5-1-1998

ESTABLISHMENT OF A NIGHTHAWK MIGRATION MONITORING PROGRAM

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by

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A Thesis Submitted to the Faculty of
Longwood College
in partial Fulfillment of the Requirements for the Degree of

Master of Science

Environmental Studies

Longwood College
May 1998

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ABSTRACT

ESTABLISHMENT OF A NIGHTHAWK MIGRATION MONITORING PROGRAM

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The Nighthawk Migration Monitoring Program was initiated in 1997 to study the Common Nighthawk, *Chordeiles minor*. Modeled after the Hawk Migration Association of North America's hawkwatching methodology, the program enlisted volunteers to record time of day for peak flight, time of season for peak flight, weather conditions affecting migration, and other data. Volunteers were enlisted by establishment of a web-page and e-mail address, preparation and circulation of a brochure, and through mail. Individual chapters of the Virginia Society of Ornithology and others expressing interest were sent a letter, brochure, a Nighthawk Count Report Form, and an instruction sheet for filling out the daily report form. Fifty-three data sheets were returned by nine individuals from ten locations for a total of 67.15 hours of observation. Two-thousand one hundred seven nighthawks were seen on 24 days between August 9 and October 11, 1997. The time of day for peak flight was within fifteen minutes before and after sunset and the time of the season for peak flight was the last week of August. Nighthawks were observed migrating in wind speeds up to 38 km/hr and clear to partly cloudy skies. Data was inconclusive on wind direction and use of leading lines by migrants. Based on the first year's results, changes are being made in the program's design and plans are being made to expand it in upcoming years.

ACKNOWLEDGMENTS

"Does the hawk take flight by your wisdom
and spread his wings toward the south?
Does the eagle soar at your command
and build his nest on high?"
Job 39:26-27

I would like to thank the Heavenly Father for creating nature and the wonderful birds for us to study and enjoy. I also thank my family for their support and encouragement.

I would like to thank my committee, Dr. Michael Stinson, Mrs. Thelma Dalmas, and Ms. Teta Kain, for their hard work and advice they have given me in researching, writing, and presenting my work. I especially thank the volunteers who dedicated their time and effort to counting Nighthawks, without them it would have been impossible.

I would also like to thank the Natural Sciences Department for their support and kind words. A special thanks goes to Greg Tsigaridas for his computer expertise and for his help in creating the report form and the brochure.

I would like to thank Chuck Ross, Malissa Heldreth, and Kim McDonald for their friendship. You listened to my problems, calmed my fears, and gave me encouragement through it all.

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INTRODUCTION

The Common Nighthawk, *Chordeiles minor,* is one of three members of the family Caprimulgidae, and the only member of the genus *Chordeiles,* found in eastern North America. It is one of five species in the genus worldwide, all of which are called "nighthawks." Nighthawks are "closely related to potoos, frogmouths, and oilbirds and rather distantly related to hummingbirds, swifts, and trogons" (Reilly 1968). The large-eyed, brown and white mottled bird is 8 ½ to 10 ½ inches (21-26 cm) in length and has a wingspan of 21 to 23 3/4 inches (53-60 cm). The wings of the nighthawk are pointed in comparison to the rounded wings of many other caprimulgids. Common names for the nighthawk include goatsucker, bull-bat, mosquito hawk, pork and beans, burnt-land bird, and chimney swift. Like other members of the order Caprimulgiformes, nighthawks are also commonly called goatsuckers, an old English term. Bent (1940) writes that the odd name "originated from a queer superstition that the bird with its enormous mouth sucked the teats of goats." Though they are called nighthawks, these birds are not actually hawks. They have been mistaken for hawks because of their swift flight and long wings.

Nighthawks are crepuscular birds that feed on insects. They have short weak bills and gaping mouths for catching insects, such as dragonflies, moths, and flying ants, on the wing. They have such large mouths that the French Creoles called them "crapau volans," meaning flying toad. According to Bent (1940) nighthawks have also been known to eat beetles, flies, mosquitoes, grasshoppers, locusts, and plant lice. The insects they feed on are mainly adults but they also eat larvae, nymphs, and eggs. Udvardy (1977) writes, "flat roofs, railroad yards, vacant lots, and sports fields provide good

feeding opportunities" for the nighthawk. Nighthawks eat more than fifty different types of insects and they eat large numbers of insects in one evening. For example, one nighthawk that was examined had 2,175 ants in its gut while another nighthawk had 500 mosquitoes (Ewins 1993). Nighthawks are often seen on evenings when there are lots of insects in the air, especially locations that have bright lights to which the insects are drawn. The birds are often seen around the lights of baseball and football fields and mall parking lots.

Nighthawks are easy to identify in flight because of their long pointed wings and slightly forked tails. Other diagnostic features are the white wing bars located midway on the wing and across the tail in males. The male and female nighthawks are sexually dimorphic. In addition to the white wing bars, males have a white throat patch and females have a buff colored throat patch. Female nighthawks do not have a tail band.

The nighthawk has a short, buzzy call that is often referred to as a nasal sounding *peent.* It is similar in size to the Whip-poor-will (*Caprimulgus vociferus*), another caprimulgrid found in eastern North America, but has a larger wing span. The Common Nighthawk was chosen for study because it is easy to identify and very visible when migrating. In flight, the bird's wingbeats are slow enough to count and are not as rapid as those of Chimney Swifts (*Chaetura pelagica*) or Barn Swallows (*Hirundo rustica*). The nighthawk flies mostly in the early evening but is sometimes seen at midday or at night.

Nighthawks can be found in open woodlands, clearings, fields, and towns. They may be observed roosting in trees, on fence posts and flat roofs, or they may be seen flying overhead. The legs of the nighthawk are short and weak so, when resting in trees,

nighthawks usually rest lengthwise along the limbs. Nighthawks nest on the ground but they do not build a nest. They are known to nest on the forest floor, blending in with their surrounding environment. Often they lay their eggs on gravel roofs and burned areas, thus the nickname burnt-land bird. The nighthawk usually lays only one or two eggs, but clutches with three eggs have been observed. The eggs are cream to pale greenish-gray and are speckled so that they blend in with the forest floor or a gravel roof on which they are laid. The camouflaged eggs are difficult for predators to see. The eggs are incubated for approximately nineteen to twenty days (Reilly 1968). Chicks are born with their eyes open and are covered with down. They remain in the nest and are fed by their parents. Nighthawks take their first flight at about three weeks of age.

Although much is known about the life history of the Common Nighthawk, little quantitative data is available on nighthawk migration. Lincoln (1950) writes that nighthawks, as well as other birds, start their migration while the food supply in the North is still relatively high. Thus, scarcity of food does not motivate migration. Nighthawks feed as they migrate in circling flocks, while gradually working southward in late summer. They do not fly in the company of other types of birds. Although nighthawk migration is generally a widely recognized event, much remains to be learned about it. This project was designed to gain more knowledge about the migration of nighthawks.

Continuous monitoring of birds is important for the study of population changes and trends. Dunn (1995) writes that it is crucial to have more monitoring to collect independent data to compare with Breeding Bird Surveys. "Without monitoring we are unable to document long-term change, to determine whether short-term fluctuation is

within a normal range or to evaluate the effectiveness of management" (Dunn and Hussell 1995). Migration counts are important because they can provide information that cannot be gained through breeding bird censuses and counts. "Habitat-specific surveys could miss large-scale population changes resulting from shrinkage in the total amount of habitat available while migration counts would detect such changes" (Dunn and Hussell 1995). Through monitoring of bird migration, population sizes of species can be determined as a way to measure the health of a species. Changes in population sizes or in population trends may be correlated with changes that are occurring in the avian habitat.

Gamebirds have been monitored for many years because of the importance of hunting as a recreational activity. However, non-game land birds "have not usually been the focus of management activities" (Ralph et al. 1993). Greater attention is now being placed on the status of landbirds. Neotropical migrants such as the Kentucky Warbler (*Oporornis formosus*), Wood Thrush (*Hylocichla mustelina*), and Red-eyed Vireo (*Vireo olivaceus*) are of special importance because they are environmental indicators of the health of the habitats in which they live.

Generally, neotropical migrants winter in Central and South America and breed in North America. "Well over half of the species of landbirds that breed in temperate North America spend the nonbreeding season at tropical or subtropical latitudes. These neotropical migrants commonly make up 65-85% of the individual breeding birds in eastern North American forests" (Askins et al. 1990). As the summer and winter habitats of these birds are altered, or destroyed for agriculture, development, or urbanization, bird

abundances also change. It is believed that the numbers of landbirds are decreasing due to habitat changes in North America and throughout Central and South America. According to Robbins et al. (1989), analysis of data from the North American Breeding Bird Survey shows that most of the neotropical migrants that breed in the eastern United States and Canada have been declining in numbers since 1978.

