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FLIGHT-SPEEDS OF HAWKS AND CROWS

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Plate 13

EXPERIMENTS in timing the flight-speeds of hawks at Hawk Mountain Sanctuary, in east-central Pennsylvania, were carried out during a period of six weeks, from late September to early November, 1942. Telephonic communication was used, over a measured course of two-thirds of a mile, along the sharp crest of the wooded ridge famous for its autumn migrations of raptores and other birds. The ridge used for the experiments runs $11\frac{1}{4}$ degrees south of west, is 1,500 feet above sea-level, and represents a spur of the Kittatinny Ridge, which traverses several states from southeastern New York through Virginia. For a detailed description of Hawk Mountain Sanctuary, and of the hawk flights, the reader is referred to an earlier report (1939). A stop watch was used, also a portable anemometer, both instruments being generously loaned by Lehigh University. Wind velocities were computed a few feet above the tree-tops on the crest of the ridge. We are indebted to Wm. H. Fricke for his yeoman services in helping the junior author to erect the telephone wires, and to Robert M. Giegler and Carl Siebecker for their coöperation as "hawk-spotters."

Flight-speed records were obtained of 152 hawks of 14 species, and of 15 Crows. The meagerness of the data may surprise some readers, in view of the passage and observation of many thousands of hawks and Crows along this ridge. Rarely do any of the migrating raptores fly 'on the beam'; hence the difficulty of accumulating reliable flight-speed data. Time and again a 'timed' subject would progress along the measured course, then suddenly swerve, or circle, or drop into the woods. There were many days when no birds were timed. Thus the 167 records listed here represent the speeds of only those birds whose passage was straight and uninterrupted.

