

MIGRANT BIRDS KILLED AT THE VEHICLE ASSEMBLY BUILDING (VAB), JOHN F. KENNEDY SPACE CENTER

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During the annual autumn and spring migrations, nocturnal migrant birds are killed at radio and television towers, ceilometers, lighthouses, smoke stacks, and buildings. Weir (1976) and Avery et al. (1980) have reviewed and summarized most of the literature on these mass mortalities in North America. Two important factors associated with the fatal collisions are inclement weather and attraction of migrating birds to lights mounted on the man-made structures (Cochran and Graber 1958, Crawford 1974, Weir 1976). Kills have provided large samples of birds for studying migration patterns, influences of weather on migration, age-sex ratios, flight energetics, and other information often difficult to obtain except where large samples are available.

In Florida, two long-term studies have been conducted on nocturnal migrants killed at television towers. One study has been conducted for over 25 yrs in northwest Florida (Leon County) on Tall Timbers Research Station (Crawford 1981, Stoddard and Norris 1967). The other study, totaling 6 yrs of data, was conducted at 2 towers located about 1.6 km apart near Bithlo (Orange County) in central Florida (Taylor 1981; Taylor and Anderson 1973, 1974). Kills of nocturnal migrant birds similar to those at the TV towers have occurred at the Vehicle Assembly Building (VAB), John F. Kennedy Space Center. The VAB is a coastal site in contrast to the towers which are located inland (Fig. 1). The northwest tower is an obstacle to trans-Gulf migrants, whereas the central Florida towers lie in the pathway of birds migrating through the Florida peninsula.

In this paper we report and discuss the VAB spring and autumn kills and compare the data with those published from the Florida towers. Nearly 60,000 individuals representing over 180 species of migrants have been collected at the towers and VAB.

THE VAB

The VAB is located about 2.5 km west of the Atlantic Ocean at the John F. Kennedy Space Center on Merritt Island, Brevard County, Florida. The structure is one of the largest buildings in the world, covering a ground area of 32,376 m². The building is 218 m long, 158 m wide, and is divided into a high bay area 160 m tall and a low bay area 64 m in height. A large paved area for parking cars and transport vehicles surrounds the building.



FIGURE 1. Three migrant bird kill sites in Florida. A. Vehicle Assembly Building (VAB), John F. Kennedy Space Center. B. Central Florida TV towers (Orange County). C. Northwest Florida TV tower (Leon County).

METHODS

The kills reported herein occurred during 1970–1981. Over 80% of the individuals were collected from 1970–1975 when access to the VAB was easier with better notification by personnel of the space center when a kill occurred. Rigorous security measures in recent years have prevented timely systematic collections of birds, which continue to be killed.

The possibility of a kill occurring on a given night was anticipated from weather reports of the news media. At the onset of a kill, persons living in the nearby area and from Merritt Island National Wildlife Refuge were notified by VAB personnel. The birds were collected as they began to hit the VAB shortly after darkness fell and collection continued throughout the night and into the early morning. There were a few kills where salvage of the dead birds did not commence until early morning. Dates of the kills given in this paper are mornings after the kills when the birds were collected.

All dead birds found were enumerated. The carcasses were frozen for processing at a later date at the University of Central Florida. Passerines were aged by plumages and by skull ossification; nonpasserines were aged by plumages. Sex was determined by plumages and dissection.

