

The Influence of Weather Conditions on Hawk Migration at Pilot
Mountain State Park, N. C.

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Abstract The first observation of migrating hawks at Pilot Mountain State Park was made on 4 October, 1973 (Chat 38:26). In the ensuing years numerous sightings have been made of raptor species during the autumnal migration. The subsequent sightings and unusual abundance for a relatively unknown flyway prompted more detailed study and observations. As is generally found at most look-out stations, the Broad-winged Hawk demonstrated the most dramatic migratory flights, often appearing in thermals containing several hundred circling hawks. Additional sightings of Bald and Golden Eagles provided the flyway with heretofore unreported raptor species. Following a cold-front passage, the strong northwest winds produce updrafts as they strike the mountain range. Under such favorable flight conditions, the greatest number of individuals was observed in September. This same weather pattern during October and November played no significant role in migratory patterns. The northeast winds following a high pressure system located northwest of the lookout site, however, created conditions for the largest variety of species for each of the three months. Much is being learned about migrating raptors and the factors influencing their movement as more research is undertaken. However, there still remain many unsolved questions concerning the essential ingredients which cause hawks to move when known influences are absent.

Introduction Prior studies at Pilot Mountain State Park revealed a migratory pattern of raptors during the annual autumnal movement. The past work

consisted of observation of general migration and weather-related flight patterns, identification of raptors, and the study of essential ingredients of a flyway.

The unique location, topographical and physiographic features of this flyway prompted a more thorough and detailed investigation of the raptors migrating through the area on their southward flight to Central and South America.

The purposes of this paper are to review the uniqueness of the Sauratown Mountain Range, to assess the present status of migrants using this range as a flyway, and to evaluate weather-related factors with the migratory activity.

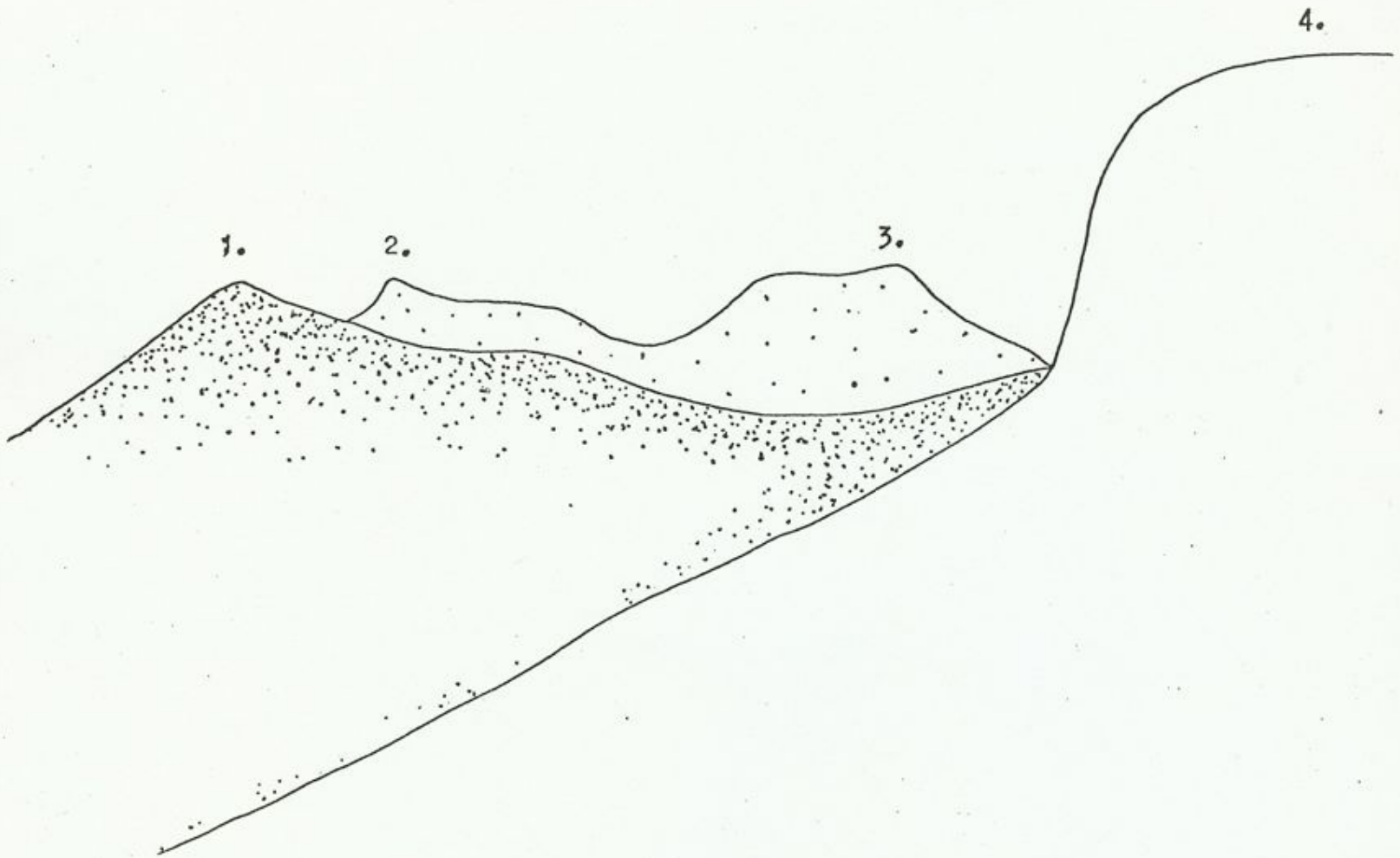
Methods and Materials

Location

Observations were made from the conspicuous rock out-cropping atop the Little Pinnacle at Pilot Mountain. This site is immediately west of the Big Pinnacle (or Pilot Knob). The site affords a northeasterly view of the entire Sauratown Range comprised of Pilot Mountain, Sauratown Mountain, Hanging Rock State Park, and Moore's Knob. (Figure 1).