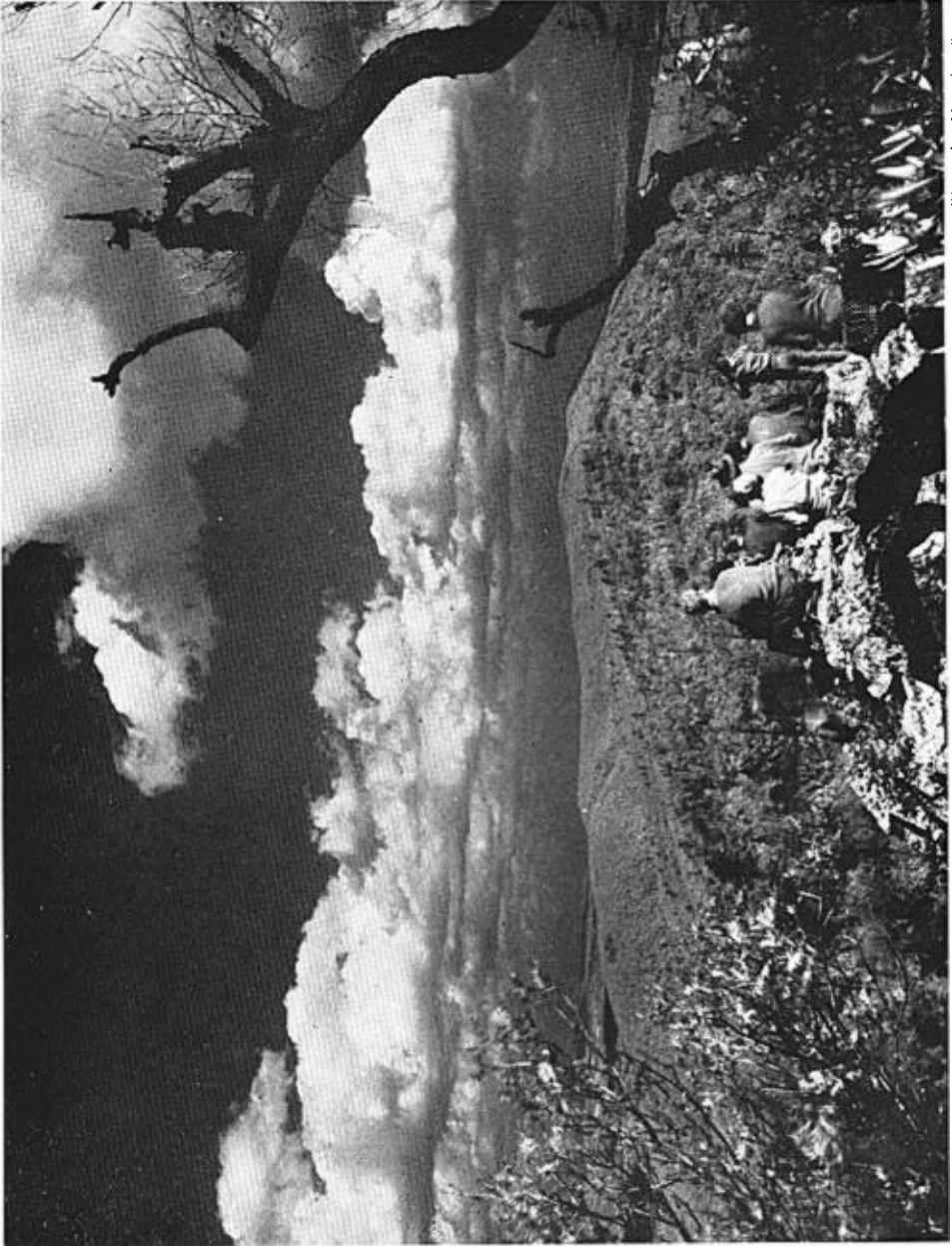


Photo by Maurice Brown

VIEW OF HAWK MOUNTAIN, A SPUR OF THE KITTATINNY RIDGE, IN EAST-CENTRAL PENNSYLVANIA. THE SPEED-OF-FLIGHT EXPERIMENTS WERE CONDUCTED ALONG THE CREST OF HAWK MOUNTAIN.

The importance of securing precise data on wind direction and velocity was realized, and this information was patiently accumulated in order to present, if possible, a complete picture of the ground-speeds of the birds, as has been suggested and so ably demonstrated by Allen (1939). Yet, though these important factors of wind are applicable in most instances to ground-speeds of birds, a glance at the tables will reveal that, at Hawk Mountain, wind velocity has no relationship to the speed of flight of the hawks, since the hawks utilize the *up drafts*—an unmeasurable factor—created by the winds. Thermal up drafts also play an important part in these flights.

In most instances, and especially in the case of the Sharp-shinned Hawks, the birds rarely flapped when the wind increased above 15 m. p. h. The birds then folded their wings as though in diving flight, in order to ride the strong up drafts. When a hawk appeared to be working hard (flapping vigorously), as did the Sharp-shin timed at 52 m. p. h. in a 20-mile wind, the bird was apparently struggling to avoid being blown off its course, and between flaps it reduced its wing area in the manner just described.

As for the Crows, here again the effect of wind on their flight could not be determined. A timed Crow, 'low over the valley,' though pursuing a level flight parallel with the measured section of the ridge, would obviously encounter a different wind velocity than that measured on the crest of the ridge. Incidentally, our speeds of migrating Crows approximate closely the Crow speeds of from 25 to 32 m. p. h. recorded by Rathbun (1934).

Great variation in speed will be noted in some species, as in the case of the Sharp-shinned Hawks, of which 37 individuals ranged from 16 m. p. h. to 60 m. p. h. The speeds of the Ospreys show even greater variation; 16 birds ranged from 20 to 80 miles per hour. The Osprey sailing along the ridge at 80 m. p. h. was evidently making use of a very strong thermal, so that the bird was in reality in steep diving flight without losing altitude; this particular bird was also witnessed by Robert M. Giegler and Henry Rosenkrantz, both of Penn State College. It may be relevant to recall Miss Cooke's words that "The age of the bird, the state of its plumage, and other physical conditions modify its powers of flight and thus affect its speed" (1937).

Our data provide but a single example of air speed, that of a Sharp-shinned Hawk, flapping continuously, making 34 m. p. h.

Since reliable records of flight-speeds of birds, and hawks in particular, are none too plentiful, the following data are set forth for their intrinsic interest, with the hope that they may be of value to other investigators along these lines.