The decreases in bird numbers may be due to changes in the breeding habitat in North America, changes in the winter habitat in Central and South America, or both. The changes in habitat may be a change from a diverse environment to a monoculture, complete destruction of the forest or vegetation, or fragmentation of a forested area. Askins et al. (1990) write, "The Greater Antilles, Mexico, Central America, and northern South America, where the greatest concentrations of migrants occur, are also among the areas with the highest rates of deforestation." The rate of tropical deforestation has been increasing at an alarming rate. Estimates of annual tropical deforestation range from 1-4.5% (Robbins et al. 1989, Askins et al. 1990). The primary reason for deforestation is agriculture. Approximately 90% of tropical forests clearing are for dairy and beef cattle farming (Askins et al. 1990). In addition to being cleared for cattle ranching, the forest is cleared for subsistence farming by many poor individuals and families in the less developed countries. The forests are cleared for the planting of economic goods such as coffee, cacao, bananas, cotton, sugarcane, melons, and palms for oil. This switch from diverse forest habitat to monocultural environments affects birds in their ability to find food and shelter from predators. Monocultures typically support fewer bird species than the natural habitats they replace.

Deforestation, whether in the tropics or in the United States and Canada, is a problem for many animals, especially birds, because they need vast areas of forest habitat during the breeding season. Forest fragmentation results in greater amounts of exposed edge. An "edge" is any place where different types of vegetation come together, for example where forest meets a field. In these ecotones, the areas where the blending of the zones occurs, an increase of exposed edge leads to an increase in predation and parasitism of birds and their incubating eggs. Generally, neotropical migrant birds raise one brood each season, have a small clutch size, and have open nests, which for many species are on the ground (Robbins et al. 1989, Terborgh 1989). For these reasons, breeding birds in deforested and fragmented areas are extremely vulnerable to predators. Predators such as raccoons (*Procyon lotor*), skunks *(Mephitis*, sp.), opossums (*Didelphis virginiana*), Blue Jays (*Cyanocitta cristata*), and domestic house cats (*Felis silvestris*), can more easily find nests on the ground and those on low branches of trees due to the increased amount of exposed forest. Examples of ground nesters include the Common Nighthawk, Whip-poor-will, Black-and-white Warbler (*Mniotilta varia*), and Ovenbird (*Seiurus aurocapillus*). Terrestrial nests and open arboreal nests are more vulnerable than those found within cavities of trees.

In addition to exposing eggs and young to predators, increases in forest fragmentation account for increased parasitism by Brown-headed Cowbirds (*Molothrus ater*). These birds, which feed in open habitats, lay their eggs in other bird species' nests. They often knock the other species' eggs out of the nest in order to make room for their own eggs and also to fool the owners of the nest. The "foster" parents then raise the

young as their own. It is believed that cowbirds parasitize up to 200 different bird species (Terborgh 1989). The more edge there is around the forested area, the more nest parasitism is seen.

Deforestation is thus a leading hypothesis for decreases in bird abundance. There may be other causes, separate from or combined with deforestation, causing decreases in bird populations. These may include natural fluctuations, disease, increased predation due to increases in predator populations, weather extremes, decreases in food supply, and subtle or slight changes in habitat. A habitat may change during the season when the migratory species is in another place. For example, forests in the northern hemisphere may be cut while the birds that breed there are wintering in South America.

There may be other factors affecting bird health and population. Agricultural pesticides decrease the number of insects and also decrease the diversity of insects on which many birds feed. Destruction, reduction, or changes of natural ponds and streams also affect insect populations. And finally, overuse of land for agriculture and industry may change the habitat in such a way that insects are unable to reproduce. Any action that decreases insect populations, or seed and nectar availability, will negatively affect many birds' diets. Studies are now focusing on determining which species are declining in abundance, reasons for the declines, and what habitats have been affected the most. Butcher et al. (1993) write, "It is vital that all agencies inventory their lands to measure presence, distribution, and relative abundance of neotropical migrants in specific habitats in all seasons."

For hundreds of years individuals have been watching and identifying birds for

enjoyment. Many people watch birds only as a hobby, but every aspect of bird life is studied by professional ornithologists. Through the years, much information about the life histories of many bird species has been recorded. Checklists have been compiled for many areas to summarize the variety of species present while many varieties of bird counts are used to determine the number of birds in an area. Checklists have been in existence for many centuries but more detailed "systematic record-keeping only became widespread in the last several decades" (Dunn 1995).

Checklist data is important because it gives initial information on whether a species is present in a given location and also when it is present. Timing of migration and the speed at which migrants travel from their winter home to summer home may also be estimated from checklist data (Dunn 1995). Data collected from checklists over many years may reveal increases or decreases in bird numbers. Though checklists are invaluable to bird study, monitoring programs offer more information, such as seasonal and daily timing of migration, migration patterns in relation to weather, and migration in relation to biogeography. Record keeping or monitoring can be done in a variety of ways to study bird abundance, migration, and habitats. Monitoring programs for birds are important because more accurate knowledge of the status of birds can provide a better indication of environmental conditions.

There are many different methods for monitoring landbirds. Monitoring birds using various count methods increases our knowledge of migration, competition, community ecology and structure, population dynamics, ability to adapt to the environment, and effects of habitat changes caused by man (Scott and Ralph 1981).

Monitoring programs serve a variety of purposes. Data collected may be an aid in estimating population size (abundance) and trends and determining demographic parameters. Information collected may also correlate habitat status of various species of birds to their population sizes and trends (Ralph et al. 1993). The majority of these programs depend on the participation of volunteers for the collection of data. Participants record data, often on a daily basis, and the information is then collected and entered into a data base.

A few of the more well-known monitoring programs in the United States are the North American Breeding Bird Survey, the Audubon Christmas Bird Count, the Breeding Bird Census, and spring and fall hawk migration counts. The North American Breeding Bird Survey (BBS), which began in 1966, was established by Chandler Robbins, of the Migratory Bird Population Station in Laurel, Maryland (Sauer et al. 1997). It is sponsored by the U.S. Fish and Wildlife Service. The survey, which is conducted annually in late May or June, is performed by volunteers who collectively travel approximately two thousand random routes, each 24.5 miles long, during the breeding season. The survey requires participants to make fifty three-minute stops which are 0.8 km (0.5 mile) apart. At each stop the volunteer records all bird species seen or heard within 1/4 mile of the stop. The operation starts at exactly one half hour before the local sunrise. Preferably, the same observer performs the count on the same route each year to "maintain continuity of data" (Sauer and Droege 1992). The information collected is entered into a database and used to describe species' distributions and to prepare indices of relative abundance of breeding birds. Data have been collected from more than three

thousand BBS routes in the United States. Population changes and trends are also studied from the data collected.

There are several problems associated with the Breeding Bird Survey. Since the study is conducted along roads, which are usually located on higher ground, it is biased in the habitats surveyed. Habitats that are often not included are marshy and swampy areas and deep forests. Roads generally pass through urban, suburban, and agricultural areas, but rarely do they go through large tracts of forest. Another problem relating to the survey is the changing of roadside habitat from year to year. Increases and decreases in agricultural and urbanization are observed. As the habitat changes so do the population trends of certain birds. For example, roadside fields that are left to grow over will lead to increases in some birds and decreases in others. Terborgh (1989) refers to this as an "uncontrolled bias."

The Audubon Christmas Bird Count (CBC) is the oldest bird census in North America (Bock and Root 1981) and its data base is the longest record of bird populations in North America. The first CBC was conducted in 1900 in New York City's Central Park by Frank Chapman and Charles Rogers. Twenty-six individuals participated in the first CBC; during the 1995-1996 season there was a total of 45,000 participants who worked on one thousand six-hundred ninety-two CBCs (USGS 1997a). Birders make their counts on a single, preselected day during the two weeks before or after Christmas. The goal of the count is to observe as many bird species and numbers of birds as possible. The location of the count is chosen by the observers, but the area surveyed must be within a 7.5 mile radius around a central, specific location. Information recorded includes the

location in latitude and longitude, lists of species and number of each species, number of observers, and the total numbers of party-hours and party-miles covered, which act as an index of effort. Weather information and the vegetation of the habitat are also recorded. This information is gathered from each group participating by a compiler, who forwards it to the National Audubon Society. In recent years some groups have been conducting winter bird counts using CBC methods, but not submitting their data due to fees now charged to participants by the National Audubon Society. The purpose of the CBC is to determine winter distribution patterns and population trends (USGS 1997a).