Pilot Mountain is located at the southernmost terminus of the eroded remains of a small, ancient chain of prominent hills known as the Sauratown Mountains. The geologic features of Pilot Mountain are special in themselves. It is part of a series of quartzite ridges, typical of the Sauratown Mountains. Pilot Mountain is an excellent example of a monadnock, a quartzite mountain of resistant rock that has survived millions of years

3.



SAURATOWN MOUNTAIN RANGE (looking northeast)

1. Sauratown Mountain, 2. Hanging Rock State Park, 3. Moore' Knob, 4. Big Pinnacle at Pilot Mountain State Park

Figure 1.

and has not been reduced to the general level of the regional peneplain because of its exceptional resistance to weathering and erosion. Pilot Mountain is topped by two distinctive pinnacles. The Big Pinnacle rises 2440 feet above sea level. The quartzite forming its knob is interlayered with biotite and hornblende schist and gneiss. The Little Pinnacle, lying westward, rises 125 feet less than the Big Pinnacle. (Figure 2) (Butler, et al, 1975)

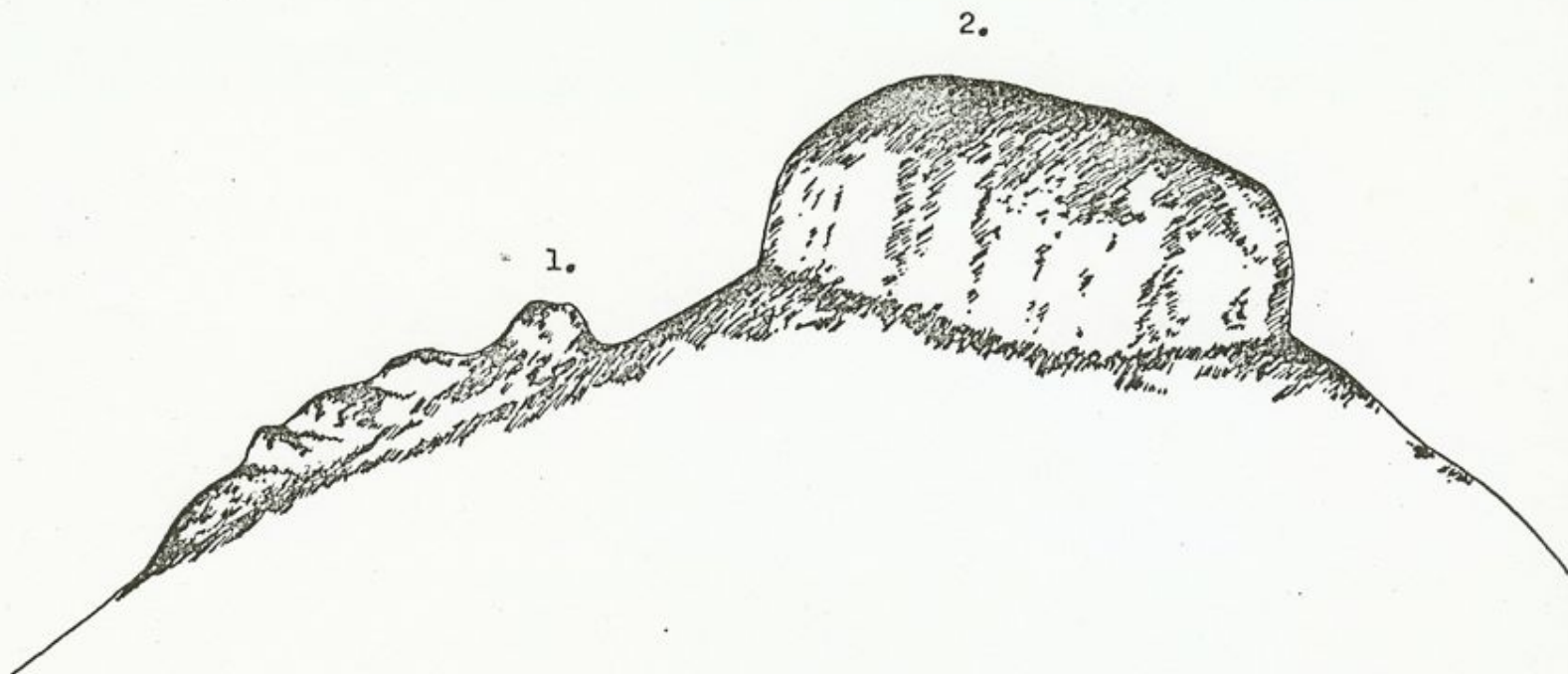
Monitoring Techniques

Two to seven trips were made to the site weekly with observations ranging each time from one to eight hours. Data relative to temperature, wind speed, cloud cover, visibility, and flight altitude and direction were recorded hourly. In addition, data deemed pertinent by Hawk Migration Association of North America were recorded. Forms distributed by this organization were ordered and used as a criteria for record-keeping.