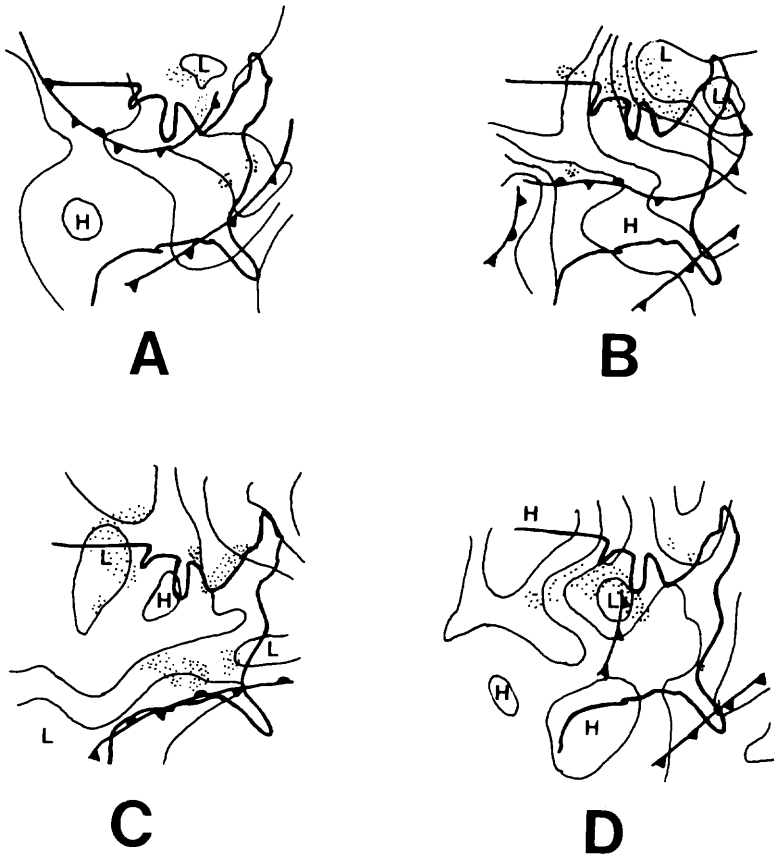


FIGURE 2. Weather patterns that resulted in 2 large kills in 1971 at the VAB. A. (24 April), B. (25 April): Three-hundred and seventy-eight individuals were collected on 25 April. Winds were from the west at a mean speed of 14.2 mph (11.5–18.4 mph). C. (30 April), D. (1 May): The largest VAB kill of 847 individuals were collected on 1 May. Winds were from the southwest at a mean speed of 18.2 mph (11.5–21.8 mph), with gusts up to 24 mph.

Weather data cited in this paper were recorded at Cape Canaveral Air Force Station's weather observation site, Patrick Air Force Base, located about 2.5 km south of the VAB. In addition, weather maps published in appropriate issues of *Weatherwise* were consulted.

MAJOR KILLS

Kills of 100 or more birds occurred on the nights of 26–27 September 1971, 16–17 April 1972, 23–24 and 24–25 April 1971, 24–25 and 26–27 April 1976, 28–29 and 29–30 April 1971, 30 April–1 May 1971, 3–4 May 1972 and 1973, and 9–10 May 1972. On these dates, 3937 (78%)

of 5046 individuals were found. The largest autumn kill was on 26–27 September 1971; 149 individuals of 15 species were collected. The largest spring kill was on 30 April–1 May 1971; 847 individuals of 21 species were collected.

WEATHER CONDITIONS AND CHARACTERISTICS OF THE KILLS

The large VAB kills were associated with inclement, frontal weather conditions (Fig. 2). Mean temperatures recorded from 1800–0600 hrs during 8 April and 3 May kills that totaled 100 or more birds were 23.7°C and 22.9°C. For the 11 kills, the drop in temperature in the 12-h period ranged from 8° to 18°C. For 5 kills the temperature dropped approximately 15°C. Winds were usually from the west, northwest, or southwest at a mean speed of 14 MPH. Six of the 11 spring kills were associated with gusty winds ranging from 20 to 30 MPH. Three of the largest kills (376, 558, 847 individuals) were associated with gusty winds in excess of 24 MPH for 4 to 8 hrs. Rainfall (0.58 cm) was recorded only on the 23–24 April 1971 kill. Similar weather conditions prevailed during the autumn kills. Winds, however, were from the north and northeast.

During the disasters the building and parking area were lit with bright, white lights as well as red lights at the top of the facility. The well-lit building and surrounding area undoubtedly attracted the birds toward the facility, thereby causing them to become confused and disoriented (see Weir 1976, p. 12). Most birds hit the VAB at heights ranging from 61 to 122 m. Many individuals died instantly upon striking the building, however, a number of warblers (e.g., American Redstart [*Setophaga ruticilla*] and Prairie [*Dendroica discolor*]) fluttered enough to cushion their impact and these individuals survived. As has been reported at other sites, such as the northwest Florida tower, some injured and dead individuals were lost to crows, gulls, and other predators (Crawford 1974, Stoddard and Norris 1967).

Birds began to strike the VAB shortly after it became dark. The numbers killed usually reached a peak around midnight and large numbers continued to be killed until about 0300. Thereafter, the number of individuals killed decreased and at dawn the kills ceased.

