of calls
13 May	5	12 May	11
14 May	6	14 May	24
18 May	14	18 May	40
19 May	24	20 May	15
21 May	13	24 May	29
25 May	12	26 May	33
26 May	14	27 May	36
27 May	21	28 May	33
Mean	13.6*	Mean	27.6*

*Difference between means significant at 99% level as determined by Student's *t* test.

Table IV. Total Number of Pheasants Observed During Roadside Counts

1970		1971	
Date	Number of pheasants observed	Date	Number of pheasants observed
13 May	10	12 May	36
14 May	10	14 May	49
18 May	8	18 May	67
19 May	11	20 May	33
21 May	12	24 May	39
25 May	16	26 May	45
26 May	11	27 May	50
27 May	14	28 May	41
Mean	11.5*	Mean	45.0*

*Difference between means significant at 99% level as determined by Student's *t* test.

Table V. Number of Pheasant Calls Heard on Roadside Counts at Six Control and Six Test Area Stops

1970			1971		
Date	Control area	Test area	Date	Control area	Test area
13 May	2	3	12 May	2	9
14 May	0	6	14 May	10	14
18 May	3	11	18 May	25	15
19 May	9	15	20 May	8	7
21 May	4	8	24 May	11	18
25 May	4	8	26 May	8	25
26 May	5	9	27 May	20	16
27 May	3	18	28 May	5	28
Mean	3.8	9.8	Mean	11.1	16.5

of observations agree very closely. Birds thus seem to breed in substantial numbers in the potentially contaminated woodlot, in spite of the fact that the area has been downwind from many tests with various chemical agents for more than 20 years.[2]

Table VI. Density of Singing Males of 24 Species Recorded on Three Territorial Male Census Trips in the Control and Test Area Woods*

Species	Number of birds counted	
	Control woodlot	Test area woodlot
Yellowthroat	76	72
Carolina Wren	20	18
Red-Wing	20	7
Rufous-Sided Towhee	16	31
Red-Eyed Vireo	14	3
Cardinal	13	9
Wood Thrush	7	9
Tufted Titmouse	6	7
Yellow Warbler	6	1
Yellow-Breasted Chat	6	7
Ovenbird	6	0
Carolina Chickadee	5	7
Scarlet Tanager	5	1
Ring-Necked Pheasant	3	5
Catbird	3	9
Brown Thrasher	2	4
Robin	2	0
Bobwhite	1	8
Field Sparrow	1	0
Great Crested Flycatcher	0	1
Eastern Meadowlark	0	4
Baltimore Oriole	0	3
Indigo Bunting	0	1
Swamp Sparrow	0	1
Total	212	208

*Results from the test area woodlot were multiplied by 1.36 to compensate for the difference in area between the two woodlots.

Diversity indices, based on weely strip counts, were similar in test and control areas except in winter (figure 2). During November, December, January, and February, diversity was greatly reduced in test areas. Large sections of this area are mowed fields (figure 1), which offer little shelter for wintering birds. The fact that diversities are similar during other seasons would tend to eliminate effects of chemical agent tests as the cause of reduced winter diversity.

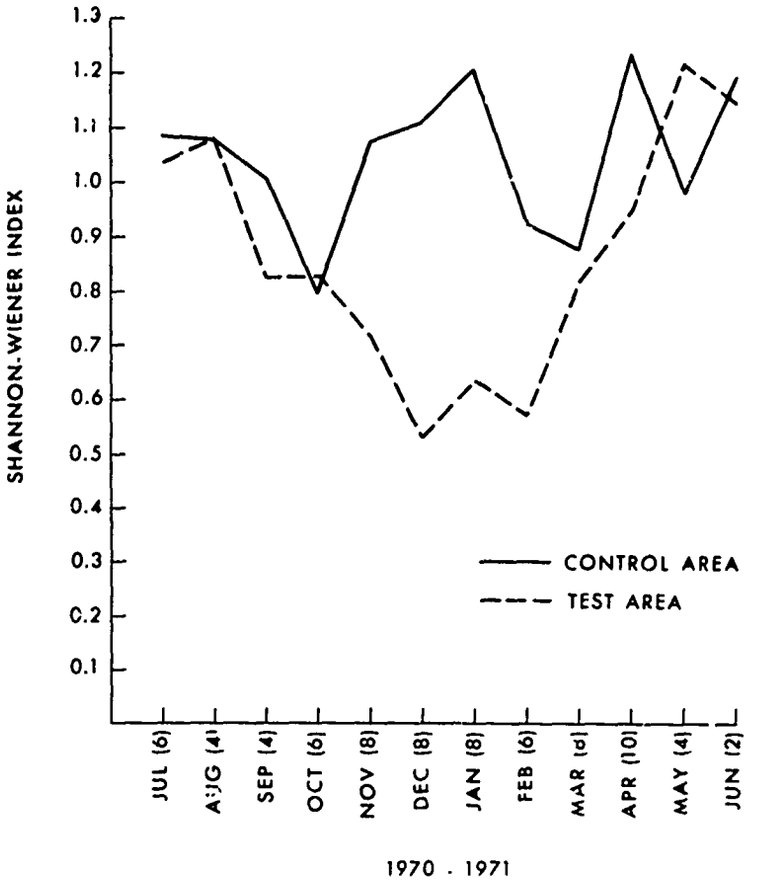

Figure 2. Monthly Averages of Shannon-Wiener Diversity Indices Based on Weekly Strip Counts

The numbers in parentheses indicate the total number of strip counts on test and control areas during that month.

V. SUMMARY.

The fact that chemical agents are field tested on the eastern sector of Carroll Island appears to have little effect on avian populations inhabiting this area. More nesting birds were counted in this area during the breeding seasons of 1970 and 1971 than in an area remote from agent tests. Pheasant populations were also higher in this potentially contaminated area than in the control area. The density of nesting birds in a woodlot directly downwind from grid 1 was the same as the density in a similar woodlot upwind from the grid.

Bird diversity was reduced in the test area only during winter months, but this reduction probably was related to a paucity of adequate shelter for wintering birds. A total of 178 species of birds were identified on the study area during the investigation; considering the number of species on the official Maryland list (355), this number indicates a diverse avifauna for Carroll Island.

LITERATURE CITED

1. Slack, R. S., Rolle, J. E., Ward, F. P., and Pinkham, C. F. EATR 4593. Reptiles and Amphibians on Edgewood Arsenal's Chemical Agent Test Area. February 1972. UNCLASSIFIED Report.

2. Ward, F. P. EASP 100-101. A Summary of Ecological Investigations at Edgewood Arsenal, Maryland: Fiscal Year 1970. June 1971. UNCLASSIFIED Report.

3. Welty, J. C. The Life of Birds. pp 189-190. W. B. Saunders Company, Philadelphia, Pennsylvania. 1962. 546 pp.

4. Robbins, C. S. Recommendations for an International Standard for a Mapping Method in Bird Census Work. Audubon Field Notes *24*(6), 723-726 (1970).

5. Dahlberg, M. D., and Odum, E. P. Annual Cycles of Species Occurrence, Abundance, and Diversity in Georgia Estuarine Fish Populations. Amer. Midl. Nat. *83*(2), 382-392 (1970).