All observed raptors were counted as they passed if they were in a migratory pattern of flight. Those birds which seemed to be hunting or feeding and generally staying in the immediate vicinity were considered local residents and not counted as migrants. Falling in this category were most Turkey Vultures, some Black Vultures and a small portion of Red-tailed Hawks.

Observers were equipped with 7X binoculars and essential weather-recording equipment.

Observations were made from 5 September through 30 November, 1982, th peak autumn migration season.



View showing 1. Little Pinnacle, 2. Big Pinnacle at Pilot Mountain State Park (looking north)

Figure 2

Results and Analysis

Statistics

A total of 2643 raptors representing 14 species was recorded during 107½ hours of observation. The highest number of hours spent in one field day was 8 on 22 September.

The Broad-winged Hawk was the predominant species noted during this field study and it accounted for 86% of the total hawks recorded. Sharp-shinned Hawks and Red-tailed Hawks followed in decreasing order of abundance and accounted for an additional 5% and 3% respectively of the count. The remaining 6% of the total count was composed of 10 species plus unidentified raptors (Table 1).

Unusual Records

The count of 1780 Broad-winged Hawks on 22 September was a record high for Pilot Mountain during the nine years of observations. 574 individuals in a single kettle was also a new record. The previous high was 250 individuals in a single kettle on 30 September, 1977 (Chat 42:37). Two immature Bald Eagles were sighted during this study, the first record of this species migrating on the Sauratown Flyway. An additional sighting of an immature Golden Eagle on 30 October at Hanging Rock State Park was a significant record. This species had never been recorded in this area. Although the raptor was not sighted from the Little Pinnacle look-out station on Pilot Mountain, it was seen in the Sauratown Range in which Hanging Rock State Park is located.

Flight vs. Weather

TABLE 1. Species & Number of hawks per month observed at Pilot Mountain during 1982 fall migration

<u>Species</u>	<u>Sent.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Total</u>	<u>% of Total Hawks</u>
Turkey Vulture	0	8	0	8	.30
Black Vulture	15	36	0	51	1.93
Sharp-shinned Hawk	76	66	0	142	5.37
Cooper's Hawk	4	5	1	10	.38
Red-tailed Hawk	29	40	23	92	3.48
Red-shouldered Hawk	2	4	0	6	.23
Broad-winged Hawk	2279	6	1	2286	86.49
Bald Eagle	2	0	0	2	.07
Golden Eagle	0	1	0	1	.04
Northern Harrier	6	0	0	6	.22
Osprey	7	3	0	10	.38
Merlin	1	0	0	1	.03
American Kestrel	12	2	1	15	.56
Unidentified Raptor	11	2	0	13	.50
*Peregrine Falcon (observed in 1973 & 1976) (Chat 38:26 & 41:53)					
Total	2444	173	26	2643	99.98

Table 1.

Mechanics of Flights

Scientists and ornithologists have differed sharply for many years about the role wind plays in influencing the migration of hawks. It is generally accepted, however that much additional field work is necessary to produce a greater understanding of the mechanics of hawk flights.

(Heintzelman 1979)

Diversion Lines

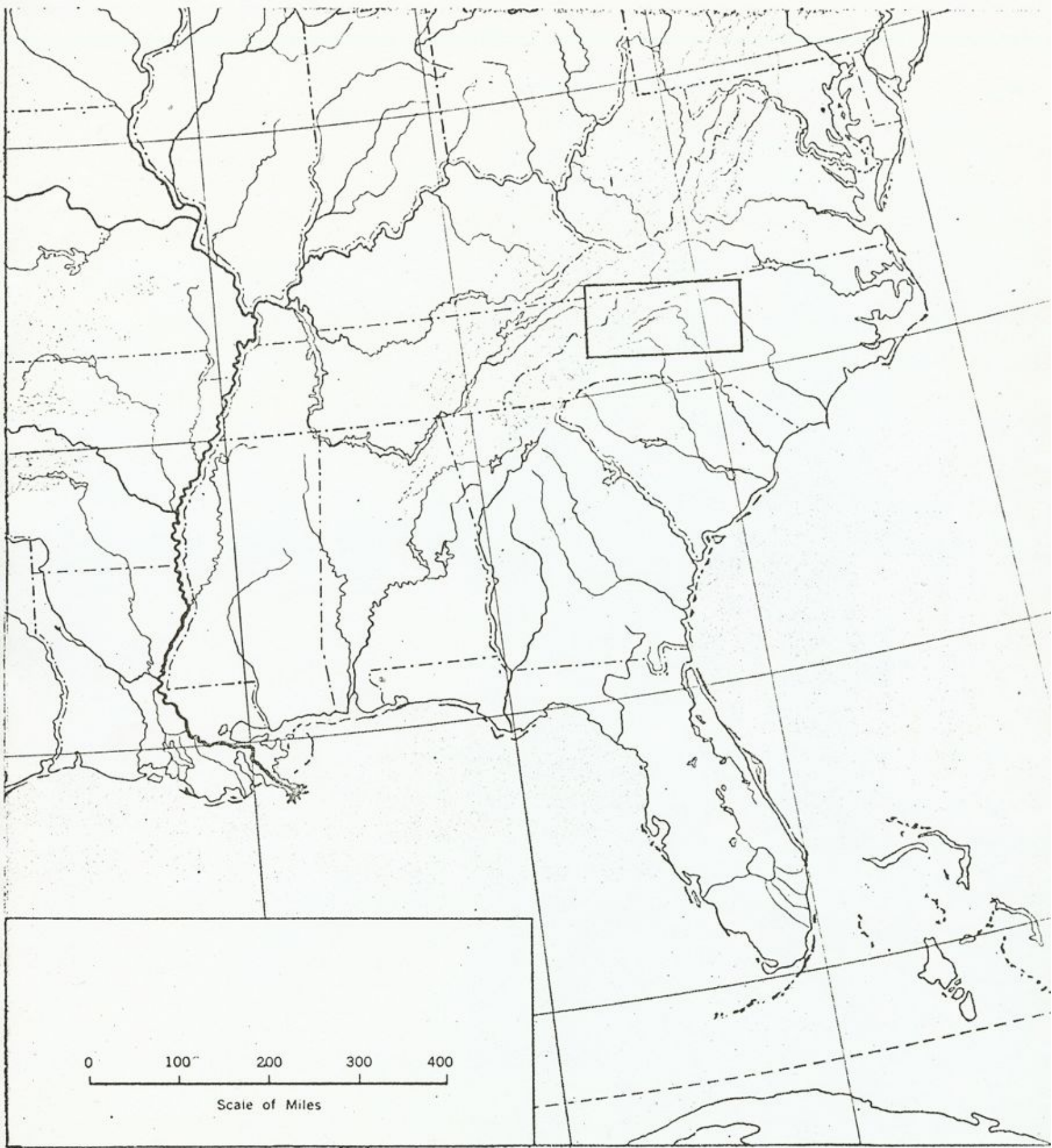
Among the most important factors essential for hawk migrations are favorable local weather conditions such as updrafts and thermals and the presence of prominent land features called diversion lines.