RESULTS AND DISCUSSION

Species composition.—Over 5000 individuals of 62 species were collected at the VAB (Tables 1 and 2). Twenty-three spring kills (1 in March, 12 in April, and 10 in May) totaled 4336 individuals of 47 species. Eighty-three percent of the individuals were killed from 24 April to 6 May. In the 16 autumn kills (6 in September, 10 in October) there were 710 individuals of 45 species. Eighty percent of the individuals were killed from 27 September to 9 October. Seventeen species killed in the spring were absent in the autumn kills and 15 autumn species were not found in the spring kills (Tables 1 and 2). There were no species found that were not expected in Florida in either season. The lack of

TABLE 1. Spring migrants killed from 1971-1981 at the Vehicle Assembly Building (VAB), Kennedy Space Center, Brevard County, Florida.

Species	Numbers killed						Totals
	20 Mar (1)	11-20 Apr (1)	21-30 Apr (11)	1-10 May (8)	11-20 May (2)*	May	
Least Bittern (<i>Ixobrychus exilis</i>)			2				2
Black Rail (<i>Laterallus jamaicensis</i>)	1		2	1			4
Clapper Rail (<i>Rallus longirostris</i>)			2				2
King Rail (<i>R. elegans</i>)			5	2			7
Virginia Rail (<i>R. limicola</i>)				1			1
Sora (<i>Porzana carolina</i>)			1				1
Purple Gallinule (<i>Porphyryla martinica</i>)				1			1
Common Moorhen (<i>Gallinula chloropus</i>)				1			1
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)			10	6			16
Chuck-will's-widow (<i>Caprimulgus carolinensis</i>)				1			1
Eastern Wood-Pewee (<i>Contopus virens</i>)			1				1
Eastern Phoebe (<i>Sayornis phoebe</i>)			2				2
Marsh Wren (<i>Cisothorus palustris</i>)			4	1			5
Veery (<i>Catharus fuscescens</i>)			3				3
Gray Catbird (<i>Dumetella carolinensis</i>)		1	38	21			60
Brown Thrasher (<i>Toxostoma rufum</i>)			1				1
European Starling (<i>Sturnus vulgaris</i>)			1				1
White-eyed Vireo (<i>Vireo griseus</i>)			4				4
Red-eyed Vireo (<i>V. olivaceus</i>)		1					1
Tennessee Warbler (<i>Vermivora peregrina</i>)			2				2
Northern Parula (<i>Parula americana</i>)	2	8	79	44	1		134
Magnolia Warbler (<i>Dendroica magnolia</i>)				8			8
Cape May Warbler (<i>D. tigrina</i>)		30	209	117	1		357
Black-throated Blue Warbler (<i>D. caerulescens</i>)		5	208	177	6		396
Yellow-rumped Warbler (<i>D. coronata</i>)	1		1				2

TABLE 1. Continued.

Species	Numbers killed							Totals
	20 Mar (1)	11-20 Apr (1)	21-30 Apr (11)	1-10 May (8)	11-20 May (2) ^a	May (2) ^a	Totals	
Yellow-throated Warbler (<i>D. dominica</i>)			1				1	
Prairie Warbler (<i>D. discolor</i>)		7	16		3		26	
Blackpoll Warbler (<i>D. striata</i>)		2	262		349	39	652	
Black-and-white Warbler (<i>Mniotilta varia</i>)		21	313		166	4	504	
American Redstart (<i>Setophaga ruticilla</i>)		1	28		74	26	129	
Prothonotary Warbler (<i>Protonotaria citrea</i>)			1				1	
Worm-eating Warbler (<i>Helmitheros vermivorus</i>)		18	110		16		144	
Swainson's Warbler (<i>Limothlypis swainsonii</i>)		15	19		5		39	
Ovenbird (<i>Seiurus aurocapillus</i>)		51	688		422	20	1181	
Northern Waterthrush (<i>S. noveboracensis</i>)		4	38		41	2	85	
Louisiana Waterthrush (<i>S. motacilla</i>)					1		1	
Kentucky Warbler (<i>Oporornis formosus</i>)					1		1	
Connecticut Warbler (<i>O. agilis</i>)					10	1	11	
Common Yellowthroat (<i>Geothlypis trichas</i>)	21	8	139		161	9	338	
Hooded Warbler (<i>Wilsonia citrina</i>)			2				2	
Rose-breasted Grosbeak (<i>Pheucticus ludovicianus</i>)			1				1	
Indigo Bunting (<i>Passerina cyanea</i>)		4	13		5		22	
Painted Bunting (<i>P. ciris</i>)		4	20		7		31	
Savannah Sparrow (<i>Passerculus sandwichensis</i>)			4				4	
Grasshopper Sparrow (<i>Ammodramus savaannarum</i>)		1	29		20		50	
Swamp Sparrow (<i>Melospiza georgiana</i>)	1		15		40	9	16	
Bobolink (<i>Dolichonyx oryzivorus</i>)			35				84	
Totals	26	181	2309	1702	118		4336	