6. Robbins, C. S., and Van Velzen, W. T. Field List of the Birds of Maryland. Maryland Avifauna Number 2. Maryland Ornithological Society. 1963. 44 pp.

7. Robbins, C. S., Bruun, B., Zim, H. S., and Singer, A. Birds of North America. Golden Press, New York 1966. 340 pp.

APPENDIX

Annotated Species List–Birds of Carroll Island

This is an annotated list including graphs of abundance and occurrence of 178 species of birds observed on Carroll Island from January 1970 to July 1971. Comments are made concerning unusual dates or numbers of individuals and in cases when the graphs do not adequately describe the situation for a given species.

1. Common Loon, *Gavia immer*.

2. Horned Grebe, *Podiceps auritus*. One bird observed 31 December 1970 in Bay Cove.

3. Pied-Billed Grebe, *Podilymbus podiceps*.

4. Double-Crested Cormorant, *Phalacrocorax auritus*. Single birds observed 11 May 1971, 21 May 1970, and 8 October 1970.

5. Great Blue Heron, *Ardea herodias*. Numbers vary during winter; maximum of approximately 50 herons counted from helicopter on 8 January 1970.

6. *Green Heron, *Butorides virescens*.

7. Little Blue Heron, *Florida caerulea*. One adult observed 20 May 1971 in marsh A.

8. Cattle Egret, *Bubulcus ibis*. One bird observed 2 June 1971 in vicinity of grid 1.

9. Common Egret, *Casmerodius albus*. Irregular spring migrant; single bird observed 6 August 1970 in vicinity of grid 1.

10. Snowy Egret, *Leucophoyx thula*. Single bird observed 24 April 1971 in marsh A.

11. *Least Bittern, *Ixobrychus exilis*. Single bitterns observed 20 May 1971, 25 May 1970, and 7 July 1971.

12. American Bittern, *Botaurus lentiginosus*.

13. Glossy Ibis, *Plegadis falcinellus*. Irregular spring migrant.

14. Whistling Swan, *Olor columbianus*. Spring migration peak in third week of March 1971 (635 swans observed 19 March 1971). Six unusually late swans observed 12 May 1971.

15. Canada Goose, *Branta canadensis*. Spring migration peak in last week of February 1971 (2400 geese observed 26 February 1971). Approximately 200 geese spent winter of 1970-71 on and around Carroll Island.

16. *Mallard, *Anas platyrhynchos*.

17. *Black Duck, *Anas rubripes*.

18. Gadwall, *Anas strepera*.

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*Indicates species that are thought to have nested on study area.

19. Pintail, *Anas acuta*.

20. Green-Winged Teal, *Anas carolinensis*.

21. Blue-Winged Teal, *Anas discors*.

22. American Widgeon, *Mareca americana*.

23. Shoveler, *Spatula clypeata*. Three shovelers observed 10 March 1971 in Hawthorne Cove.

24. *Wood Duck, *Aix sponsa*. At least one pair nested on study area in both 1970 and 1971.

25. Redhead, *Aythya americana*. One or two individuals observed in Bay Cove on several days during winter of 1970-71.

26. Ring-Necked Duck, *Aythya collaris*. Small flocks observed in Bay Cove 6 November 1970, 31 December 1970, and 2 April 1971.

27. Canvasback, *Aythya valisineria*. Small numbers observed on 6, 17, and 18 November 1970, 10 March 1971, and 2 April 1971.

28. Greater Scaup, *Aythya marila*. Flock consisting of 300 to 600 scaup present in Bay Cove from 22 March 1971 to 13 April 1971. This flock, as well as other smaller flocks observed at various times, probably contained some Lesser Scaup (*Aythya affinis*) also.

29. Common Goldeneye, *Bucephala clangula*. Single birds observed 22 January 1971 and 26 February 1971.

30. Bufflehead, *Bucephala albeola*.

31. Ruddy Duck, *Oxyura jamaicensis*. Flocks consisting of 35 to 75 ruddy ducks present in Bay Cove from 18 March 1971 through the first week in April 1971.

32. Hooded Merganser, *Lophodytes cucullatus*. Two individuals observed in Bay Cove 22 January 1971.

33. Common Merganser, *Mergus merganser*.

34. Red-Breasted Merganser, *Mergus serrator*. Two individuals observed on 20 May 1970 and 20 November 1970.

35. Turkey Vulture, *Cathartes aura*.

36. Sharp-Shinned Hawk, *Accipiter striatus*. At least 13 individuals observed migrating on 30 April 1971.

37. Cooper's Hawk, *Accipiter cooperii*.

38. Red-Tailed Hawk, *Buteo jamaicensis*. May nest on study area.

39. Red-Shouldered Hawk, *Buteo lineatus*.

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*See footnote on first page of appendix.

40. Broad-Winged Hawk, *Buteo platypterus*.

41. Bald Eagle, *Haliaeetus leucocephalus*. One adult and one immature on Lower Island Point 8 January 1970; one immature on Lower Island Point 5 May 1970.

42. Marsh Hawk, *Circus cyaneus*.

43. *Osprey, *Pandion haliaetus*. Three ospreys present during most of breeding season in both 1970 and 1971. On 5 April 1971 observed male attempting copulation with two females. Nest on old tower near station 7 fledged two young both years.

44. *Sparrow Hawk, *Falco sparverius*.

45. *Bobwhite, *Colinus virginianus*.

46. *Ring-Necked Pheasant, *Phasianus colchicus*.

47. King Rail, *Rallus elegans*. Single rails observed 29 March 1971, 8 April 1971, and 11 May 1971.

48. Virginia Rail, *Rallus limicola*.

49. Sora, *Porzana carolina*.

50. Black Rail, *Laterallus jamaicensis*. Individual heard singing in same location in marsh NE of station 4 on nights of 14 and 19 June 1971.

51. American Coot, *Fulica americana*.

52. Wilson's Plover, *Charadrius wilsonia*. Several individuals observed in marsh A on 25 May 1970.

53. *Killdeer, *Charadrius vociferus*.

54. Black-Bellied Plover, *Squatarola squatarola*.

55. American Woodcock, *Philohela minor*. May nest on study area.

56. Common Snipe, *Capella gallinago*.

57. Spotted Sandpiper, *Actitis macularia*. May nest on study area.

58. Solitary Sandpiper, *Tringa solitaria*.

59. Willet, *Catoptrophorus semipalmatus*. Single willets observed 27 March 1970 and 11 May 1971.

60. Greater Yellowlegs, *Totanus melanoleucus*.

61. Lesser Yellowlegs, *Totanus flavipes*.

62. Pectoral Sandpiper, *Erolia melanotos*.

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*See footnote on first page of appendix.

63. Least Sandpiper, *Erolia minutilla*.

64. Dunlin, *Erolia alpina*. Single dunlin observed near station 11, 29 March 1971; small flock observed near grid 1, 20 November 1970.

65. Short-Billed Dowitcher, *Limnodromus griseus*. Two birds observed 20 May 1970.

66. Semipalmated Sandpiper, *Ereunetes pusillus*. Small flocks observed 12 and 19 May 1971. Probably more common than indicated, but difficult to distinguish from other small sandpipers.