An additional feature enhancing the Sauratown Mountain Range as an attractive flyway is the fact that the well-defined Brushy Mountain Range lies immediately southwest of Pilot Mountain. This range then blends into the southern portion of the predominant and major flyway along the Blue Ridge Mountains in the western part of the state. Equally important is the presence of the Yadkin River flowing along a path parallel with the Sauratown/Brushy Mountain ranges. (Figure 3)

It is an accepted fact that prominent land features (known as diversion lines) are frequently used during migration. These natural geographic features such as rivers, coastlines, and mountain ranges provide the diurnal migrants with visual guidance (Brett 1973).

Updrafts

The mountain ranges additionally provide updrafts along the ridges as the northwest winds following passage of a cold front strike the sides of mountains and are deflected upward. These deflections create strong



Relief Map of Southeastern U. S. Showing Prominent Diversion Lines
(inset) Sauratown/Brushy/Blue Ridge Mountains & Yadkin River

Figure 3

Map Published by
Denoyer-Geppert Co.

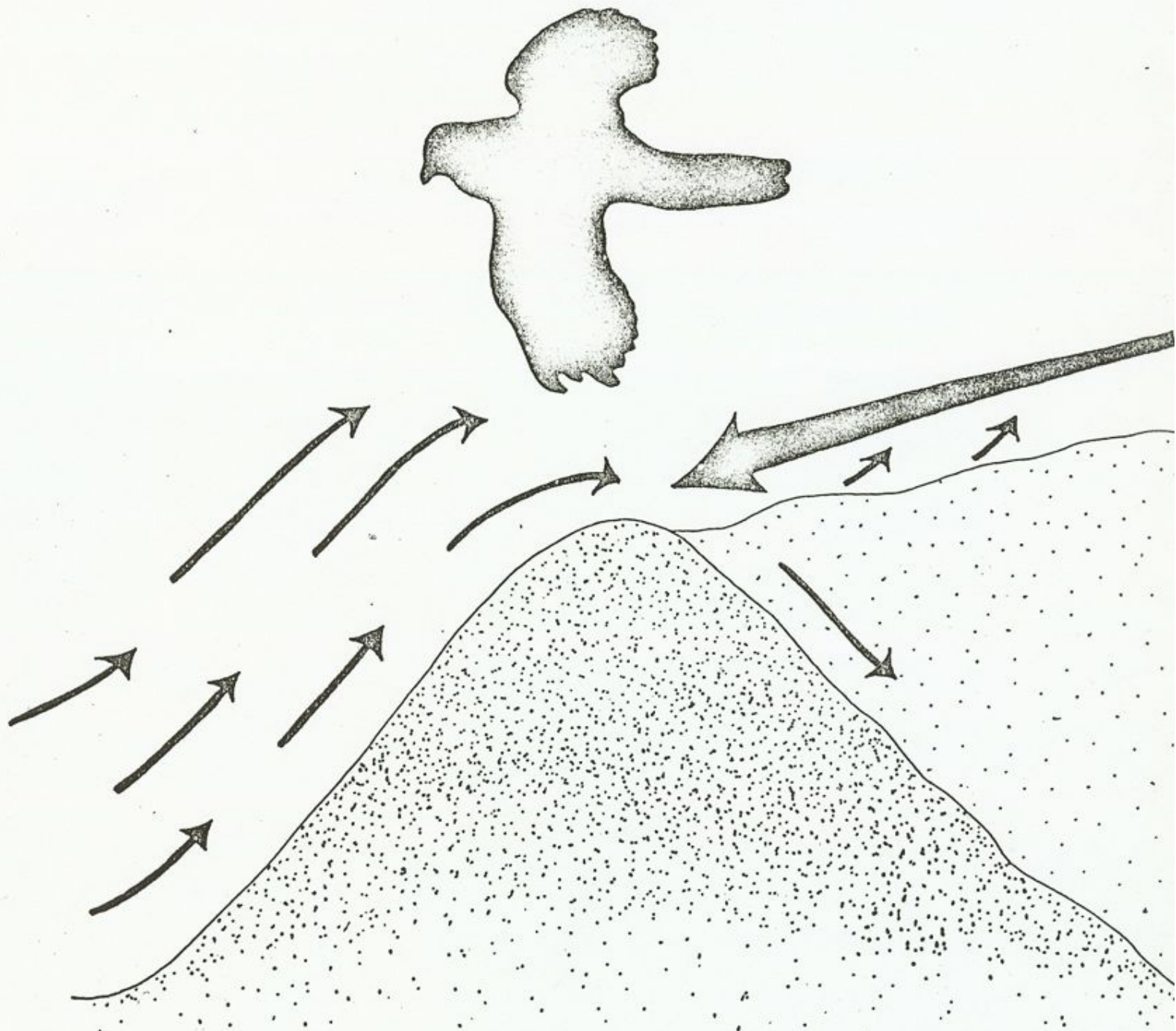
updrafts which are readily utilized as a means of conserving energy in the long journey southward. (Heintzelman 1976)(Figure 4)