^a Number of kills in parentheses.

TABLE 2. Autumn migrants killed from 1970-1980 at the Vehicle Assembly Building (VAB), Kennedy Space Center, Brevard County, Florida.

Species	Numbers killed					Totals
	21-30 Sep (6)	1-10 Oct (5)	11-20 Oct (2)	21-31 Oct (3) ^a		
Pied-billed Grebe (<i>Podilymbus podiceps</i>)		1				1
Clapper Rail (<i>Rallus longirostris</i>)	5	1	1			7
Virginia Rail (<i>R. limicola</i>)	2	1				3
Sora (<i>Porzana carolina</i>)	2					2
Common Moorhen (<i>Gallinula chloropus</i>)				1		1
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)		3		1		4
Yellow-bellied Sapsucker (<i>Sphyrapicus varius</i>)				1		1
Acadian Flycatcher (<i>Empidonax virescens</i>)	1	1	1			3
Eastern Phoebe (<i>Sayornis phoebe</i>)	1					1
Sedge Wren (<i>Cistothorus platensis</i>)				1		1
Marsh Wren (<i>C. palustris</i>)				1		1
Ruby-crowned Kinglet (<i>Regulus calendula</i>)				1		1
Gray Catbird (<i>Dumetella carolinensis</i>)				3		3
White-eyed Vireo (<i>Vireo griseus</i>)	1					1
Solitary Vireo (<i>V. solitarius</i>)	20	7				27
Yellow-throated Vireo (<i>V. flavifrons</i>)	2	6				8
Red-eyed Vireo (<i>V. olivaceus</i>)	22	10	7			39
Northern Parula (<i>Parula americana</i>)	6	8	3			17
Magnolia Warbler (<i>Dendroica magnolia</i>)		1				1
Cape May Warbler (<i>D. tigrina</i>)	3		3			6
Black-throated Blue Warbler (<i>D. caerulescens</i>)	11	14	15	1		41
Blackburnian Warbler (<i>D. fusca</i>)		1				1
Yellow-throated Warbler (<i>D. dominica</i>)	1	2				3
Pine Warbler (<i>D. pinus</i>)		2				2

TABLE 2. Continued.

Species	Numbers killed					Totals
	21-30 Sep (6)	1-10 Oct (5)	11-20 Oct (2)	21-31 Oct (3) ^a	Totals	
Prairie Warbler (<i>D. discolor</i>)	3	2			5	
Palm Warbler (<i>D. palmarum</i>)	7	2	2	3	14	
Blackpoll Warbler (<i>D. striata</i>)		1	4		5	
Black-and-white Warbler (<i>Mniotilta varia</i>)	7		2	1	10	
American Redstart (<i>Setophaga ruticilla</i>)	16	19	13	1	49	
Worm-eating Warbler (<i>Helmitheros vermivorus</i>)		4			4	
Swainson's Warbler (<i>Limnothlypis swainsonii</i>)	2	4			6	
Ovenbird (<i>Seiurus aurocapillus</i>)	22	15			37	
Northern Waterthrush (<i>S. noveboracensis</i>)	4	2			6	
Kentucky Warbler (<i>Oporornis formosus</i>)	2				2	
Common Yellowthroat (<i>Geothlypis trichas</i>)	250	66	23	29	368	
Hooded Warbler (<i>Wilsonia citrina</i>)	2	1			3	
Yellow-breasted Chat (<i>Icteria virens</i>)				1	1	
Summer Tanager (<i>Piranga rubra</i>)		1		1	2	
Painted Bunting (<i>Passerina ciris</i>)			1		1	
Savannah Sparrow (<i>Passerculus sandwichensis</i>)				1	1	
Grasshopper Sparrow (<i>Ammodramus savaannarum</i>)				6	6	
Sharp-tailed Sparrow (<i>A. caudacutus</i>)				1	1	
Seaside Sparrow (<i>A. maritimus</i>)	1				1	
Swamp Sparrow (<i>Melospiza georgiana</i>)				1	1	
Northern Oriole (<i>Icterus galbula</i>)	1				1	
Totals	394	175	75	66	710	

^a Number of kills in parentheses.