The Breeding Bird Census (BBC), first proposed by British ornithologist H.E. Howard in 1920, estimates breeding bird densities in selected habitats. The standardized BBC technique was not fully developed and used until the 1940s (Terborgh 1989). BBCs are long-term studies aimed at improving our understanding of changes in distribution and abundance patterns of avian communities (USGS 1997b). Study plots, with a minimum size of ten hectares in closed habitats and forty hectares in open habitats, are set up within a single habitat type. Information is collected on the vegetation in the habitat and bird locations are mapped to estimate population densities of each species present in the plot. Censuses are repeated several times in a season to distinguish between resident breeding birds and transients. The objective of the study is to know exactly how many pairs of breeding birds there are on the plot and what species they are.

According to the instructions for the BBC by the Cornell Laboratory of Ornithology, observers accurately plot the locations of individual birds by gridding the plot and creating a map with the grid points and prominent topographic features, such as a

stream or a large rock. This is called the spot-mapping method. The date, start and end times, temperature, and wind speed are recorded each day of observation. The plot is surveyed, marking the location of birds as they are seen or heard. Birds flying over the plot, not using it, are not included (Robbins 1970). Population density is stated as number of stationary males or mapped territories per ten hectares or per square kilometer. Engstrom (1988) writes that the BBC is "good for measuring relative abundance of birds over a period of years, especially if a census is repeated carefully be the same observer."

Another program is the EPOQ (*Etude des Populations d'Oiseaux du Quebec* or Studies of Bird Populations in Quebec). The study, which was started in the 1950s, has data from 158,000 checklists from 3600 observation sites (Cyr and Larivee 1993). The checklists, filled out by volunteers on a daily basis, include data on any bird species seen or heard in Quebec. The date, duration of observation (with start and end times), and name of site or distance and direction to a nearby locality or geographical feature are also reported on the checklist. "The calculation involved in evaluation of long term trends is based on the ratio of total number of checklists containing species over the total number of checklists reported" (Cyr and Larivee 1993).

The study of hawks by counting and banding dates back to the 19th century. Systematic counts began in the 1930s at Hawk Mountain, Pennsylvania and in 1976 continuous seasonal hawk counts began at Cape May Bird Observatory in New Jersey. By the mid-1970s hawkwatching was popular throughout North America and the Hawk Migration Association of North America (HMANA) was formed (Kerlinger 1989). Hawkwatching programs take advantage of the obvious diurnal migrations of hawks and

the natural appeal of raptors to many observers. Hawkwatching takes place not only in the United States, but also in Europe, Israel, Egypt, and other countries.

Hawk Mountain is located along Kittatinny Ridge in the Appalachian Mountains of eastern Pennsylvania. In September 1933, Hawk Mountain Sanctuary was founded by Rosalie Barrow Edge as a refuge to protect birds of prey. Throughout the early 1900s many birds of prey, such as hawks, falcons, and eagles, were killed by hunters and farmers. In 1929 the Pennsylvania Game Commission offered a bounty of $5 per goshawk killed between November 1 and May 1 (Brett 1991). Hunters usually shot first and then identified the birds. These practices were often ignored by game wardens. Raptors are now protected in North America by the 1972 Migratory Bird Treaty Act. In September 1934 the first raptor migration count was conducted at Hawk Mountain by Maurice Broun, the first curator of Hawk Mountain, and his wife Irma. Today, an average of 20,000 raptors is observed between August 15 and December 15 each year at Hawk Mountain Sanctuary.

Another site of interest for hawkwatchers is Cape May Bird Observatory (CMBO) in New Jersey. At Cape May, averages of 50,000 to 80,000 raptors are observed each fall season (Conner 1991). One suggestion that may explain why Cape May has high numbers of migrating birds is that it acts as a funnel to concentrate migrant birds flying south. The topographic features of the area, which direct the migrants down to Cape May, are the Delaware Bay shore on the west side and the Atlantic Coast on the eastern side. The migrating birds often stop to rest and feed on the point of the cape, or wait for better weather, before flying the fourteen miles over water to reach Delaware. Regular

annual counts at Cape May began in September 1976, but season-long counts had occurred sporadically since the 1930s (Connor 1991).

In 1974 the Hawk Migration Association of North America (HMANA) was founded to gather data on hawk migration from hawkwatching stations throughout the United States. HMANA monitors raptor populations during migration through the collection of data by volunteers. Observers watch from points that are usually along leading lines. The leading line or *Leitlinie* was first defined by H.F. Geyr in 1929. A 1963 definition describes them as "topographical features, usually long and narrow with characteristics that induce migrating birds to follow them. The birds are influenced by these lines in choosing their direction of flight, being so to speak, led by them." (Mueller and Berger 1967). Topographic features that form leading lines are mountain ridges, rivers and valleys, coastlines, and peninsulas. Leading lines can also be boundaries between suitable and unsuitable habitats for migrating birds. Factors that influence a bird's usage of a leading line are how straight the line is, how prominent a feature it is, the length of the line, the relationship of the leading line to the bird's origin and destination, and whether the line is continuous and unbroken by other topographic features (Mueller and Berger 1967).

Bird migration begins across their range but as birds move southward they arrive at prominent topographic features, sometimes by wind drift, and continue to follow them southward. These topographic features act as leading lines funneling and concentrating migrants together. Raptors tend to concentrate along mountain ridges because of the updrafts created by wind striking the edge of the ridge and rising up and over it. This

allows birds to rise up, as on thermals, to conserve energy. With the updrafts hawks and other raptors can fly farther without losing as much altitude. Migrants tend to move along seacoasts because they dislike flying over water.

Hawkwatchers look for raptors from early morning to late afternoon with binoculars and unaided eye, recording the species and number of migrants passing over each hour or half hour. The observer enters only the number seen (no zeros). Observer names, the location, count leader, month, day, and year are listed on the form. Other data are recorded on the standard HMANA form (see Appendix III).

According to the HMANA methodology, hawkwatchers record the meteorological conditions (wind speed, wind direction, and sky conditions) according to the Beaufort scale. Weather conditions are entered for the first hour of observation, and only in following hours if the data changes. Wind speed is recorded by entering a code for the range as L for light winds (0-7 mph), M for moderate winds that move tree branches constantly (8-12 mph), and so on. The compass direction that the wind is coming from is entered as N, NNE, NE, etc. Temperature is recorded in degrees Celsius and cloud cover is entered as the percent of sky with background cloud cover. Visibility is also entered as a code, such as VH for very hazy (see less than 2 miles). The direction in which the migrants are headed is recorded as N, NNE, NE, etc. and the height of flight overhead is recorded as L for low (up to 100 feet), etc. The number of observers participating in the count is entered and the duration of the observation is recorded in tenths of an hour (.5 for 30 minutes). Humidity is entered as a percentage and the barometric pressure is entered in inches. Other notes and comments may be written on the back of the sheet. Rare birds

seen are recorded on the back or bottom of the sheet by listing the species, number observed, and the hour observed.

Report forms are filled out daily and sent to a regional editor who verifies that the forms are filled out completely and properly (Fuller and Titus 1990). Finally, the reports are sent to HMANA's central data bank and kept on file. In addition to counting hawks, hawkwatchers, working at stations where there is contact with the public, talk to and educate visitors, both birders and nonbirders, about bird identification, bird migration, and other wildlife. Some hawkwatchers work in remote areas.

Weather is an important factor in hawk migration. Weather is known to contribute to initiating migration but it may also delay or stall migration when it is unfavorable to birds. Certain factors and weather conditions are associated with large movements of raptors and passerines along mountain ranges during the fall migration. Lack (1960) was the first to publish weather correlations with migrations. He writes, ". . . most migration in the U.S. occurs with cold, northerly winds, especially with the passage of a cold front." In addition to Lack's observations, other authors have agreed that the weather conditions influencing migration are northerly or westerly winds which often blow for two to three consecutive days, cold fronts that move down from the Great Lakes or Canada, and the recent passage of a low-pressure system. Decreasing temperatures, rising barometric pressure, and decreasing humidity also play a role in large movements of migrants. Factors affecting the migration flight of birds are wind direction and wind speed, visibility, cloud cover, precipitation, temperature, humidity, atmospheric stability, and turbulence (Lack 1960, Richardson 1978, Brett 1991).