TABLE 1

<i>Species</i>	<i>Miles per hour</i>	<i>Wind direction</i>	<i>Wind velocity</i>	<i>Comments</i>
Turkey Vulture:	34	N.W.	15.0	Sailed mainly, low over valley
Eastern Goshawk:	38	N.W.	9.0	Along crest of ridge
Sharp-shinned Hawk: .	16	N.W.	7.5	Flapped continuously
	17	N.W.	4.5	Flapped continuously
	18	N.W.	7.7	Flapped continuously
	18	N.W.	10.1	Flapped mainly, high over valley
	18	N.	4.0	Sailed mainly, high over valley
	18	W.N.W.	5.0	Flapped continuously, low
	20	N.W.	25.0	Sailed mainly, over valley
	22	W.N.W.	5.0	Flapped almost continuously
	22	N.W.	7.0	Sailing, only 3 flaps, high
	22	N.W.	4.5	Flapped continuously
	23	N.W.	12.0	
	23	N.N.W.	19.0	Flapped mainly, along crest of ridge
	24	W.N.W.	4.0	Flapped continuously
	24	W.N.W.	3.0	Sailed and flapped, along crest
	24	N.W.	10.0	Sailed and flapped, low on slope
	25	N.W.	15.0	Flapped, over crest of ridge
	26	N.W.	25.0	Continuous sail, high over valley
	26	N.W.	15.0	
	26	N.W.	8.0	Flapped and sailed over crest
	26	W.N.W.	8.5	Flapped continuously over crest
	27	N.W.	15.0	
	28	S.W.	5.0	Flapped mainly, near crest
	30	S.S.E.	15.0	Flapped entirely, near crest
	30	S.E.	15.0	Flapped entirely, near crest
	30	N.W.	20.0	Sailing mainly
	32	S.S.E.	15.0	Flapped entirely, below crest
	32	N.W.	12.0	Sailing mainly
	32	N.W.	7.0	Sailed and flapped alternately
	34	No wind!		Flapping continuously
	36	N.W.	18.0	Continuous sail
	41	W.N.W.	4.0	Flapped, along crest
	48	S.E.	10.0	Flapped mainly, below crest
	52	S.E.	10.0	Flapped mainly, below crest
	52	N.W.	20.0	Flapped mainly, along crest
	54	N.W.	20.0	Sailed mainly, low over valley
	54	N.W.	25.0	Sailed entirely high over valley
	60	N.W.	20.0	Sailed entirely high over valley
Cooper's Hawk:	21	N.W.	4.5	
	23	N.W.	14.8	Sailed mainly
	23	N.W.	11.7	Sailed mainly
	23	W.N.W.	4.0	Sailed and flapped alternately
	26	N.W.	20.0	Sailed mainly, high over ridge
	26	N.W.	25.0	Flapped most of way
	26	N.W.	15.0	Flapped mainly, out over valley
	26	N.W.	3.0	Flapped and sailed alternately
	30	N.W.	15-20.0	Flapped mainly, along crest
	32	N.W.	18.0	Flapped continuously
	40	S.E.	10-15.0	Flapped mainly, above crest
	55	N.W.	4.0	Flapped mainly, above crest
Eastern Red-tailed Hawk:	20	N.W.	14.8	Almost continuous sail
	22	N.W.	18.0	This and following bird together; sailed mainly
	22	N.W.	18.0	
	22	N.W.	8.5	Sailed, above crest of ridge
	22	N.W.	7.0	Almost continuous sail
	23	N.W.	12.5	Continuous sail