67. Great Black-Backed Gull, *Larus marinus*.

68. Herring Gull, *Larus argentatus*.

69. Ring-Billed Gull, *Larus delawarensis*.

70. Laughing Gull, *Larus atricilla*.

71. Bonaparte's Gull, *Larus philadelphia*. Small flocks present during first 2 weeks of April 1971.

72. Least Tern, *Sterna albifrons*. Small flock observed over Hawthorne Cove, 13 May 1970; single individual observed near station 3, 25 May 1971.

73. Caspian Tern, *Hydroprogne caspia*.

74. *Mourning Dove, *Zenaidura macroura*. Several flocks (133 total doves) recorded on 18 September 1970.

75. *Yellow-Billed Cuckoo, *Coccyzus americanus*.

76. Great Horned Owl, *Bubo virginianus*. Single bird observed on Lower Island Point, 6 November 1970.

77. Barred Owl, *Strix varia*. Single bird observed in woodlot east of the spray grid, 6 March 1971.

78. Chuck-Will's-Widow, *Caprimulgus carolinensis*. From one to three individuals heard during last 3 weeks in May and first week in June 1971. Two individuals heard on 7 July 1971. May have nested on study area, but are usually thought to be only casual this far north.

79. Whip-Poor-Will, *Caprimulgus vociferus*. Probably nests on study area, but was seldom observed due to crepuscular habits.

80. Chimney Swift, *Chaetura pelagica*.

81. *Ruby-Throated Hummingbird, *Archilochus colubris*.

82. Belted Kingfisher, *Megaceryle alcyon*.

83. *Yellow-Shafted Flicker, *Colaptes auratus*.

84. *Red-Bellied Woodpecker, *Centurus carolinus*.

*See footnote on first page of appendix.

85. Yellow-Bellied Sapsucker, *Sphyrapicus varius*.

86. *Hairy Woodpecker, *Dendrocopos villosus*.

87. *Downy Woodpecker, *Dendrocopos pubescens*.

88. *Eastern Kingbird, *Tyrannus tyrannus*.

89. *Great Crested Flycatcher, *Myiarchus crinitus*.

90. Eastern Phoebe, *Sayornis phoebe*.

91. Acadian Flycatcher, *Empidonax virescens*. Single individuals observed 14 May 1970, 19 May 1971, and 9 July 1970.

92. *Eastern Wood Pewee, *Contopus virens*.

93. Olive-Sided Flycatcher, *Nuttallornis borealis*. Single bird observed 14 May 1970.

94. *Horned Lark, *Eremophila alpestris*.

95. Tree Swallow, *Iridoprocne bicolor*. Most abundant of the swallows during migration.

96. Bank Swallow, *Riparia riparia*.

97. Rough-Winged Swallow, *Stelgidopteryx r..ficollis*.

98. *Barn Swallow, *Hirundo rustica*.

99. Purple Martin, *Progne subis*.

100. *Blue Jay, *Cyanocitta cristata*.

101. *Common Crow, *Corvus brachyrhynchos*.

102. Fish Crow, *Corvus ossifragus*. Summer status uncertain.

103. *Carolina Chickadee, *Parus carolinensi*

104. *Tufted Titmouse, *Parus bicolor*.

105. White-Breasted Nuthatch, *Sitta carolinensis*.

106. Brown Creeper, *Certhia familiaris*.

107. Winter Wren, *Troglodytes troglodytes*. From one to four individuals observed on several days during first 3 weeks of April 1971.

108. *Carolina Wren, *Thryothorus ludovicianus*.

109. *Long-Billed Marsh Wren, *Telmatodytes palustris*.

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*See footnote on first page of appendix.

110. *Mockingbird, *Mimus polyglottos*.

111. *Catbird, *Dumetella carolinensis*.

112. *Brown Thrasher, *Toxostoma rufum*.

113. *Robin, *Turdus migratorius*.

114. *Wood Thrush, *Hylocichla mustelina*.

115. Hermit Thrush, *Hylocichla guttata*.

116. Swainson's Thrush, *Hylocichla ustulata*.

117. Veery, *Hylocichla fuscescens*.

118. Eastern Bluebird, *Sialia sialis*. Two bluebirds observed 6 November 1970.

119. Blue-Gray Gnatcatcher, *Polioptila caerulea*.

120. Golden-Crowned Kinglet, *Regulus satrapa*.

121. Ruby-Crowned Kinglet, *Regulus calendula*.

122. Cedar Waxwing, *Bombycilla cedrorum*.

123. *Starling, *Sturnus vulgaris*.

124. *White-Eyed Vireo, *Vireo griseus*. Uncommon breeder on study area during 1970; irregular in 1971.

125. *Red-Eyed Vireo, *Vireo olivaceus*.

126. Black-and-White Warbler, *Mniotilta varia*.

127. Blue-Winged Warbler, *Vermivora pinus*. Single individuals observed 5 and 7 May 1971.

128. Tennessee Warbler, *Vermivora peregrina*. Single individual observed in control woodlot, 12 May 1970.

129. Parula Warbler, *Parula americana*.

130. *Yellow Warbler, *Dendroica petechia*.

131. Magnolia Warbler, *Dendroica magnolia*.

132. Cape May Warbler, *Dendroica tigrina*. Three individuals observed in test area woodlot, 10 May 1971.

133. Black-Throated Blue Warbler *Dendroica caerulescens*.

134. Myrtle Warbler, *Dendroica coronata*.

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*See footnote on first page of appendix.

135. Black-Throated Green Warbler, *Dendroica virens*.

136. Blackburnian Warbler, *Dendroica fusca*.

137. Chestnut-Sided Warbler, *Dendroica pensylvanica*.

138. Bay-Breasted Warbler, *Dendroica castanea*.

139. Blackpoll Warbler, *Dendroica striata*.

140. Pine Warbler. *Dendroica pinus*. Single individual observed 31 August 1970.

141. Prairie Warbler, *Dendroica discolor*. Four individuals observed 11 May 1971.

142. Palm Warbler, *Dendroica palmarum*.

143. Ovenbird, *Seiurus aurocapillus*. May nest on study area.

144. Northern Waterthrush, *Seiurus noveboracensis*.

145. Louisiana Waterthrush, *Seiurus motacilla*.

146. *Yellowthroat, *Geothlypis trichas*.

147. *Yellow-Breasted Chat, *Icteria virens*.

148. Wilson's Warbler, *Wilsonia pusilla*.

149. Canada Warbler, *Wilsonia canadensis*.

150. American Redstart, *Setophaga ruticilla*. May nest on study area.

151. House Sparrow, *Passer domesticus*. Single birds observed 16 March 1971 and 20 May 1970.

152. *Eastern Meadowlark, *Sturnella magna*.

153. *Red-Winged Blackbird, *Agelaius phoeniceus*.

154. *Orchard Oriole, *Icterus spurius*. Recorded irregularly; adult male observed feeding fledglings, 25 May 1971.