TABLE 3. Comparison of the 5 most abundant migrants killed at each of 3 Florida facilities.

	Autumn (Sept.-Oct.)		Spring (Mar.-May)
Northwest Florida tower ^a	(n = 24,512)		(n = 9207)
Red-eyed Vireo	4041 (16.5%)	Red-eyed Vireo	2558 (27.8%)
Palm Warbler	1770 (7.2%)	White-eyed Vireo	843 (9.2%)
Common Yellowthroat	1309 (5.3%)	Yellow-rumped Warbler	794 (8.6%)
Gray Catbird	1043 (4.3%)	Northern Parula	601 (6.5%)
Veery	1002 (4.1%)	Palm Warbler	474 (5.1%)
Totals	9165 (37.4%)	Totals	5270 (57.2%)
Central Florida towers ^b	(n = 10,031)		(n = 166)
Common Yellowthroat	3408 (34.0%)	Blackpoll Warbler	43 (25.9%)
Ovenbird	1335 (13.3%)	Ovenbird	28 (16.9%)
Black-throated Blue Warbler	1058 (10.5%)	Common Yellowthroat	13 (7.8%)
American Redstart	853 (8.5%)	Northern Parula	12 (7.2%)
Palm Warbler	537 (5.4%)	Black-and-white Warbler	8 (4.8%) ^d
Totals	7191 (71.7%)	Totals	104 (62.6%)
East-coast Florida: VAB ^c	(n = 710)		(n = 4336)
Common Yellowthroat	362 (51.4%)	Ovenbird	1181 (27.2%)
American Redstart	49 (7.0%)	Blackpoll Warbler	652 (15.0%)
Black-throated Blue Warbler	41 (5.8%)	Black-and-white Warbler	504 (11.6%)
Red-eyed Vireo	40 (5.7%)	Black-throated Blue Warbler	394 (9.1%)
Ovenbird	37 (5.3%)	Common Yellowthroat	338 (7.8%)
Totals	529 (75.2%)	Totals	3069 (70.7%)

^a 25 yrs of data collection.^b 6 yrs of data collection for the autumn; 4 yrs for the spring.^c 4 yrs of data collection for the autumn; 6 yrs for the spring.^d Species tied with the American Redstart.

ducks and shorebirds, common migrants and winter residents in the surrounding area, is noteworthy. Wood-warblers had the greatest number of individuals represented in the spring (93%) and autumn (82%) kills. If the Ovenbird with 1181 individuals is excluded from the spring kills, 90% of the individuals were still warblers. When the 368 Common Yellowthroats are excluded from the autumn totals, 63% of the individuals killed in that season were wood-warblers. The percentage of warblers (82%) killed in the autumn at the VAB during the same months is similar to the 86% of warblers recorded in the autumn at the central Florida tower (Taylor and Anderson 1973, 1974; Taylor, unpublished data). These percentages of warblers exceed those recorded for the same months in seven years at the northwest Florida tower for both the autumn (38.0%) and spring (32.5%) seasons (Crawford 1974).

VAB kills compared with tower kills.—The overall species composition of the VAB kills for both seasons is similar to that reported at the towers.

The Seaside Sparrow was the only species found at the VAB and not represented at either tower. Clapper Rails and Painted Buntings, lacking at the northwest Florida tower in the autumn, were found at the VAB and at the central Florida site. In contrast, Eastern Phoebes, lacking in the central Florida kills during the autumn, occurred at the VAB and at the northwest tower. The phoebe was not a spring casualty at either tower.