Thermals

Another important property of this flyway is the availability of thermal activity. The valleys on either side of the mountain range provide ideal pockets of cool, moist air which are essential for forming a thermal. The sun gradually warms the cool, moist air which begins to rise as it heats. As it rises, it get cooler until reaching the "dew point" and then condenses into a cumulus cloud. These thermal systems become more massive as the day progresses. (Blair 1943)

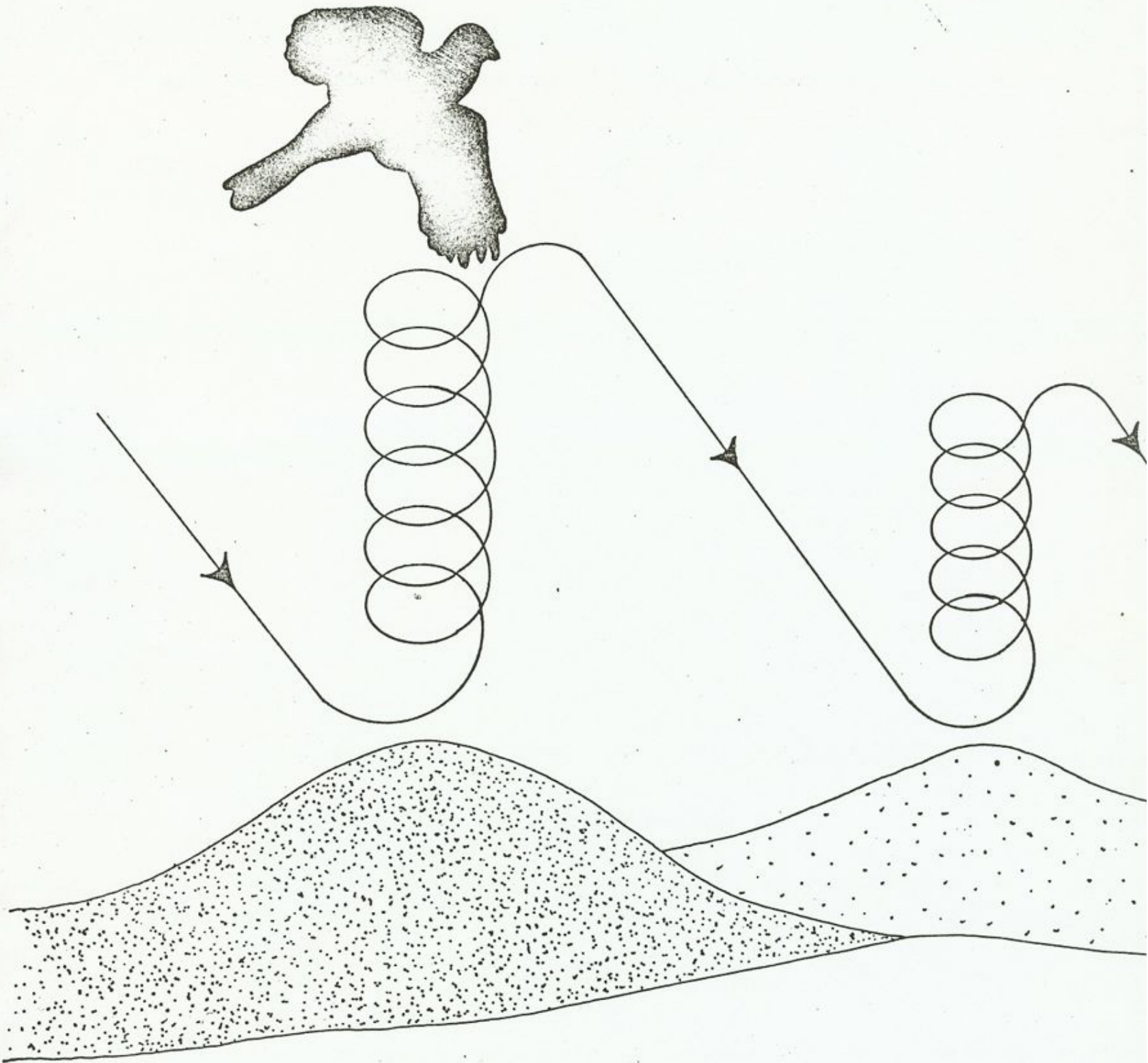
At 4 p.m. on 22 September , winds northwest at 20 mph, a large migration of Broadwinged hawks was observed about five miles north of th lookout point and subsequent mountain range. Great kettles of migrants could be detected with the aid of binoculars and were easily counted as they left the thermal and sailed southwestward on the updraft to find another thermal. This spectacle occurred on the first day following the cold-front passage as opposed to the second or third day following the passage as is frequently mentioned in literature. (Heintzelman 1975)