155. Baltimore Oriole, *Icterus galbula*.

156. Rusty Blackbird, *Euphagus carolinus*.

157. *Common Grackle, *Quiscalus quiscula*.

158. *Brown-Headed Cowbird, *Molothrus ater*.

159. Scarlet Tanager, *Piranga olivacea*. May nest on study area.

160. Summer Tanager, *Piranga rubra*. Single tanagers observed 4, 5, and 11 May 1971.

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*See footnote on first page of appendix.

161. *Cardinal, *Richmondena cardinalis*.

162. Rose-Breasted Grosbeak, *Pheucticus ludovicianus*.

163. Blue Grosbeak, *Guiraca caerulea*. Single bird observed 20, 26, and 27 May 1971.

164. *Indigo Bunting, *Passerina cyanea*.

165. *American Goldfinch, *Spinus tristis*.

166. *Rufous-Sided Towhee, *Pipilo erythrophthalmus*.

167. Savannah Sparrow, *Passerculus sandwichensis*.

168. Grasshopper Sparrow, *Ammodramus savannarum*. Several individuals observed during third week in May and second week in June 1970, but probably did not breed. More regular in 1971, and may have nested on study area.

169. Vesper Sparrow, *Pooecetes gramineus*. Several individuals observed 5 April 1971.

170. Slate-Colored Junco, *Junco hyemalis*.

171. Tree Sparrow, *Spizella arborea*.

172. Chipping Sparrow, *Spizella passerina*.

173. Field Sparrow, *Spizella pusilla*.

174. White-Crowned Sparrow, *Zonotrichia leucophrys*. Single birds observed 10 and 18 May 1971.

175. White-Throated Sparrow, *Zonotrichia albicollis*.

176. Fox Sparrow, *Passerella iliaca*. Single birds observed 6 and 18 March 1971, 27 November 1970.

177. Swamp Sparrow, *Melospiza georgiana*. May nest on study area.

178. *Song Sparrow, *Melospiza melodia*.

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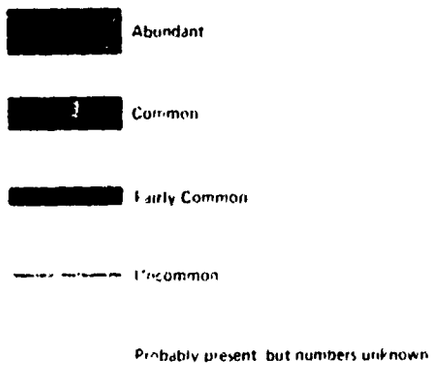
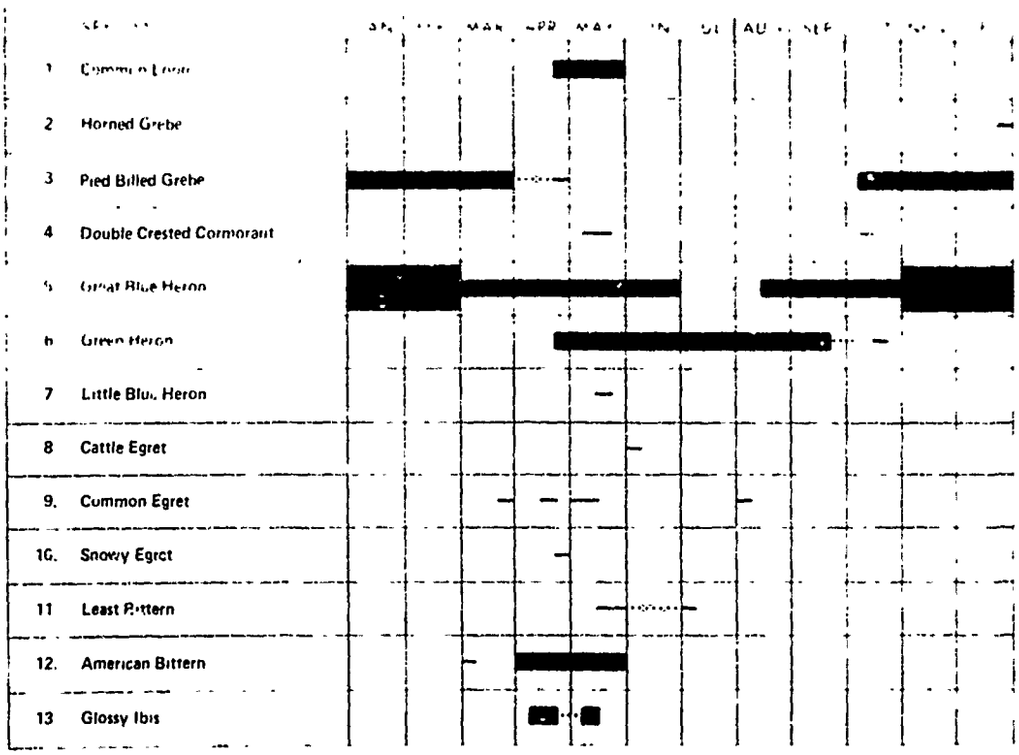
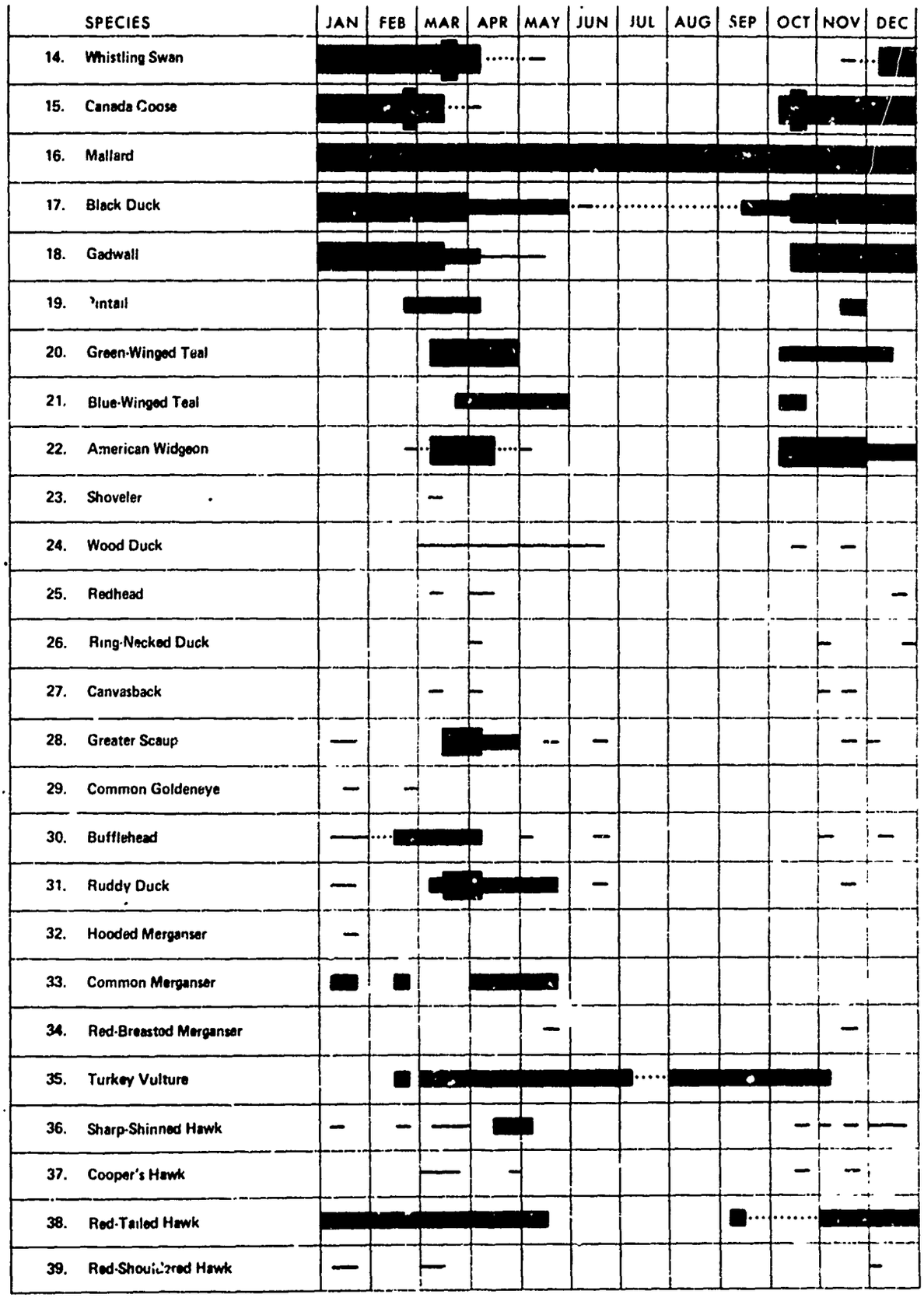
*See footnote on first page of appendix.