Although the species composition is similar for all 3 sites, the relative abundance of individuals for certain species killed at the VAB is more similar to that found at the central Florida towers than at the northwest Florida site. This similarity can be observed when the 5 most abundant species killed for the 3 sites are compared (Table 3). Species such as the Common Yellowthroat, Ovenbird, Black-throated Blue, American Redstart, and Blackpoll (spring) occurred in greater numbers at the VAB and central Florida site than at the northwest Florida tower where Red-eyed Vireos, Gray Catbirds, and Yellow-rumped Warblers were more abundant. This same relationship between the VAB and towers can be observed when the 5 most abundant birds killed at the 3 sites on 30 April–1 May 1971 are compared. This was the largest spring kill for both the VAB (847 individuals, 21 species) and central Florida towers (57 individuals, 12 species). At the central Florida site the Blackpoll (25, 44.0%), Ovenbird (11, 19.3%), Common Yellowthroat (5, 8.8%), Black-and-white (3, 5.3%), and Black-throated Blue (3, 5.3%) were the most numerous birds killed. At the VAB, the 5 most abundant species killed were Ovenbird (212, 25.0%), Blackpoll (194, 22.9%), Common Yellowthroat (88, 10.4%), Cape May (85, 10.0%), and Black-and-white (82, 9.7%). Twenty-two species and 198 individuals were found on 30 April–1 May 1971 at the northwest Florida site. The 5 most abundant species at that site were Blackpoll (64 individuals, 32.3% of total killed), Veery (32, 16.1%), Bobolink (28, 14.1%), Gray-cheeked Thrush (25, 12.6%), and Red-eyed Vireo (15, 7.6%).

Several species of migrants were killed at the VAB in the spring whose total number of individuals exceed the total number of individuals killed vernaly in 25 yrs at the northwest Florida tower (Table 4). These species evidently use the peninsula and coastal areas for migration more than the Trans-Gulf area.

The spring kills at the VAB totaled more individuals than those in the autumn. The spring totals are among the largest reported in the U.S. In contrast, both tower sites had more individuals killed in the fall than in the spring. During 6 yrs of study at the central Florida towers, over 10,000 individuals were collected in the autumn and less than 200 individuals were found in the spring. The largest spring kill (30 April–1 May 1971) totaled only 57 individuals of 12 species. The few spring kills at the central Florida site cannot be attributed to lack of appropriate weather conditions conducive to cause a kill because weather patterns such as that of 30 April–1 May 1971 (Fig. 2) prevailed on several occasions. However, few individual spring migrants were killed. The large

TABLE 4. Individuals of 14 migrant species killed in the spring at the VAB during 11 yrs compared with those killed in the spring for over 25 yrs at the northwest Florida TV tower.

Species	VAB (Mar.-May)	TV tower (Mar.-May)
King Rail	7	1
Magnolia Warbler	8	1
Cape May Warbler	357	38
Black-throated Blue Warbler	394	5
Blackpoll Warbler	652	158
Black-and-white Warbler	504	45
Worm-eating Warbler	144	24
Ovenbird	1181	23
Northern Waterthrush	88	30
Common Yellowthroat	338	47
Connecticut Warbler ^a	11	6
American Redstart	129	63
Painted Bunting	31	1
Grasshopper Sparrow	50	17

^a Sixty or more Connecticut Warblers were reported killed at the VAB in 1978 during a large kill where salvage of specimens was not permitted (Edscorn 1978).

spring kills at the VAB and low spring kills at the central Florida site may indicate that the traffic of migrating birds is heavier along the coastal area than in the interior of the Florida peninsula and that the reverse pattern may occur during autumn migration. Further investigation, including radar surveillance, is needed to confirm or refute this hypothesis.

Sex ratios.—Over 100 individuals for each of 6 warbler species killed in the spring were sexed (Table 5). The sex ratios (M:F) and species are as follows: Blackpoll (1:0.42), Common Yellowthroat (1:0.44), Black-and-white (1:0.41), Cape May (1:0.75), Black-throated Blue (1:0.54), and Ovenbird (1:0.73). The preponderance of males in all species except the Ovenbird is significant using Chi Square ($P = <0.005$). The dominance of males is significant for all 6 species found in April and for individuals of the Blackpoll and Common Yellowthroat found in May. Female Black-and-whites, Cape Mays, and Ovenbirds slightly outnumbered males in the May samples; only the male-female difference for the Cape May is significant by Chi Square ($P = <0.005$).