The hawks utilize the thermal system for migratory travel by searching for and entering these columns of warm air. On outstretched wings they rise higher and higher into the sky until the thermal dissapates. The hawks then glide in a southwesterly direction until reaching another thermal. Using these thermals as an asset in long flights, the migrating hawks eventually reach their destination. (Figure 5)



Strong Northwest Winds Produce
Updrafts Which Are Utilized For Flight

Figure 4



Thermal Flight Utilized by Broad-winged Hawks

Figure 5

Hawks/Weather/September

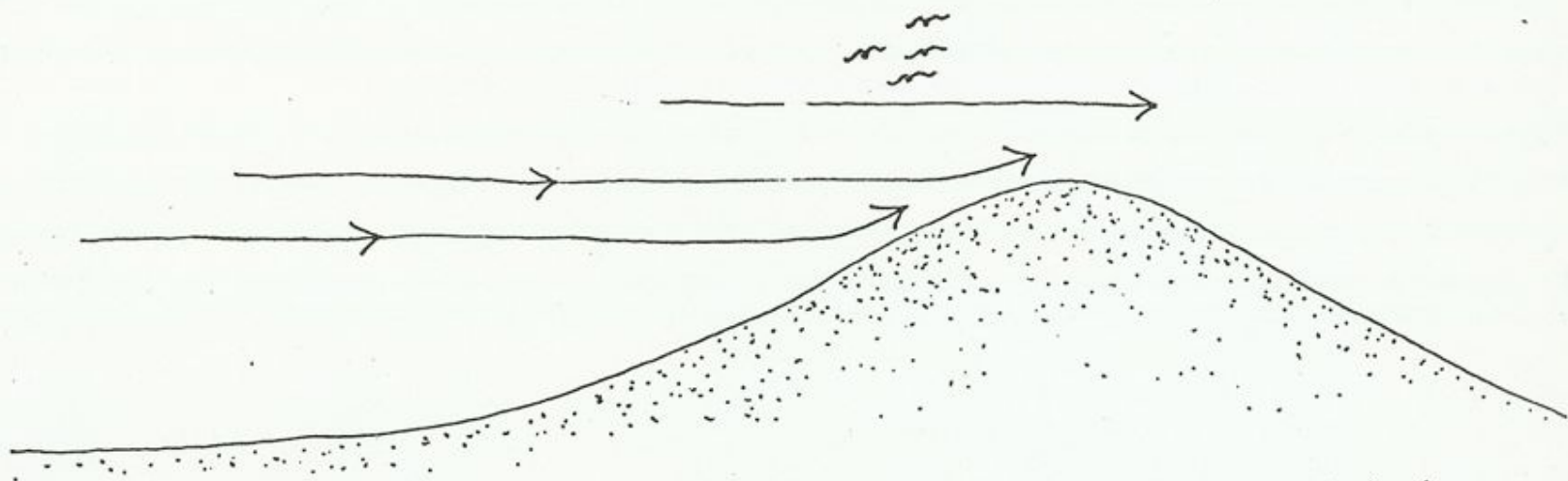
The month of September is unquestionably the most productive, rewarding and dramatic for hawk flights. This month is noted for Broad-winged Hawk flights which usually peak between the middle and end of the month. Such flights, sometimes containing thousands of hawks, are among the most extraordinary animal spectacles in the world. (Broun, 1949)

True to form, the Broad-winged Hawks made their annual flight past Pilot Mountain. The first minor frontal passage occurred on 18 September with northwest winds at 12-14 mph. With this weak cold front, 86 raptors were observed which included 75 Broad-winged, 7 Red-tailed, 1 Sharp-shinned, and 2 Ospreys. It was also on this day that the first record of a Bald Eagle was established. On 22 September the first major cold front passed through the area. With northwest winds at 18-20 mph, the hawks passed in spectacular numbers. 1783 raptors migrated on this day, of which 1770 were Broad-winged, 9 Sharp-shinned, 2 American Kestrels, and 2 Red-tailed.