Strong winds and rain are unfavorable because birds are unable to navigate in bad weather. They may become disoriented by rain, fog, or mist. High winds may blow a bird off course, out to sea, leaving the bird with only a small amount of reserve energy. Heavy rains may weigh the bird down and may cause the bird to lose the waterproofing qualities of its feathers (Richardson 1978). Rain combined with wind can also force birds to the ground. Heat loss can take place when a bird is drenched or humidity is extremely high or low. Furthermore, insects and other food sources for birds are decreased in this type of weather, often delaying or stalling migration.

The Nighthawk Migration Monitoring Program (NMMP) adopted many of these procedures in designing a monitoring program for the Common Nighthawk. It is believed that nighthawks are declining in many parts of their range and are no longer seen in some areas where they once bred (Petersen 1980, Buckelew and Hall 1994, Scott 1995). The EPOQ study has shown a negative trend with the Common Nighthawk where there have been decreases in the numbers of nighthawks in Quebec (Cyr and Larivee 1993). Quantitative data has not been collected to determine the areas in which the nighthawk is no longer seen and to what extent nighthawks have declined. Exact reasons for the decline are not known.

In the late 1800s the numbers of nighthawks were dramatically decreased due to hunting for sport and food. Wetmore (1927) writes,

> "Formerly these birds were far more abundant than at the present, and for many years it was usual to shoot them in wanton sport, especially during their autumn flights, . . . The birds were killed by the thousands and became reduced in numbers, since they rear but one brood with a maximum of two young each season, and were unable to withstand the

> excessive drain upon their numbers by the constant shooting to which they were subjected."

The killing of nighthawks was halted through laws and through education by the National Association of Audubon Societies and other groups. Even though the killing of nighthawks has stopped the greatest enemy of the Common Nighthawk is still man.

The primary purpose of any monitoring program is to learn about status and trends of a given population (Ralph et al. 1993). Bird migration monitoring is important because the data are added to an international goal to determine if changes are occurring and what they may be in migratory populations. He goes on to write that the best way to gather this data is through a migration count that can be used over a long period of time to survey populations. Before the initiation of the NMMP there were no monitoring programs for the Common Nighthawk, though the suspected decline indicates a need for monitoring of the species. For instance, Hall (1983) writes that there has been no censusing of nighthawks in West Virginia, and the authors of the West Virginia Breeding Bird Atlas (Buckelew and Hall 1994) stress, "Because of its history of declining populations, the Common Nighthawk should be watched carefully, and surveys should be organized to monitor populations in West Virginia." The goal of the Nighthawk Migration Monitoring Program is to use data gathered by volunteers to determine more about the migration of the Common Nighthawk; just as volunteer-gathered data have greatly improved our knowledge of hawk migration. Some goals of the Nighthawk Migration Monitoring Program are to correlate weather patterns with nighthawk migration, to investigate the use of leading lines by migration, and to determine time of

day for peak flight and whether this varies through the year or from year to year.

As a neotropical migrant and insectivore, the Common Nighthawk has potential value as a monitor of environmental conditions. There are many things that are not known about nighthawk migration. By beginning this program it was hoped that several things about the fall migration of nighthawks could be determined. Time of day for peak flight for the nighthawk was to be determined along with whether the peak flight varies through the migration period and if it varies from year to year. Another item of investigation was to determine whether the Common Nighthawk migrates primarily by leading lines or broad front.

A major goal of the program is to determine whether the nighthawk is decreasing in numbers. Quantitative studies of nighthawk population may reflect changes in the environment. If the number of nighthawks is decreasing, then their summer or winter habitats may be changing in some way. Their food supply of insects may be affected by pollution or pesticides. Other factors possibly affecting population numbers of nighthawks are increased stress on migration routes or changes of their breeding habitats or nest sites. According to Bibby et al. (1992), "Trends in numbers over time are of particular interest to nature conservation." It will be impossible to determine this from one year's data but rather a continued study over several years may be able to answer these questions.

Finally, during the first year of the monitoring program it was hoped that flaws in the Nighthawk Migration Monitoring Program technique could be detected. Thus the 1997 NMMP was initiated so that valuable data could be gathered, but during which time

the program itself could be refined to enhance its long-term value.

METHODS

The Nighthawk Migration Monitoring Program (NMMP) was modeled after HMANA's hawkwatching methodology, because, like hawks, the nighthawk is a visible, diurnal migrant. The NMMP used volunteers from the state of Virginia to perform daily counts and to record weather data on the Nighthawk Count Report Form (see Appendix II). To enlist volunteers, a brochure was designed (see Appendix I). The brochure describes the program and the purpose of the study. On the cover of the brochure is the title of the program, a picture of a nighthawk in flight, and the statement that it is a project of the Graduate Program in Environmental Studies at Longwood College. Reasons for choosing the nighthawk for study and some of the distinguishing characteristics of the bird are included on the inside, left panel. The four goals of the program are listed beside bullets on the same panel. The goals listed are to count migrant nighthawks, to make year to year population comparisons possible, to correlate weather patterns with nighthawk migration, to investigate the use of leading lines by migrant nighthawks, and to determine the time of day for peak flight and whether this varies through the year or from year to year. More facts about the Common Nighthawk are on the back of the third panel. Common names for the bird, its call and diet, its range, when it is commonly seen, and where it breeds are mentioned on the panel and a drawing of North and South America is included.

A description of the procedures for the program and a silhouette of a nighthawk resting on a fence post are on the center panel. Participants asked to help in the count included professional ornithologists, birders, and beginning birders. Anyone who has a

love for birds and the ability to identify nighthawks was welcomed and encouraged to participate. Those who decided to participate could fill out a form that was included on the right side panel and return it to the NMMP address listed. The form included the participant's name, address, city, state, zip code, and daytime phone. There was also a place for the volunteer to check if he or she is a member of a bird club and, if so, which one. The NMMP phone number, e-mail address, and web address were listed on the bottom of the inside, right panel.

A web page was created for the program and linked to the Longwood College home page. Those interested could view the page at *http://www.lwc.edu/academic/LAS/Science/nighthwk.htm*. The web page is similar in content to the brochure. An e-mail address, *nighthwk@longwood.lwc.edu*, was established for correspondence with clubs and individuals who had questions or comments.

I enlisted volunteers by speaking at the Virginia Society of Ornithology's annual meeting at Windmill Point in Lancaster County, Virginia in May 1997. At that time I passed out brochures and wrote down names and addresses of those expressing interest in participating in the program. At the end of July 1997, a letter was written to birders telling about the program and explaining what was required of participants and how to participate (see Appendix I). Included with the letter were a Nighthawk Count Report Form and the NMMP Instructions for Daily Report Forms (see Appendix II). Packets were sent to the 24 Virginia chapters of the Virginia Society of Ornithology and to individuals who had requested them.

Observers began counting migrant nighthawks in mid-August 1997. As with hawkwatching, observers recorded the numbers of nighthawks seen and other weather data on the Nighthawk Count Report Form. Daily counts were repeated at the same location. Instructions for Daily Report Forms gave a detailed description for filling out the Nighthawk Count Form (see Appendix II). One data sheet was used for each day's observations. The form was to be filled out as completely as possible. All observer names were recorded at the top of the sheet. If observers changed locations during any one day, or if the group split its operation to cover the passage of nighthawks from more than one vantage point at a time, then a separate form was to be used for each post. The location was recorded by giving the observation site a distinct name which would separate it from any other observation site. An example is "meadow, Sailor's Creek Battlefield, Amelia County, VA." The nearest town or prominent map feature, county or township, and locality name was recorded. Locality name is a common name such as Jones Marsh or Smith Meadows. The state was entered by abbreviating with capital letters. The latitude and longitude were recorded to the nearest minute if known.

Field of view was entered by estimating the percentage of the sky visible from where the observer was performing the count and checking the appropriate line. Options for field of view were 0-25%, 25-50%, 50-75%, and 75-100%. An area where the entire sky could be seen would be checked as 75-100%, while an area with complete coverage such as a forest would be recorded as 0-25%. Observers were also asked to indicate, by checking yes or no, if nighthawks are known to breed within one mile (1.6 km) of the observation site. If so, the observer was to estimate the number of breeding pairs.

The start time and end time of the day's count were entered on the appropriate lines. Temperature was entered in degrees Celsius. The direction toward which the birds were moving when they were directly above or to the side of the count point was recorded on the line for Direction of Flight as N, NE, S. If different birds followed markedly different courses, the variations could be noted on the back of the form.