It is not clear why these warblers differ from the expected 1:1 sex ratio. Apparently all 6 warblers have an overlapping asynchronous migration pattern where males peak before females. Leberman and Clench (1969) found that male Black-throated Blue Warblers banded in the spring at Powdermill near Rector, Pennsylvania, migrate several days earlier than females. Of 29 Blackpoll Warblers killed at the central Florida tower from 27 April to 1 May, 19 were males and 10 were females. Considering the large number of birds banded and killed at man-made structures, it is surprising that so few published data are

TABLE 5. Numbers of males and females for 6 warbler species killed during spring migration at the Vehicle Assembly Building (VAB), Kennedy Space Center.

Species	Dates	Males	Females
Blackpoll (<i>n</i> = 514)	April (8) ^a	132	30*
	May (8)	229	123*
	Totals	361	153*
Common Yellowthroat (<i>n</i> = 243)	March (1)	17	4*
	April (7)	50	20*
	May (8)	102	50*
	Totals	169	74*
Black-and-white (<i>n</i> = 343)	April (8)	207	50*
	May (6)	37	49
	Totals	244	99*
Cape May (<i>n</i> = 238)	April (11)	120	66*
	May (4)	16	36*
	Totals	136	102*
Black-throated Blue (<i>n</i> = 337)	April (7)	129	31*
	May (8)	90	87
	Totals	219	118*
Ovenbird (<i>n</i> = 128)	April (3)	51	26*
	May (3)	23	28
	Totals	74	54

^a Numbers in parentheses represent numbers of kills.

* Differences between males and females are significant using Chi Square ($P = <0.005$).

available on sex ratios of spring migrants with which to make comparisons.

SUMMARY

Over 5000 individuals representing 62 species of migrant birds were killed during spring and autumn migrations at the Vehicle Assembly Building (VAB), Kennedy Space Center, Brevard County, Florida. The large kills were associated with inclement, frontal weather conditions. The overall species composition of the VAB kills for both seasons is similar to that reported at 2 tower sites in Florida. The relative abundance of individuals for certain species killed at the VAB is more similar to that found at the central Florida towers than at the northwest Florida site. The large spring kills at the VAB and low spring kills at the central Florida site may indicate that the traffic of migrating birds is heavier along the coastal area than in the interior of the Florida peninsula and that the reverse pattern perhaps occurs during autumn migration. Several species are represented by higher numbers of individuals killed at the VAB than at the northwest Florida tower, a site where kills have been studied more than 25 yrs. Males outnumbered females in 6 species of warblers collected in the spring.

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LITERATURE CITED

- EVERY, M. L., P. F. SPRINGER, AND N. S. DAILEY. 1980. Avian mortality at man-made structures: an annotated bibliography (revised). U.S. Fish Wildl. Serv. Biol. Serv. Program, National Power Plant Team, FWS/OBS-80/54.
- COCHRAN, W. W., AND R. R. GRABER. 1958. Attraction of nocturnal migrants by lights on a television tower. *Wilson Bull.* 70:378–380.
- CRAWFORD, R. L. 1974. Bird casualties at a Leon County, Florida TV tower: October 1966–September 1973. *Bull. Tall Timbers Res. St.* 18:1–27.
- . 1981. Bird casualties at a Leon County, Florida TV tower: a 25-year migration study. *Bull. Tall Timbers Res. St.* 22:1–30.
- EDSCORN, J. 1978. Florida birds. *Fl. Nat.* 51:30–31.
- LEBERMAN, R. C., AND M. H. CLENCH. 1971. Bird-banding at Powdermill, 1970 Powdermill Nat. Res. Research Rept. no. 28.
- STODDARD, H. L., SR., AND R. A. NORRIS. 1967. Bird casualties at a Leon County, Florida TV tower: an eleven year study. *Bull. Tall Timbers Res. St.* 8:1–104.
- TAYLOR, W. K. 1981. No longer a big killer. *Fl. Nat.* 54:4–5, 10.
- , AND B. H. ANDERSON. 1973. Nocturnal migrants killed at a central Florida TV tower; autumns 1969–1971. *Wilson Bull.* 85:42–51.
- . 1974. Nocturnal migrants killed at a central Florida TV tower, autumn 1972. *Fl. Field Nat.* 2:40–43.
- WEIR, R. D. 1976. Annotated bibliography of bird kills at man-made obstacles: a review of the state of the art and solutions. Dept. Fisheries and Environment, Can. Wildl. Serv., Ontario Region.

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