Each month was divided into four weeks for the purposes of the graphs. A species present on any day of a particular week was considered present for the entire week. Several categories of abundance were used, as indicated by the width of a bar (in all cases, the habits of the species were considered)






SPECIES
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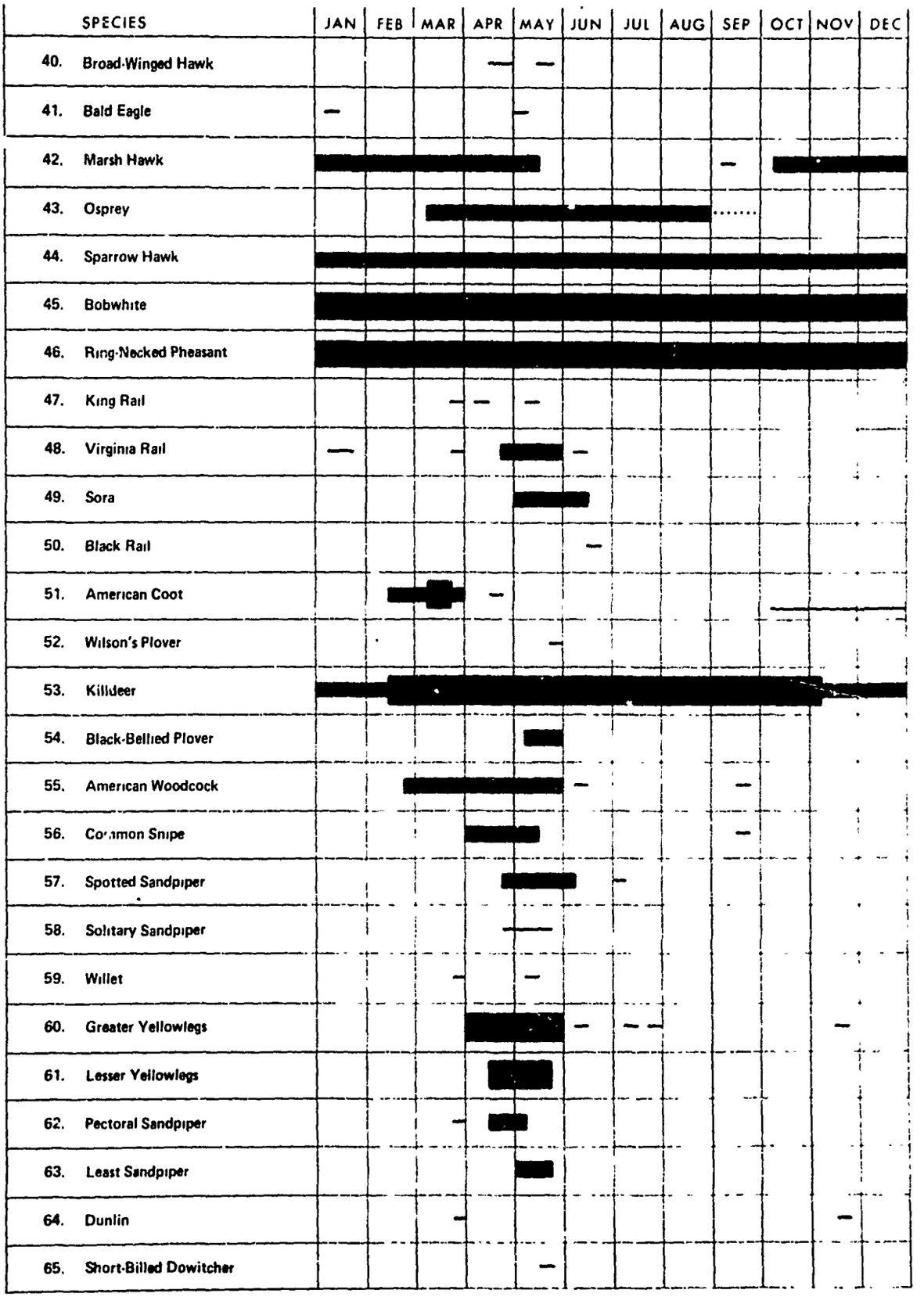
14. Whistling Swan
15. Canada Goose
16. Mallard
17. Black Duck
18. Gadwall
19. Pintail
20. Green-Winged Teal
21. Blue-Winged Teal
22. American Widgeon
23. Shoveler
24. Wood Duck
25. Redhead
26. Ring-Necked Duck
27. Canvasback
28. Greater Scaup
29. Common Goldeneye
30. Bufflehead
31. Ruddy Duck
32. Hooded Merganser
33. Common Merganser
34. Red-Breasted Merganser
35. Turkey Vulture
36. Sharp-Shinned Hawk
37. Cooper's Hawk
38. Red-Tailed Hawk
39. Red-Shouldered Hawk