Wind speed, wind directions, and sky conditions were recorded for the first fifteen minutes of observation. For the following fifteen minute blocks the weather code was entered only if the data changed. Wind speed was entered in the appropriate WS/WD (wind speed/wind direction) box. Wind speed was described by using the numerical codes from the table on the back of the instruction's sheet. These were based on the Beaufort wind scale. A zero was recorded for winds less than one km/hour (smoke rising vertically), a six for winds at 39-49 km/hour (25-31 m/h), observed as larger branches in motion and/or whistling heard in wires and 1 to 5 for rates in between. Wind direction was determined by using a flag or strip of ribbon and entered as an abbreviation, i.e., N, NE, S, in the appropriate WS/WD box. Wind direction was determined at the count site and not recorded from radio or television information because they may not be the same. Sky conditions were observed and recorded using the scale on the back of the instruction sheet that best described the predominant condition. If no code appropriately described the current conditions then a "C" was marked in the appropriate box and a description was written on the back of the form.

Time from 2:00 p.m. until 9:30 p.m. was divided into fifteen minute blocks, for example 2:00-2:15. The number of nighthawks seen was recorded in the appropriate

fifteen minute block. If zero birds were seen, then a zero was recorded. Blocks were left empty for the time that the observer was not in the field. If large flocks prevented accurate counts, then an "e" was recorded after the estimated total, e.g., 200e. Any unusual sightings such as large flocks were noted on the back of the report form with information about the time of appearance and disappearance, numbers, and behavior. Anything else the observer thought was unusual or noteworthy was recorded on the back of the report form.

The instruction sheet also mentioned what equipment and supplies which could be brought to the field such as topographic maps for locating new lookouts and for finding the latitude and longitude of the observer's location. Other equipment listed were a watch, a pencil, and a thermometer. In addition, it was suggested the observer bring a strip of ribbon or flagging tape to determine wind direction.

Daily report forms were filled out by observers during the fall migration of the Common Nighthawk and returned to the NMMP at Longwood College at the end of the season. The data were collected and analyzed to determine the total number of nighthawks seen, correlations to weather, use of leading lines by migrating birds, and time of day for peak flight.

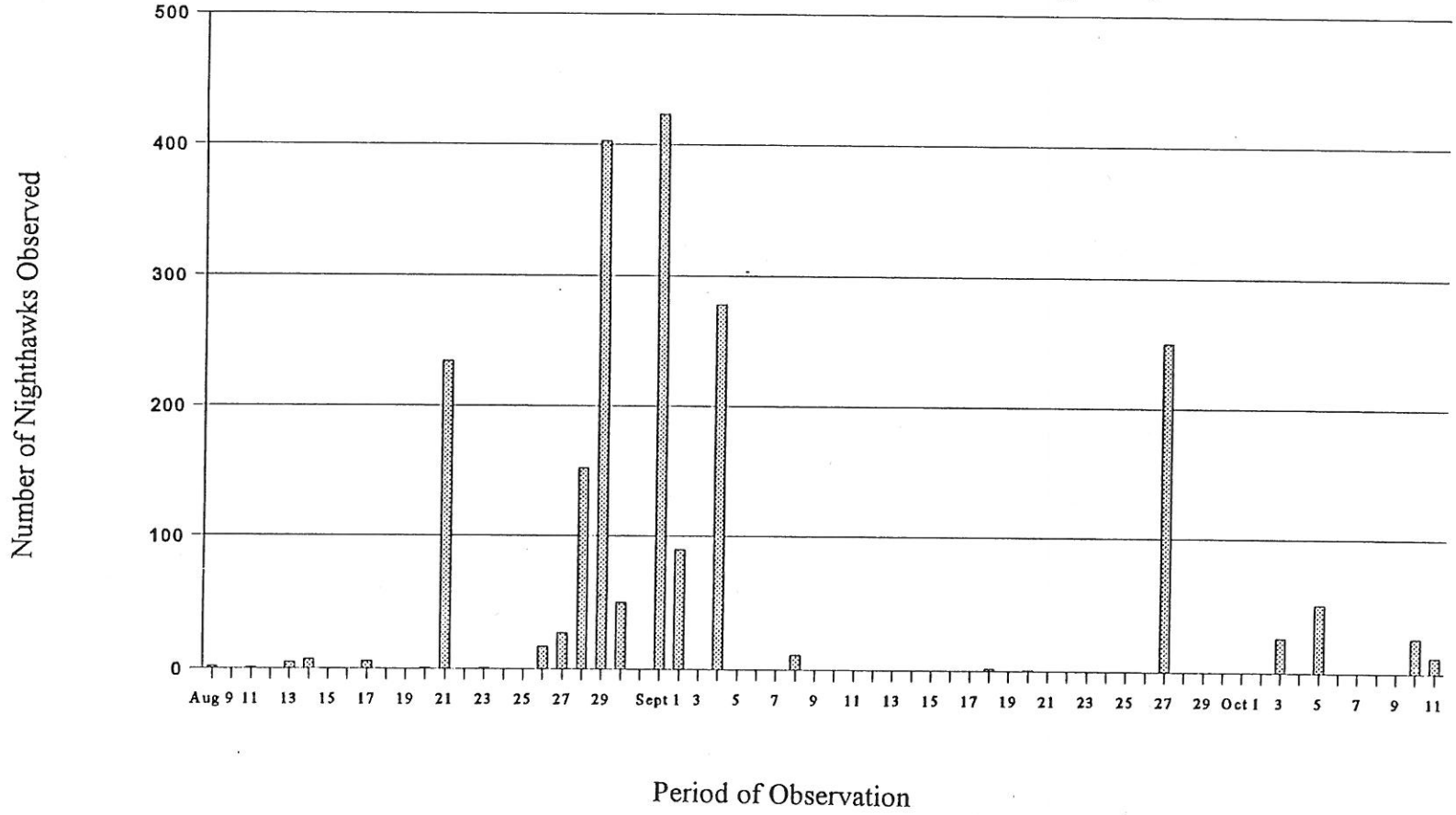
RESULTS

A total of 2107 nighthawks was observed in the 1997 Nighthawk Migration Monitoring Program. Fifty-three data sheets were returned by participants (Table 1). Nine individuals participated in the count with a total of 67.15 hours of observation. Data collection began on August 9, 1997 and ended October 11, 1997. Data were collected thirty-four days from ten separate observation sites, all in the state of Virginia. The locations were Charlottesville, three sites in Callaway (Franklin County), Rocky Mount (Franklin County) two sites in Farmville, Rice, Prospect (all in Prince Edward County), and Bluefield. Peak time of migration for the season was from August 26 to September 4. Nighthawks were seen every day during this period except for August 31 and September 3, (Figure 1; see page 33).

TABLE 1 NUMBER OF NIGHTHAWKS REPORTED ON DATA SHEETS

DATE	NUMBER OF SHEETS RETURNED	NUMBER OF NIGHTHAWKS OBSERVED	DATE	NUMBER OF SHEETS RETURNED	NUMBER OF NIGHTHAWKS OBSERVED
August 9	1	2	August 29	2	403
August 11	1	1	August 30	1	50
August 12	1	0	August 31	1	0
August 13	2	5	September 1	2	424+
August 14	1	7	September 2	2	90+
August 16	1	0	September 3	1	0
August 17	3	6	September 4	2	278
August 18	2	0	September 8	1	11
August 19	1	0	September 18	1	2
August 20	2	1	September 20	1	1
August 21	1	234	September 27	1	250
August 22	3	0	October 1	1	0
August 23	2	1	October 3	1	26
August 24	2	0	October 5	1	51
August 26	2	17	October 7	1	0
August 27	3	27	October 10	1	26
August 28	4	152	October 11	1	12
+number too large to count					
TOTALS				53	2107

Figure 1 Migrant Nighthawks Observed in Virginia, Fall 1997



Participants were in the field as early as 12:30 p.m. Eastern Standard Time (EST) and as late as 10:30 p.m. EST. Collectively, volunteers began observing in the field five hours and forty-five minutes before sunset and ended observing one hour and fifteen minutes after sunset (see Table 2; page 35). The earliest time that a nighthawk was observed was 5:00 p.m. EST and the latest time of the day was 8:30 p.m. EST, with the exception of one nighthawk seen in the early afternoon at 12:30 p.m. EST.