TABLE 1—Continued

<i>Species</i>	<i>Miles per hour</i>	<i>Wind direction</i>	<i>Wind velocity</i>	<i>Comments</i>
Eastern Red-tailed Hawk:.....	23	N.W.	10.0	Continuous sail
	24	N.N.W.	15.0	Continuous sail
	24	N.W.	15.0	Continuous sail
	25	N.W.	12.0	Flapped occasionally, over valley
	25	N.W.	5.5	Continuous sail low over valley
	25	N.W.	14.0	Sailed, high over crest of ridge
	25	N.W.	18.0	Sailed, high over north slope
	25	N.W.	15.0	Sailed, high over north slope
	26	N.W.	4.0	Continuous sail, high over crest
	26	N.W.	4.0	Continuous sail, high over crest
	26	N.W.	4.0	Continuous sail, high over crest
	27	N.W.	12.0	Flapped occasionally, high
	27	N.W.	11.7	Continuous sail, along crest
	27	N.W.	8.5	Continuous sail, along crest
	27	N.W.	8.5	Continuous sail, along crest
	27	N.	11.0	Continuous sail, along crest
	28	N.W.	12.0	Continuous sail, along crest
	28	N.W.	11.7	Continuous sail, along crest
	28	N.W.	11.7	Continuous sail, along crest
	28	N.W.	11.7	Continuous sail, along crest
	28	N.W.	15.0	Continuous sail, along crest
	28	N.W.	10.0	Continuous sail, low over slope
	30	N.W.	20.0	Sailed mainly
	30	N.W.	5.7	Continuous sail, high over valley
	30	N.W.	22.0	Continuous sail, high over valley
	30	N.W.	15.0	Sailed mainly, along crest
	30	N.W.	15.0	Continuous sail, high over ridge
	30	N.W.	13.0	Continuous sail, along crest
	30	N.N.W.	19.0	Continuous sail, high over crest
	31	S.E.	11.9	Flapped and sailed alternately, low
	31	N.N.W.	11.3	Continuous sail, along crest
	32	S.E.	0-5.0	Flapped and sailed, along crest
	32	N.W.	8.5	Continuous sail, high over ridge
	32	N.W.	15.0	Continuous sail, high over ridge
	32	N.N.W.	11.0	Continuous sail, high over ridge
	32	N.N.W.	13.0	Continuous sail, high over ridge
	32	N.N.W.	4.0	Continuous sail, off south slope
	33	N.W.	8.5	Continuous sail, high over ridge
	33	N.W.	10.0	Continuous sail, high over ridge
	33	N.N.W.	11.0	Continuous sail, along crest
	34	N.N.W.	8.5	Continuous sail, high over ridge
	35	N.N.W.	7.0	Continuous sail, high over ridge
	35	N.W.	12.0	Flapped occasionally, very high
	35	N.W.	4.0	Flapped occasionally, very high
	38	N.N.W.	8.0	Flapped occasionally, very high
	40	N.N.W.	7.0	Flapped occasionally, very high
	40	N.N.W.	7.0	Flapped occasionally, very high
	40	N.N.W.	3.0	Flapped occasionally, very high
Northern Red-shouldered Hawk:.....	18	N.W.	25.0	Flapped continuously
	23	N.W.	9.7	Flapped occasionally
	26	N.W.	9.7	Flapped occasionally
	31	N.W.	7.0	Flapped mainly
	32	N.N.W.	7.0	Flapped mainly
	34	N.W.	6.0	Flapped mainly
	34	N.W.	6.0	Flapped mainly
Broad-winged Hawk:	20	N.W.	10.0	Sailed and flapped, low over crest
	30	S.E.	10.0	