SPECIES
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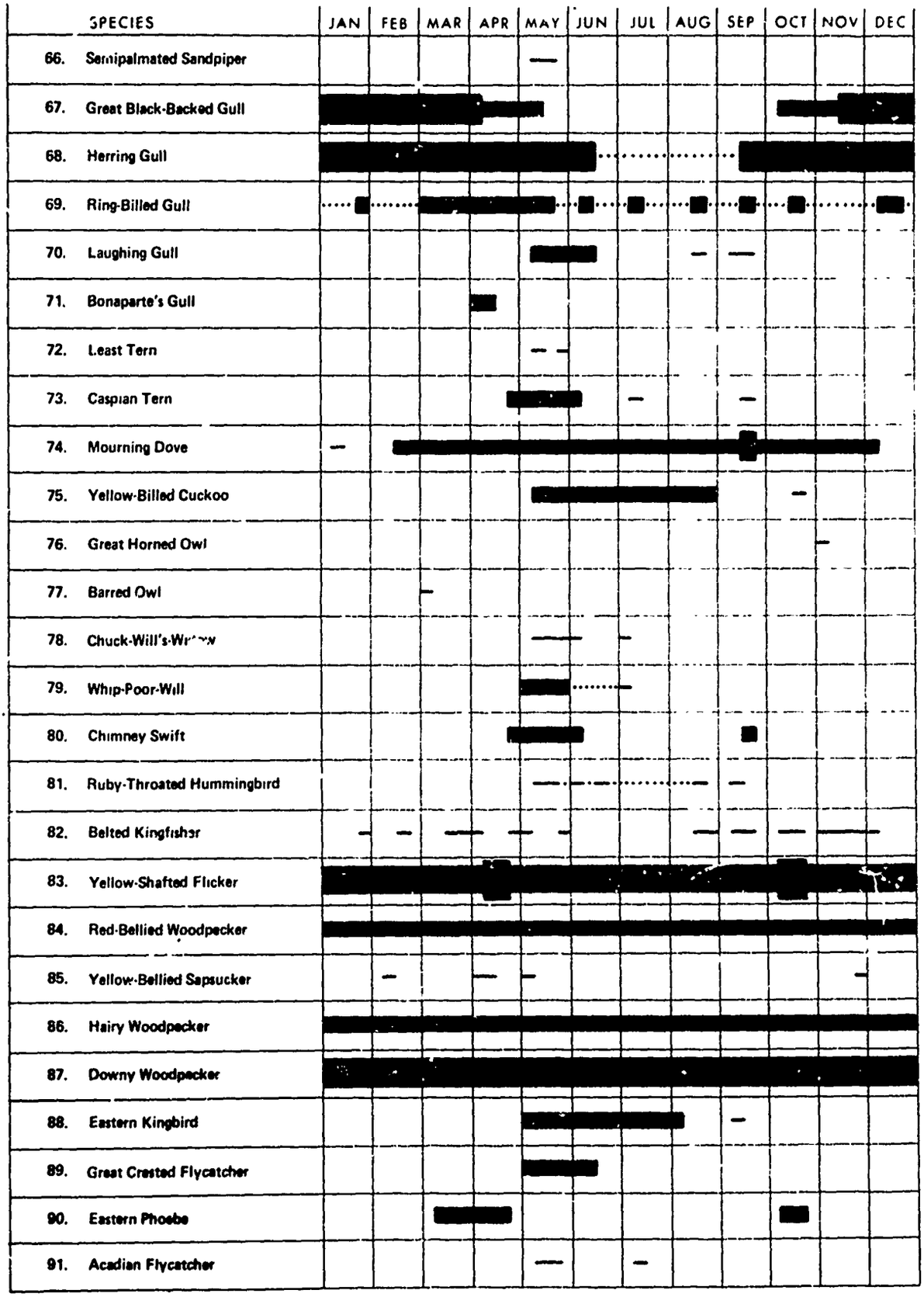
40. Broad-Winged Hawk
41. Bald Eagle
42. Marsh Hawk
43. Osprey
44. Sparrow Hawk
45. Bobwhite
46. Ring-Necked Pheasant
47. King Rail
48. Virginia Rail
49. Sora
50. Black Rail
51. American Coot
52. Wilson's Plover
53. Killdeer
54. Black-Bellied Plover
55. American Woodcock
56. Common Snipe
57. Spotted Sandpiper
58. Solitary Sandpiper
59. Willet
60. Greater Yellowlegs
61. Lesser Yellowlegs
62. Pectoral Sandpiper
63. Least Sandpiper
64. Dunlin
65. Short-Billed Dowitcher


SPECIES
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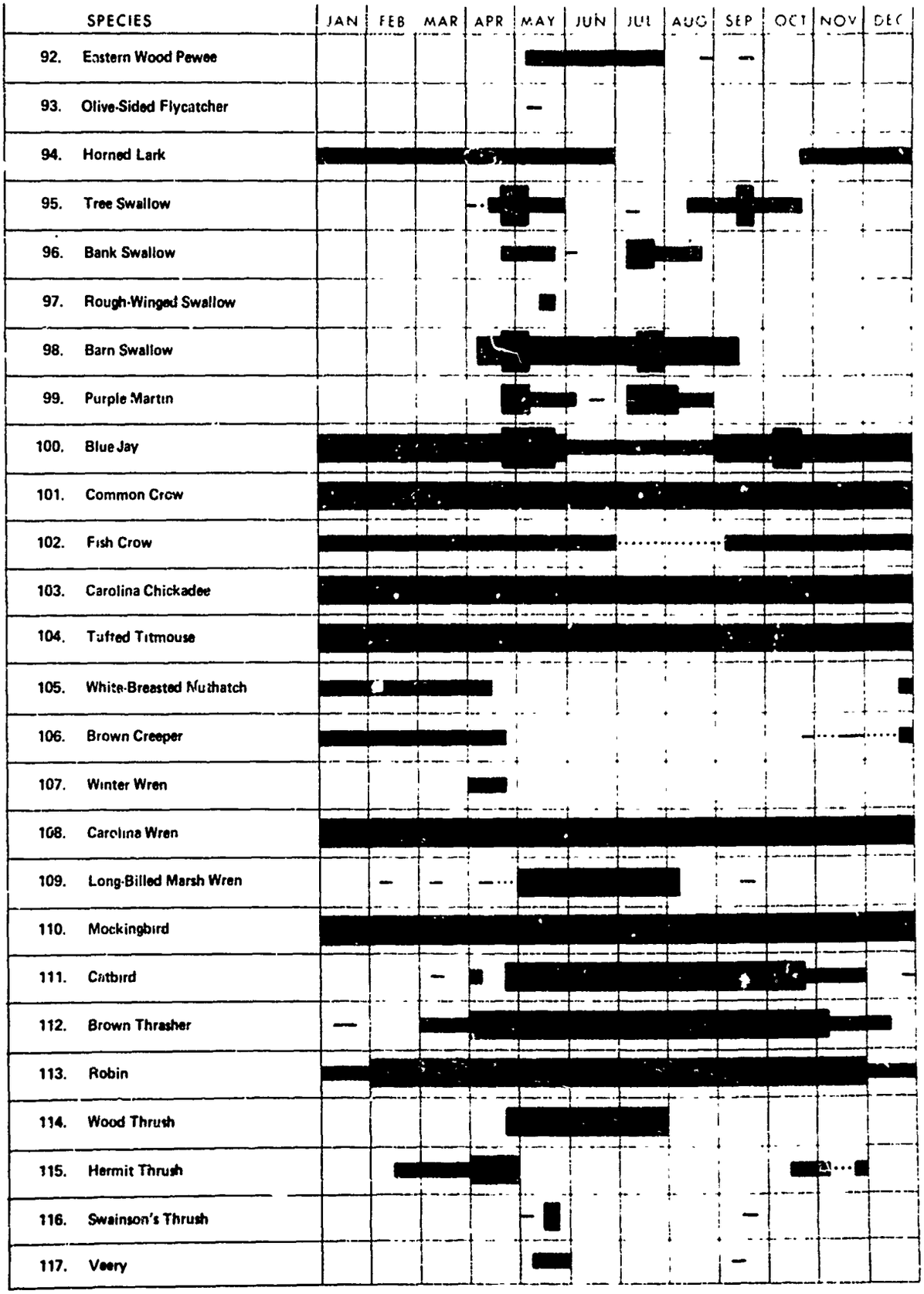
66. Semipalmated Sandpiper
67. Great Black-Backed Gull
68. Herring Gull
69. Ring-Billed Gull
70. Laughing Gull
71. Bonaparte's Gull
72. Least Tern
73. Caspian Tern
74. Mourning Dove
75. Yellow-Billed Cuckoo
76. Great Horned Owl
77. Barred Owl
78. Chuck-Will's-Widow
79. Whip-Poor-Will
80. Chimney Swift
81. Ruby-Throated Hummingbird
82. Belted Kingfisher
83. Yellow-Shafted Flicker
84. Red-Bellied Woodpecker
85. Yellow-Bellied Sapsucker
86. Hairy Woodpecker
87. Downy Woodpecker
88. Eastern Kingbird
89. Great Crested Flycatcher
90. Eastern Phoebe
91. Acadian Flycatcher