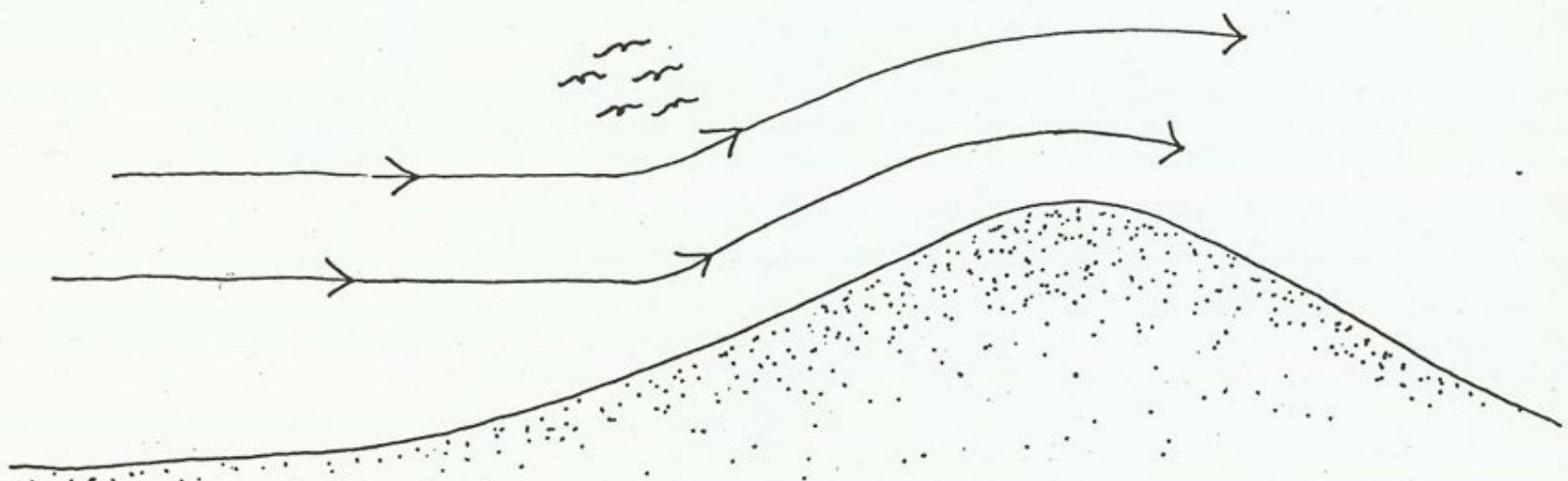
One interesting observation relative to this dramatic migratory pattern was that the hawk's distance from the ridge system was greatest when the wind was the strongest. This variation of pattern is explained by the fact that the interference effect of the mountain on the airflow occurs at a greater distance from the mountain when wind velocity is high than when it is low. This is a natural consequence of airflow over a protusion. (Figure 6) (Forrester, 1981)

Hawks/Weather/October

The pattern of migration in October varied sharply from that observed in September. There was a dramatic drop in the number of Broad-winged



Light Winds = Flights Close To Mountain



Strong Winds = Flights At a Greater Distance From Mountain

Figure 6

Hawks sighted in October. Also during October, a significant increase in Red-tailed Hawks was noted. The number of Sharp-shinned Hawks decreased instead of increasing as expected. Two factors may have contributed to this. First, the accipiters (Cooper's Hawk, Sharp-shinned, and Peregrine) all feed on other birds and heavily favor the coastline as a migratory route. It is believed these raptors follow the migrating shorebirds as a means of adequate food supply. (Bent, 1961) Coastal look-out stations experience spectacular waves of Sharp-shinned Hawks in October in a similar manner that Broad-winged Hawks are observed at mountain look-out stations in September. (HMANA, 1975) A total of 141 Sharp-shinned Hawks was observed at Pilot Mountain, a fraction of the number expected to be observed. A second factor is the strong possibility that the large flights were simply missed because numerous days in October were foggy and heavily overcast. The Sharp-shinned Hawks, however, were present in small numbers on each of the days that observations were made in October, the highest number being on northeast winds. It was also noted that the Sharp-shinned Hawks were more active in the earlier part of the day while the winds were stronger rather than later in the day when thermals were more predominant. The presence of these stiff breezes brought the Sharp-shinned Hawks closer to the tree-tops than other raptors which were observed.

Hawks/Weather/November

November proved to be a Red-tailed Hawk month although it, also, produced smaller numbers than were expected. 88% of the raptors observed during November were Red-tailed Hawks. Many November days were foggy with light rain or drizzle, providing less-than-ideal hawk-watching days.

No frontal systems with strong winds and clear skies were present throughout the entire month. There were only two days with northwest winds, one of which precipitated the sighting of 3 Red-tailed Hawks in a single kettle, but no other raptors were observed. On the other day with northwest wind, no raptors of any species were observed.

Interspecific Interaction

It was of considerable interest to observe the interaction between species as well as the behavioral traits characteristic of each species. The Red-tailed Hawks would frequently stop to hunt and/or feed as they passed over the Big Pinnacle. During this respite, two or three of the birds often would dive and swoop at each other. On numerous occasions the birds would roll over and clasp talons, tumbling in mid-air, then would release their hold and fly off in different directions, only to return and repeat the encounter. Eventually, the birds would search for a thermal and continue their southward flight.

The most spirited species seemed to be Sharp-shinned Hawks. They bounced in their flight and could not seem to resist harassing other raptors in the area. The resident ravens always seemed receptive to a challenge and apparently equally enjoyed the diving, playing, and mock attacks. These play respites lasted up to an hour on some occasions before the Sharp-shinned Hawks suddenly broke away and headed southwest.

Perhaps the most sedate and disciplined raptor migrants were the Broad-winged Hawks. They moved in a very methodical and orderly manner on thermals, seemingly intent only in an uninterrupted flight to their wintering grounds.