TABLE 1—Continued

<i>Species</i>	<i>Miles per hour</i>	<i>Wind direction</i>	<i>Wind velocity</i>	<i>Comments</i>
Broad-winged Hawk :	30	S.S.E.	10.0	This and next together, sailing along crest of ridge
	30	S.S.E.	10.0	
	32	S.E.	5-10.0	Flock of 43 birds, sailed mainly
	32	S.E.	5-10.0	Sailed mainly
	40	S.E.	15.0	This and next together, sailing along crest of ridge
	40	S.E.	15.0	
American Golden Eagle:	28	N.W.	8.5	Flapped occasionally
	32	N.W.	13.5	Sailed continuously
Bald Eagle:.....	36	S.E.	10.0	Flapped and sailed alternately
	44	N.N.W.	15.0	Sailed continuously
Marsh Hawk:.....	21	N.W.	11.7	Flapped occasionally
	22	W.N.W.	9.0	Flapped and sailed alternately
	34	N.W.	6.0	Flapped continuously
	38	S.E.	15.0	Sailed mainly
Osprey:.....	20	N.W.	18.0	Sailed high over north slope
	20	N.N.W.	4.0	Sailed, along crest of ridge
	27	N.W.	12.0	Sailed, along crest of ridge
	28	N.W.	18.0	Sailed low, along crest of ridge
	29	N.W.	12.0	Sailed mainly along crest of ridge
	36	S.E.	15.0	Sailed along crest of ridge
	36	N.W.	12.0	Sailed well out over valley
	38	S.E.	15.0	Sailed along crest of ridge
	38	S.E.	5.0	Flapped continuously
	39	S.E.	15.0	Sailed mainly
	40	S.E.	15.0	Flapped and sailed alternately
	44	S.E.	10.0	Sailed mainly along crest of ridge
	48	S.E.	15.0	Flapped and sailed alternately
	56	N.W.	25.0	This and next bird together, both sailed mainly
	56	N.W.	25.0	
Duck Hawk:.....	80	N.W.	4.0	Continuous sail except for 2 half flaps
	28	N.W.	11.3	Flapped continuously
	30	N.W.	25.0	Flapped continuously
	32	N.W.	4.0	Flapped and sailed alternately
Pigeon Hawk:.....	28	N.W.	12.0	Flapped mainly
Eastern Sparrow Hawk:	22	N.W.	18.0	Flapped entirely
	23	N.W.	25.0	Flapped entirely
	24	N.N.W.	4.0	Flapped entirely
	36	N.W.	15-20.0	Flapped entirely
Eastern Crow:.....	17	N.	15.0	Low, along north slope
	19	N.W.	22.0	Along crest of ridge
	23	N.W.	10.0	Low, well out over valley
	23	N.W.	9.8	Low, well out over valley
	25	N.W.	10.8	Low, well out over valley
	25	N.	17.0	High over valley
	26	N.W.	20.0	Low along north slope
	27	N.W.	8.2	Low, out over valley
	27	N.E.	6.1	Low, out over valley
	27	N.N.W.	15.0	High above ridge
	28	N.W.	10.0	Low along north slope
	29	N.W.	3.0	High over south slope
	30	N.W.	25.0	Low, flock of 11 birds
	30	N.N.W.	13.0	High, out over valley
	35	N.	1.0	Low, out over valley

TABLE 2

<i>Species</i>	<i>Total records</i>	<i>Range of speed</i>	<i>Average speed</i>	<i>Median</i>
Turkey Vulture.....	1	34	—	—
Eastern Goshawk.....	1	38	—	—
Sharp-shinned Hawk.....	37	16-60	30.0	26
Cooper's Hawk.....	12	21-55	29.3	26
Eastern Red-tailed Hawk.....	54	20-40	29.0	28
Northern Red-shouldered Hawk.....	7	18-34	28.3	31
Broad-winged Hawk.....	8	20-40	31.7	32
American Golden Eagle.....	2	28-32	30.0	—
Bald Eagle.....	2	36-44	40.0	—
Marsh Hawk.....	4	21-38	28.7	—
Osprey.....	16	20-80	41.5	38
Duck Hawk.....	3	28-32	30.0	30
Pigeon Hawk.....	1	28	—	—
Eastern Sparrow Hawk.....	4	22-36	26.2	—
Eastern Crow.....	15	17-35	26.0	27

REFERENCES

ALLEN, F. H.

1939. Effect of Wind on Flight Speeds. Auk, 56: 291-303.

BROWN, M.

1939. Fall Migrations of Hawks at Hawk Mountain, Pennsylvania, 1934-1938. Auk, 56: 429-441.

COOKE, M. T.

1937. Flight Speed of Birds. U. S. Dept. Agric., Circ. 428.

RATHBUN, S. F.

1934. Notes on the Speed of Birds in Flight. Murrelet, 15: 23-24.

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NOTES ON THE BREEDING OF THE PINE SISKIN

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INTRODUCTION

AN unusual occurrence of Pine Siskins (*Spinus pinus pinus*) throughout New England during the winter and spring of 1941 was followed by the nesting of some of the birds south of, or at lower elevations than, their usual breeding range. This afforded an opportunity to make a detailed study of the breeding habits of the species at Hanover, New Hampshire, where one nest was observed by fifteen members of the Dartmouth Natural History Club from the time that the nest was being built until the young had departed from it.

Previous records of Siskins breeding in New England are relatively scarce and detailed observations made during the nesting period are rare. The general behavior pattern in regard to nesting is fairly well known from casual observations and by comparisons with re-