SPECIES
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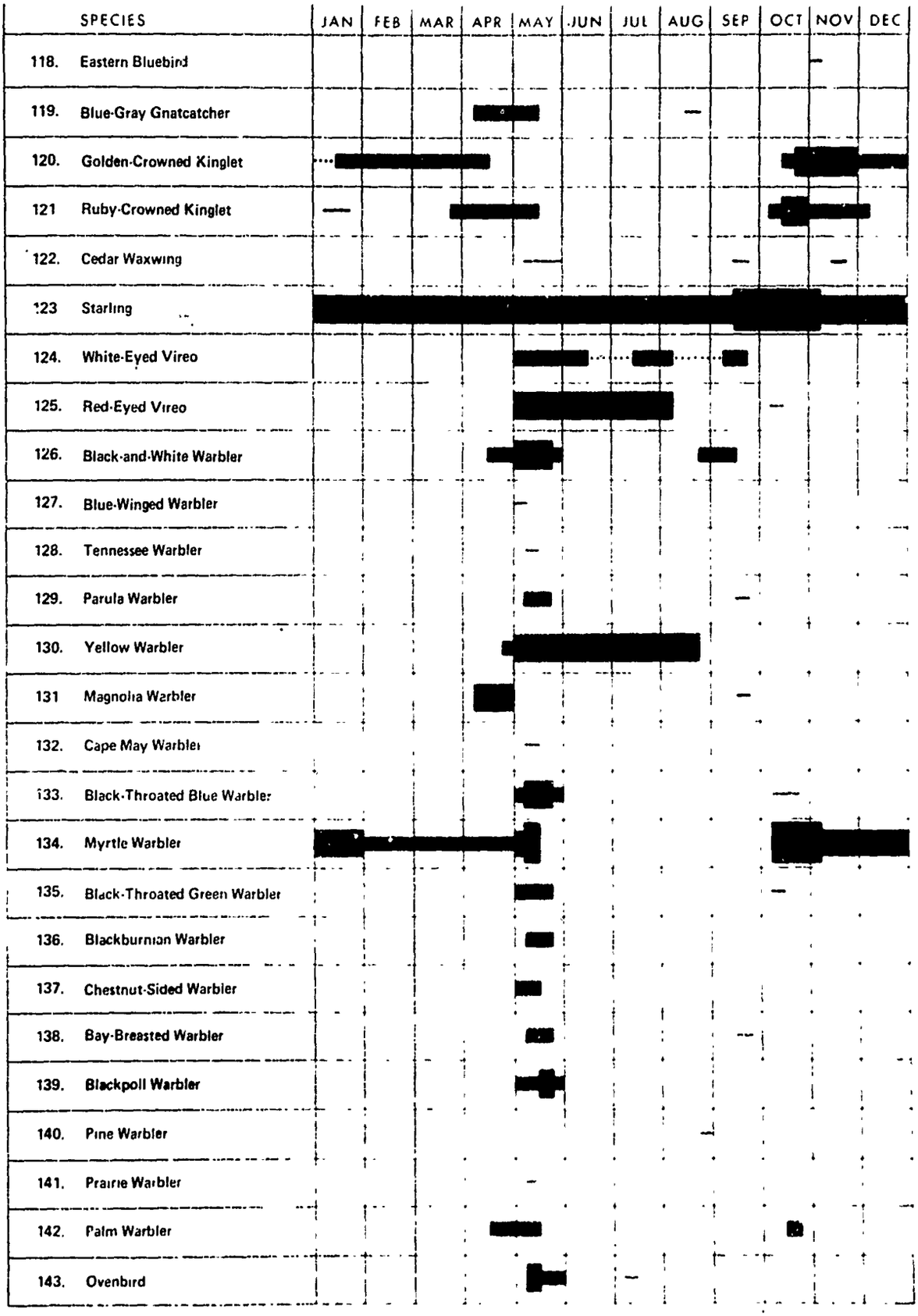
92. Eastern Wood Pewee
93. Olive-Sided Flycatcher
94. Horned Lark
95. Tree Swallow
96. Bank Swallow
97. Rough-Winged Swallow
98. Barn Swallow
99. Purple Martin
100. Blue Jay
101. Common Crow
102. Fish Crow
103. Carolina Chickadee
104. Tufted Titmouse
105. White-Breasted Nuthatch
106. Brown Creeper
107. Winter Wren
108. Carolina Wren
109. Long-Billed Marsh Wren
110. Mockingbird
111. Catbird
112. Brown Thrasher
113. Robin
114. Wood Thrush
115. Hermit Thrush
116. Swainson's Thrush
117. Veery