Nighthawks were observed on twenty-four of the thirty-four days, with zero nighthawks seen ten out of thirty-four days. They were observed as early as two hours and forty-five minutes before sunset and as late as thirty minutes following sunset. The greatest number of nighthawks, one thousand three-hundred eighty, was observed during the 15-minute block including sunset (Figure 2), with the largest concentration of birds in the 1.5 hours before sunset.

Figure 2 Number of Nighthawks in Relation to Sunset

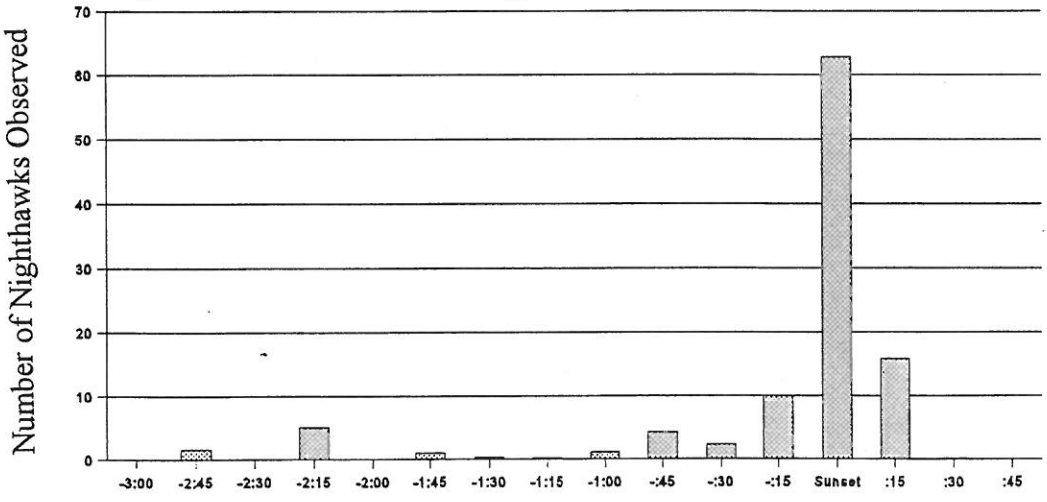


TABLE 2 NUMBER OF NIGHTHAWKS OBSERVED IN RELATION TO SUNSET

TIME	NUMBER OF NIGHTHAWKS SEEN	NUMBER OF INDIVIDUALS OBSERVING	NUMBER OF INDIVIDUALS SEEING BIRDS	NUMBER OF BIRDS SEEN/TOTAL NO. OF INDIVIDUALS.
-6:00	0	0	0	0.00
-5:45	0	1	0	0.00
-5:30	0	1	0	0.00
-5:15	0	1	0	0.00
-5:00	0	1	0	0.00
-4:45	0	1	0	0.00
-4:30	0	2	0	0.00
-4:15	0	1	0	0.00
-4:00	0	1	0	0.00
-3:45	0	1	0	0.00
-3:30	0	2	0	0.00
-3:15	0	1	0	0.00
-3:00	0	3	0	0.00
-2:45	11	7	1	1.57
-2:30	0	10	0	0.00
-2:15	95	19	2	5.00
-2:00	0	19	0	0.00
-1:45	17	18	5	0.94
-1:30	5	20	3	0.25
-1:15	4+	24	3	0.17
-1:00	21	19	3	1.11
-00:45	76	18	8	4.20
-00:30	47++	21	6	2.24
-00:15	180	18	6	10.00
SUNSET	1380	22	11	62.73
00:15	269	17	4	15.82
00:30	1	8	1	0.13
00:45	0	5	0	0.00
1:00	0	4	0	0.00
1:15	0	2	0	0.00
1:30	0	0	0	0.00
1:45	0	0	0	0.00
2:00	0	0	0	0.00
2:15	0	0	0	0.00
2:30	0	0	0	0.00
2:45	0	0	0	0.00

+could not count, dozens ++too many to count

Migrant nighthawks were first seen on August 9 in Callaway (Franklin County), Virginia at N37 degrees latitude, W80.5 degrees longitude. The last day nighthawks were observed was on October 11 at N38 degrees, W78.5 degrees in Charlottesville, Virginia. The largest number of nighthawks was seen on August 29, also in Charlottesville (see Table 3; page 36).

TABLE 3 LOCATION OF NIGHTHAWKS ON A GIVEN DATE

DATE	NUMBER OF BIRDS SEEN	LATITUDE DEGREES (N)	LONGITUDE DEGREES (W)
August 9	2	37.0	80.5
August 11	1	37.0	80.5
August 13	5	37.0	80.5
August 14	7	37.0	80.5
August 17	6	37.0	80.5
August 20	1	37.0	80.5
August 21	234	38.0	78.5
August 23	1	37.0	80.5
August 26	17	37.3	81.3
August 27	7	37.0	80.5
	50	38.0	78.5
August 28	20	37.5	78.3
	7	37.0	80.5
	125	38.0	78.5
August 29	3	37.0	80.5
	400	38.0	78.5
August 30	50	38.0	78.5
September 1	385	38.0	78.5
	39	37.0	80.5
September 2	90	37.0	80.5
September 4	278	38.0	78.5
September 8	11	38.0	78.5
September 18	2	37.3	81.3
September 20	1	38.0	78.5
September 27	250	38.0	78.5
October 3	26	38.0	78.5
October 5	51	38.0	78.5
October 10	26	38.0	78.5
October 11	12	38.0	78.5

The direction of flight for migrating nighthawks is summarized in Table 4; page 37. Direction of flight reported for migrant nighthawks was north, northeast, or northwest for 69% of birds. Due to ambiguity in the instruction sheet, however, it is unclear whether this number represents birds coming from the north or flying toward the north.

TABLE 4 DIRECTION OF FLIGHT

NUMBER OF BIRDS	DIRECTION	NUMBER OF BIRDS	DIRECTION	NUMBER OF BIRDS	DIRECTION
17	SE to W	2	SE	3	W
2	W	150	N	25	W
20	Circling	100	W	10	S
1	SE	23	E	100	N
5	S	50	N	25	N
7	SW	1	W	6	S
1	E	1	N	5	NW
3	S	1	S	1	E
1	SE	1	S	250	N
1	SW	1	S	26	N & NW
1	S	1	NW	1	N
1	S	5	N	16	SW
4	S	102	N	2	W
4	SW	1	SW	2	S
3	-----	3	E	30	S
2	S-SE	2	SW	1	S
3	W	1	NE	3	S
3	N	90	N	1	W
39	SW & NNE+	70	N	1	S
90	E-NE	98	N	20	N
234	N++	2	E	4	N
50	N	5	N	3	E
125	NW	12	N	3	E
100	W	100	S	1	N
25	N	3	E	1	S

+ "flying every where" ++ several moving to west and south

TOTALS:							
N	1322	S	173	E	129	No direction given	3
NW	131	SW	70	W	3		
NE	1	SE	21	Circling	20		

Weather conditions are given in Tables 5 and 6; page 38. Nighthawks were seen migrating in temperatures from 17 degrees Celsius (63 degrees Fahrenheit) to 32 degrees Celsius (90 degrees Fahrenheit). The average temperature on days when nighthawks were migrating was reported as 26 degrees Celsius (79 degrees Fahrenheit). Participants were in the field and nighthawks were observed when wind speeds were 0 to 5 on the Beaufort scale, or approximately zero to thirty-eight kilometers per hour. The wind direction was primarily southeast during large movements of nighthawks, but it is unclear if this refers

to the direction from which the wind is coming or the direction the wind is blowing.

TABLE 5 WIND SPEED IN RELATION TO NIGHTHAWK MIGRATION

WIND SPEED CODE	TOTAL NUMBER OF 15 MINUTE BLOCKS	NUMBER OF BLOCKS WHEN BIRDS SEEN	NUMBER OF BLOCKS WHEN NO BIRDS SEEN	TOTAL NUMBER OF BIRDS SEEN
0	52	13	39	79+
1	51	14	37	498+
2	91	14	77	678
3	35	10	25	326
4	4	2	2	126
5	5	2	3	400
6	0	0	0	0

Observers in the field reported sky conditions of 0, 1, 2, 3 and 6. A sky condition of 0 on the Beaufort scale corresponds to clear skies. Observers were not in the field under sky conditions 4, 5, 7, 8, or 9 (see Table 6). Eighty-three percent, 1,749, of the nighthawks were observed on evenings that were clear with zero to 15 percent cloud cover, or sky condition code 0. Sixteen percent, 336 of the birds, were observed in mostly cloudy weather with 51 to 75 percent cloud cover, or sky condition code 2. The remaining 2 percent, 22 birds, were seen in partly cloudy, overcast skies, or drizzle, sky conditions 1, 3, or 6.