Hawks/Weather/Summary

Data gathered in this study were not altogether agreeable with those which were anticipated and generally found in literature.

The Broad-winged Hawks migrated in September regardless of wind direction along with other buteos and Ospreys, utilizing the thermal system of flight whereas the accipiters (Sharp-shinned and Cooper's) seemed to prefer the updrafts. The northwest wind did not seem to be a dominant influence except during September when large numbers of hawks are moving regardless of wind direction. At this time, the hawks followed on the first day rather than the expected second or third day after the frontal passage. The months of October and November did not have unusual numbers of migrants associated with northwest winds.

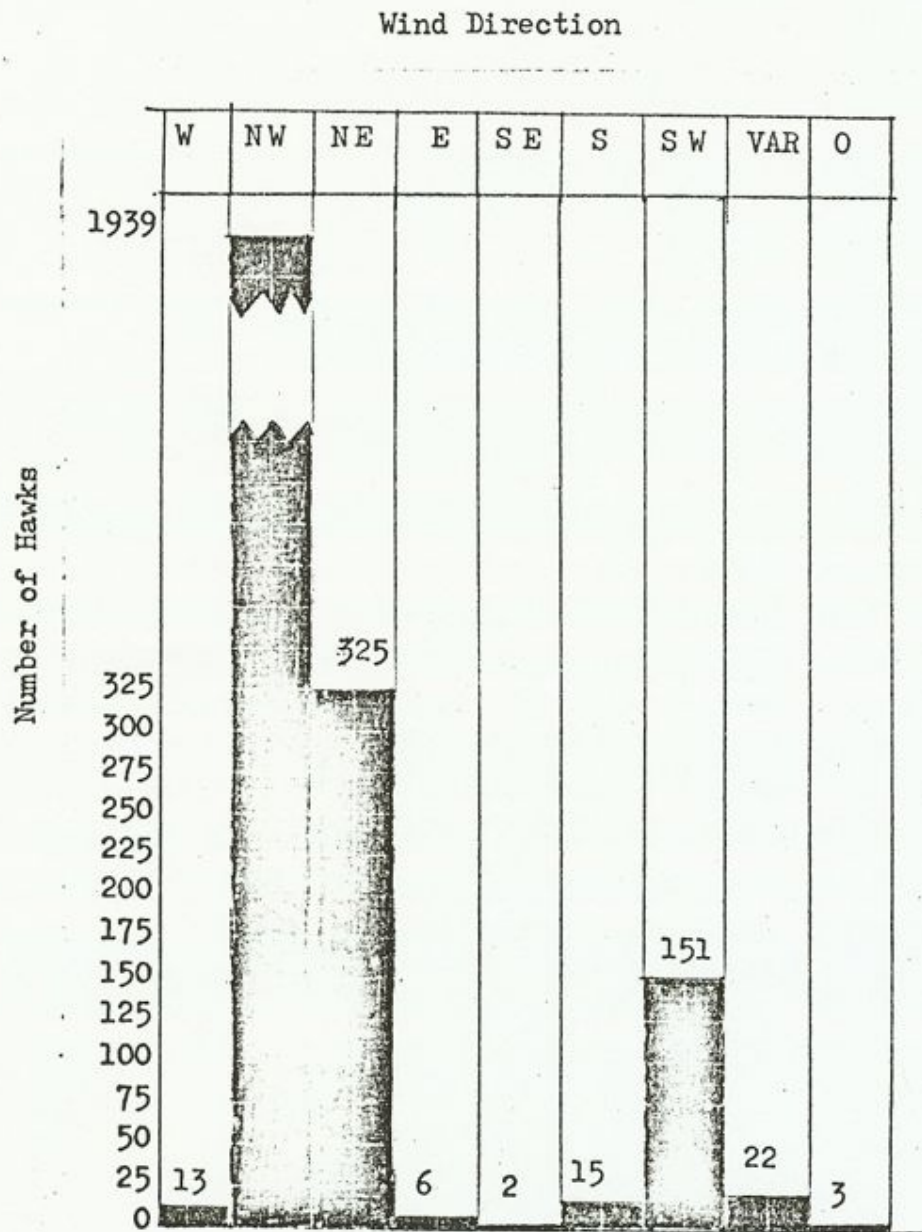
Northeast winds produced the greatest variety of species along with a respectable number of individuals during the entire observation period. The smallest amount of activity was on days with east, southeast, or no appreciable wind present. (Table 2)

The seasonal weather pattern was not considered normal during this particular study. There were very few significant frontal passages. Also the temperature remained mild and far above the normal range. Accompanying the mild weather were numerous days with fog and haze or heavy overcast with light rain.

The infamous "lull in the middle of the day" was typical at Pilot Mountain as is experienced at numerous other look-out points. This author speculates the reason for this phenomenon is because the brisk winds are predominant in the morning hours but as the ambient air warms, the thermals

begin to form and become the predominant source of flight assistance for the hawks. During this interim from updrafts to thermals the hawks must make a transition from ridge flying to valley flying, thereby causing a delay in movement as the hawks await the thermal activities. This transition begins to occur around the noon hour.

By the end of November, there was essentially no activity at the Little Pinnacle look-out except for the resident Ravens and Vultures.



Graph Showing Number of Hawks Migrating Relative to Wind Direction

Table 2

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