SPECIES
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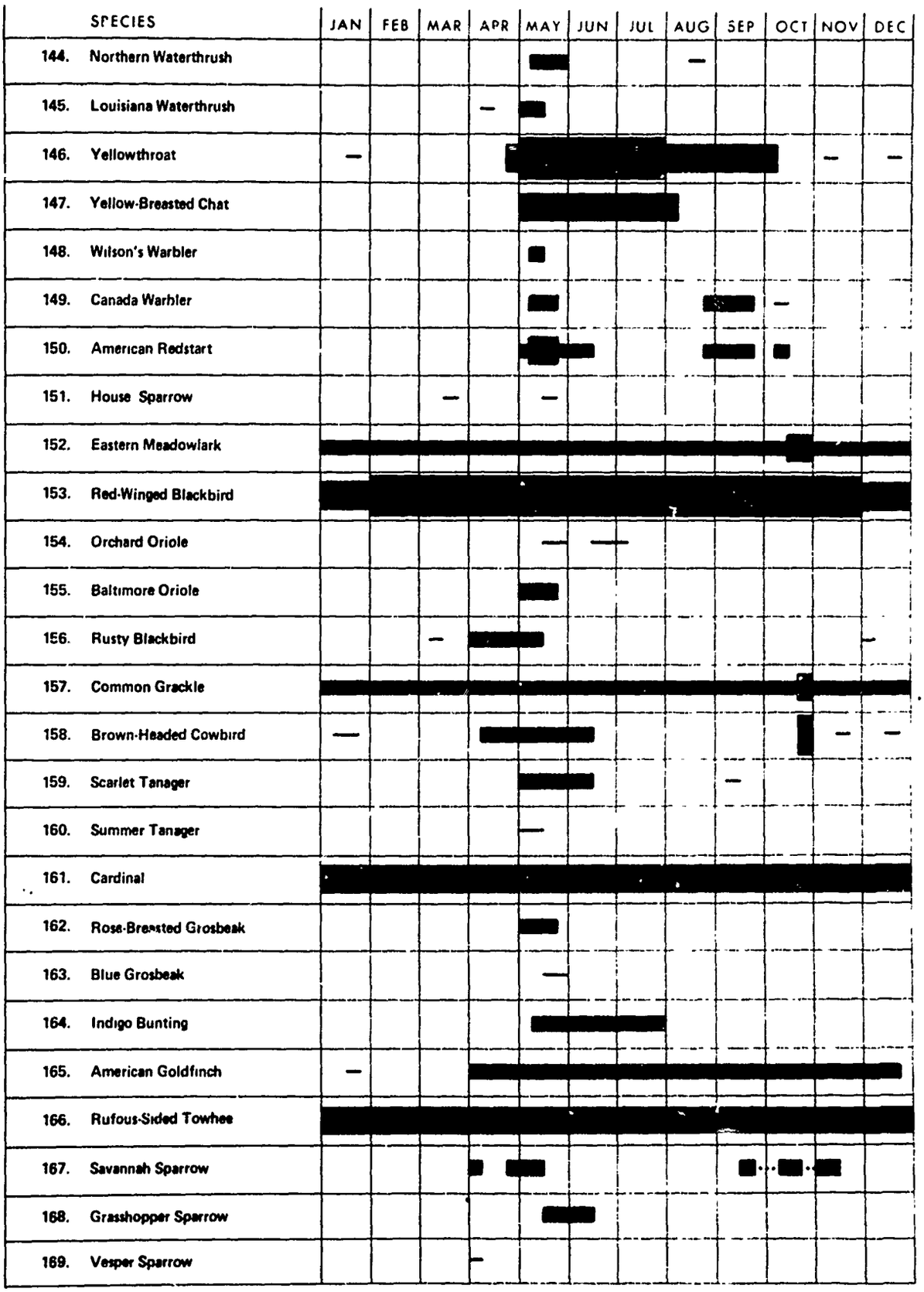
118. Eastern Bluebird
119. Blue-Gray Gnatcatcher
120. Golden-Crowned Kinglet
121 Ruby-Crowned Kinglet
122. Cedar Waxwing
123 Starling
124. White-Eyed Vireo
125. Red-Eyed Vireo
126. Black-and-White Warbler
127. Blue-Winged Warbler
128. Tennessee Warbler
129. Parula Warbler
130. Yellow Warbler
131 Magnolia Warbler
132. Cape May Warbler
133. Black-Throated Blue Warbler
134. Myrtle Warbler
135. Black-Throated Green Warbler
136. Blackburnian Warbler
137. Chestnut-Sided Warbler
138. Bay-Breasted Warbler
139. Blackpoll Warbler
140. Pine Warbler
141. Prairie Warbler
142. Palm Warbler
143. Ovenbird


SPECIES
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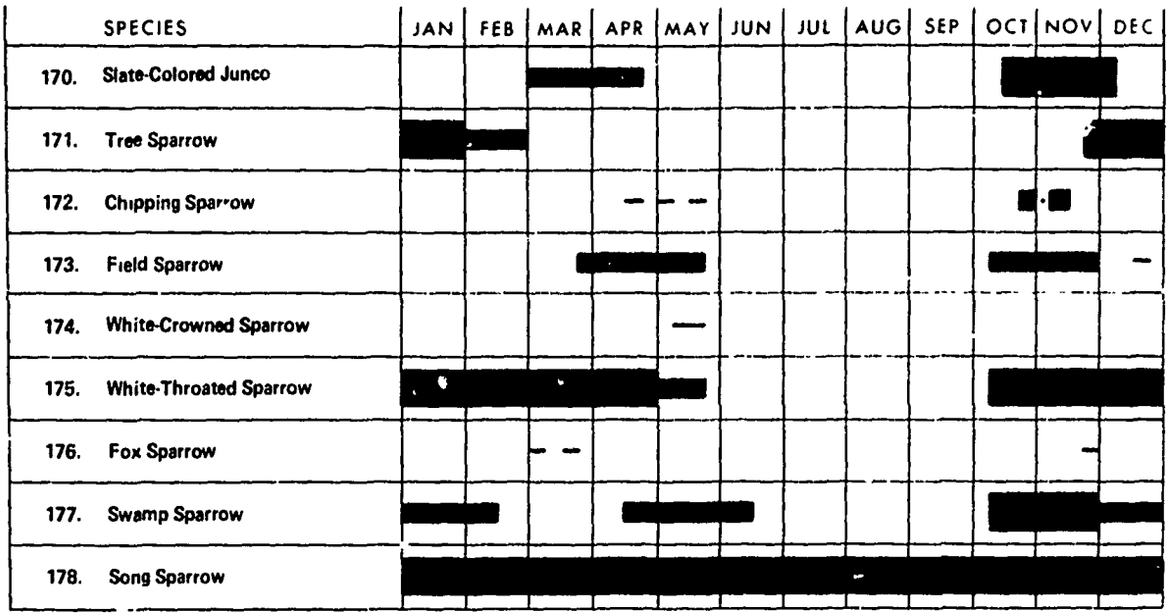
144. Northern Waterthrush
145. Louisiana Waterthrush
146. Yellowthroat
147. Yellow-Breasted Chat
148. Wilson's Warbler
149. Canada Warbler
150. American Redstart
151. House Sparrow
152. Eastern Meadowlark
153. Red-Winged Blackbird
154. Orchard Oriole
155. Baltimore Oriole
156. Rusty Blackbird
157. Common Grackle
158. Brown-Headed Cowbird
159. Scarlet Tanager
160. Summer Tanager
161. Cardinal
162. Rose-Breasted Grosbeak
163. Blue Grosbeak
164. Indigo Bunting
165. American Goldfinch
166. Rufous-Sided Towhee
167. Savannah Sparrow
168. Grasshopper Sparrow
169. Vesper Sparrow


SPECIES
JAN
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170. Slate-Colored Junco
171. Tree Sparrow
172. Chipping Sparrow
173. Field Sparrow
174. White-Crowned Sparrow
175. White-Throated Sparrow
176. Fox Sparrow
177. Swamp Sparrow
178. Song Sparrow