TABLE 6 SKY CONDITIONS IN RELATION TO NIGHTHAWK MIGRATION

SKY CONDITION CODE	TOTAL NUMBER OF 15 MINUTE BLOCKS	NUMBER OF BLOCKS WHEN BIRDS SEEN	NUMBER OF BLOCKS WHEN NO BIRDS SEEN	TOTAL NUMBER OF BIRDS SEEN
0	94	31	63	1749
1	49	6	43	20
2	73	15	58	336+
3	20	1	19	1
4	0	0	0	0
5	0	0	0	0
6	2	1	1	1
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0

Comments recorded on the data sheets by volunteers included types of insects

present on the evenings when nighthawks were seen migrating. Insects noted included flying ants, mosquitos, sweat bees, wasps, honeybees, bumblebees, hornets, biting flies, house flies, beetles, moths, gnats, lightning bugs, butterflies, and dragonflies.

Other sightings of nighthawks were reported for which no data sheets were filled out. Most of these incidental sightings were posted on the Valley Birds e-mail list server. Reports ranged from August 24 to November 25. More than 1,685 nighthawks were seen over seventeen days by nine individuals in nine different cities or counties throughout the southeastern United States, as seen in Table 7.

TABLE 7 INCIDENTAL SIGHTINGS OF NIGHTHAWKS IN SOUTHEASTERN U.S.

DATE	NUMBER SEEN	LOCATION AND COMMENTS
August 24	30	*Memphis, Tennessee
August 25		*Many groups moving through Ellet Valley, Montgomery County, Virginia
August 27	~400	*Bristol, Tennessee
	1	*Memphis, Tennessee
August 30		*Flocks of 25 to 50 moving in every direction, too many to count. Tupelo, Mississippi
August 31	~1200	*Humboldt, Tennessee
September 3	4	*Lynchburg, Virginia
September 4	1	*Lynchburg, Virginia
September 5	13	*Lynchburg, Virginia
September 21	1	*Greenville County, South Carolina
October 6	1	*Lynchburg, Virginia
October 31	1	*Memphis, Tennessee
November 1	2	*Memphis, Tennessee
November 4	2	*Knoxville, Tennessee
November 11	12	*Knoxville, Tennessee
	1	*Huntsville, Alabama
November 18	10	*Knoxville, Tennessee
November 24	1	*Memphis, Tennessee
November 25	5	*Knoxville, Tennessee

Observers reported seeing nighthawks as late as 12:07 a.m. EST, often flying around lights of sports fields, shopping malls, and roadside billboards. Two nighthawks were reported on December 9 and one was reportedly seen on January 17, 1998 in Knoxville, Tennessee. It is unclear whether these should be considered fall migrants;

they may have been injured, juveniles, or present out of season for some other reason.

DISCUSSION

The total number of nighthawks seen by participants in the Nighthawk Migration Monitoring Program was greater than the number of nighthawks reported by incidental sightings. While incidental sightings usually report large numbers of birds and rarely report zero birds, the NMMP data reported a larger total number of nighthawks than incidental reports. NMMP participants recorded the number seen daily which included many days when no nighthawks were seen while incidental reports contained no data on days with zero nighthawks seen. Those regularly observing, even when recording seeing zero nighthawks, may produce larger data sets than sporadic reporting of impressively large flocks.

Although the number of participants was low due to this being the first year of the study, it was a success because amateur and hobbyist birders were the main participants. The continued success of the program will likely continue to depend on these volunteers. The program depended on the work of volunteer birders who were mostly amateurs and naturalists. Of the nine individuals participating only two were professionals and both of these reported seeing zero birds.

Observation sites were located in southwest Virginia, the Blue Ridge Mountains, and also in the Piedmont region of the state. No reports were given for the Coastal Plain, so no conclusions on the relative frequency of migration across the state can be reached. No birds were reported migrating through most of the Piedmont, although nighthawks have commonly been seen in that area of the state in previous years. The concentration of nighthawks reported was near Charlottesville and areas west. This may indicate that

nighthawks were following the leading line of the mountains in those areas, but there are not enough data to conclude this. If more data had been collected equally throughout the state from the Mountain and Valley, Piedmont, and Coastal Plain regions, then a better comparison of the regions could have been made and the use of leading lines by migrating nighthawks determined. Such comparisons will hopefully be possible in future years when more data are generated by the NMMP.

Volunteers returned data from 34 dates with observations every day from August 16 to September 4, except for August 25. These daily observations show that from the middle of August to the beginning of September the number of nighthawks migrating gradually increased, with numbers greater than 400 on two dates only--August 29 and September 1. From the data, the numbers of nighthawks migrating appear to be at their peak in Virginia in the last week of August and the first week of September. Counts were not conducted daily through the end of September, so a reliable comparison of the following three weeks of September cannot be made, though the data show the peak of the migration for the 1997 season to be the last week of August and the first week of September. A reasonable goal for next year's migration count is to better determine the exact peak of migration. Another goal of next season's count will be to record location data of migrant nighthawks early in August and in October and early November, to determine when migration is first evident and when nighthawks completely leave the state.

The clearest conclusion to be drawn from the 1997 data concerns the peak flight time of migrant nighthawks relative to sunset. As the results show, peak flight for the day

is an hour and a half before sunset until fifteen minutes after sunset. Migration is most likely to be observed during the fifteen minutes before or after sunset. Nighthawks were not seen migrating until two hours and forty-five minutes before sunset and the number seen was low in comparison to the number seen migrating at sunset (see Figure 2; page 34).

The direction of flight of migrant nighthawks was reported as primarily toward the north, northeast, and northwest, while only a small number were reported flying in a southerly direction. Only twenty of the total number of birds were reported circling and one observer commented that they were "flying everywhere." Due to the ambiguity in the instruction sheet for direction of flight, it cannot be determined if the migrants were moving from the north or flying toward the north. The direction of flight of migrant nighthawks will be an important factor to study in the following seasons for a comparison to the 1997 season data, and the instruction sheet will be revised so reporting this data is less ambiguous.

The primary wind direction recorded when large numbers of nighthawks were migrating was southeast. However, the wind direction data recorded was also not specified as wind coming from a specific direction or wind blowing toward a specific direction, so the data are inconclusive. The wind was most likely blowing in a southeasterly direction, which migrating birds might be expected to favor in the fall. The instructions for filling out the daily report forms next season will specify recording the direction from which the wind is coming.

The migrants were recorded in flight in winds up to 38 kilometers per hour (wind

speed code 5), when small trees and leaves sway. No surveys were taken in wind speeds greater than this. It is doubtful that nighthawks would be able to remain on course in winds greater than 38 kilometers per hour, though additional data in future years will allow firmer conclusions about this. At higher wind speeds they may be blown off course, may become disoriented, and may even be blown out to sea. Migrants typically do not move in high winds. The largest number of migrants was seen when the wind speed was six to eleven kilometers per hour, when only a slight breeze is felt.

Nighthawks were most often observed on days when the sky conditions were clear with 0 to 15% cloud cover. They were also seen migrating on days that were partly to mostly cloudy. Nighthawks seem to favor clear days with mild weather for migration because it is easier for them to orient themselves in the right direction. But observers may also be more likely to perform a count during these conditions. A few nighthawks were observed when the sky was overcast and when there was drizzle. The nighthawks did not migrate on days when there were strong winds, fog or haze, rain, or thunderstorms, either because navigation is more difficult in these types of conditions or no one was looking for them under these conditions. Only two data report forms were filled out on days that were rainy. They may become disoriented in fog, haze, or rain, or be blown off course or to the ground in high winds. Heavy rains weigh birds down and they may lose the waterproofing of their feathers. Birds can lose heat when soaked with rain or in high humidity, so they do not migrate unless the weather is fair. It is suggested from this study that nighthawks are more likely to migrate in mild weather when the wind speed is less than 38 kilometers per hour, the sky is clear or only partly cloudy, and there

is no rain or thunderstorms.

The 1997 Nighthawk Migration Monitoring Program was a success in that important weather data and time of day and season for peak flight was determined. The long-term success of the NMMP, like many other efforts, depends on the number of individuals who dedicate their time and energy to recording birds and weather data over several years. A greater success, unique to the first year's efforts, was that the initial year's cooperators allowed flaws to be detected in the program's design and a basis for the program's expansion was set. The number of amateur birders greatly outnumbered the number of professionals that participated, and only through the work of amateurs will the program continue to work in future seasons.

One goal of the 1998 program will be to involve a larger number of participants to increase the number of observation sites. It will be important to have coverage throughout the three regions of Virginia, namely, the Mountains and Valleys, Piedmont, and Coastal Plain. A related long-term goal will be to include data collected in all states where nighthawk migration can be observed. The program also should have coverage of all days from the beginning of August until mid-October for better continuity of data.

Based on the 1997 count, several changes in the Daily Report Form will be made for next season's count. As already mentioned, instructions for filling out the form will state that the wind direction recorded is the direction from which the wind is coming. Likewise, the direction of flight for migrant nighthawks will be recorded as the direction toward which the bird is going. The approximate time of sunset will be recorded on the report form. For direction of flight, a "C" will be recorded when nighthawks are

observed circling.

Some participants reported seeing fewer migrant nighthawks in the 1997 than in previous years. It is a long term goal of this program to study the population trends of the nighthawk to determine if they are decreasing in number as many observers now suspect (Peterson 1980, Buckelew and Hall 1994, Scott 1995). It is important to establish bird monitoring programs to study migration, population trends, and for comparison to other bird studies such as the Breeding Bird Survey. The 1997 NMMP count determined the time of day for peak flight, time of season for peak flight, and weather factors that nighthawks favor for migration, but these conclusions are tentative, awaiting confirmation from future years' data. Future research on the nighthawk by those involved in the Nighthawk Migration Monitoring Program should reveal more valuable information about this species.

APPENDIX I

This section contains materials that were used to encourage participation in the Nighthawk Migration Monitoring Program. The following two pages are the front and back of the brochure that was created to publicize the program. Page 50 is the letter that was mailed the chapters of the Virginia Society of Ornithology and others who requested information about the NMMP. The following page is a follow-up letter at the end of the 1997 migration season thanking participants for their contributions and a reminder to those who participated to return the data sheets.

MORE ABOUT THE COMMON NIGHTHAWK

- Other names include goatsucker, bull-bat, mosquito hawk, pork and beans, burnt-land bird

- Related to the Whip-poor-will, but has a short, buzzy call

Eats large numbers of flying insects

Often breed on top of flat buildings such as schools and are commonly seen in cities and towns

Breeds from northern Canada to Panama and winters in South America

NIGHTHAWK MIGRATION MONITORING PROGRAM
Longwood College
Department of Natural Sciences
Farmville VA 23909
(804) 395-2717
(804) 395-2652 FAX

NIGHTHAWK MIGRATION MONITORING PROGRAM

a project of the
Graduate Program
in Environmental Studies
at Longwood College

ABOUT THE PROGRAM

The program is modeled after hawkwatching methodology and is a quantitative study of a Neotropical migrant called the Common Nighthawk, *Chordeiles minor*. The nighthawk was chosen for study because it is easy to identify and very visible when migrating. It is a relatively large bird with pointed wings and slightly forked tail. A Neotropical migrant and insectivore, the Common Nighthawk has potential value as a monitor of environmental conditions.

Goals of the Program

- count migrant nighthawks, making year to year population comparisons possible
- correlate weather patterns with nighthawk migration
- investigate the use bf leading lines by migrant nighthawks
- determine time of day for peak flight and whether this varies through the year or from year to year

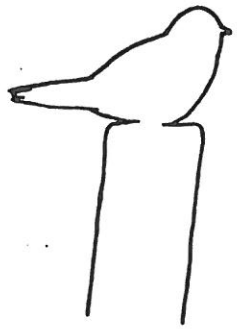
To learn more, we need your help.

WE CAN LEARN TOGETHER!

Volunteers in the project will

- perform daily counts
- fill out tally sheets with the number of nighthawks seen, weather information, and other relevant data
- return data sheets to Longwood College

Volunteers will receive a participant's packet with complete instructions and data count sheets. Each participant's data will be combined with information collected by other volunteers all over the southeastern United States. The data will be analyzed and then we will share the findings with you.



WHO MAY PARTICIPATE?

Anyone who has a love for birds and the ability to identify nighthawks is welcome and encouraged to participate:

--professional ornithologists
--birders
--beginners

I WANT TO PARTICIPATE

Name_____
Address_____
City_____
State_____ZIP_____
Daytime Phone( )_____
( ) Member of a bird club?_____
_____

Mail to:
Nighthawk Migration Monitoring Program
Longwood College
Dept. of Natural Sciences
Farmville, VA 23909

You may also call or e-mail us for more information or to sign up:
Phone: (804) 395-2717
E-mail: nighthwk@longwood.lwc.edu
www.lwc.edu/academic/LAS/Science/nighthwk.htm

LONGWOOD

201 High Street, Farmville, Virginia 23909-1899

July 1997

Dear Fellow Birders,

We are writing this letter to ask for your help as we start a new monitoring program for a familiar North American bird, the Common Nighthawk. Like many other Neotropical migrants, this bird's populations may be declining at an increasing rate. We have established a program through which birders anywhere can help us get a better measurement of the nighthawk's populations and also learn more about its migration patterns.

Nighthawks are easy to observe in migration during the late summer and early autumn as they fly low overhead in the afternoon and evening hours. When migrating, they can appear almost anywhere, so counts can be made almost anywhere. By applying some methods already familiar to many birders from hawkwatching, we plan to count as many migrant nighthawks as possible this fall and in coming years.

Observers should start counting in mid to late August. If it's hot and humid outside, it may seem early to be thinking about fall migration, but nighthawks migrate earlier than many other birds. Also, don't be discouraged if you look for nighthawks but don't see any. Please report zeros as well! It is important to know when people looked but did not see nighthawks as well as when they were seen.

Enclosed with this letter are a brochure telling more about the program and single copies of the data sheet and instructions we are using. Please copy these pages and give them to anyone who wishes to participate. The only qualifications for observers are interest and the ability to identify nighthawks. At the end of the season we will make available a summary of the results to anyone who is interested.

Thanks for your help!

Paige Guilliams C. Michael Stinson

Paige Guilliams
C. Michael Stinson

Department of Natural Sciences
Longwood College

Founded in 1839

Nighthawk Migration Monitoring Program
Longwood College
Farmville, Virginia
October 27, 1997

Dear Bird Club Leaders,

I would like to thank all of you who have participated in the first season of the Nighthawk Migration Monitoring Program. I also wanted to remind everyone who took part in the program to return all data sheets to me as soon as possible so that the data can be analyzed. I look forward to hearing from you all soon and will let you know my results once all of the data is in and has been studied.

Thanks again for your time and participation. I look forward to working with you again next fall!

Sincerely,

J. Paige Guilliams

J. Paige Guilliams

APPENDIX II

Appendix II contains the Nighthawk Count Report Form that was designed for the first year of the study. Pages 54 and 55 are the front and back of the instruction sheet for filling out the NMMP report form. The back of the form contains the Beaufort Scale for wind speed and sky conditions for filling in the weather information on the data sheet. This scale is also used by the Hawk Migration Association of North America for recording weather information on the hawkwatching data form. The last page in Appendix II is a completed form from one of the participants in the 1997 season of the NMMP.

NIGHTHAWK MIGRATION MONITORING PROGRAM

Nighthawk Count Report Form

Return to: NMMP, Department of Natural Sciences, Longwood College, Farmville, VA 23909

Observer(s) name_____

Day_____ Month_____ Year_____

Location: Observation site_____

County/Township_____

Locality name_____State_____

Latitude/Longitude to nearest minute: Latitude_____Longitude_____

Field of View: (Check one)

___0-25%

___25-50%

___50-75%

___75-100%

To your knowledge, do nighthawks breed within one mile (1.6 km) of your observation site? _____yes _____no

If so, estimate the number of pairs _____

Start time:_____End time:_____

Temperature:_____

Direction of Flight:_____

Time	WS/ WD	SC	Number Observed	Time	WS/ WD	SC	Number Observed	Time	WS/ WD	SC	Number Observed
2:00-2:15				4:30-4:45				7:00-7:15			
2:15-2:30				4:45-5:00				7:15-7:30			
2:30-2:45				5:00-5:15				7:30-7:45			
2:45-3:00				5:15-5:30				7:45-8:00			
3:00-3:15				5:30-5:45				8:00-8:15			
3:15-3:30				5:45-6:00				8:15-8:30			
3:30-3:45				6:00-6:15				8:30-8:45			
3:45-4:00				6:15-6:30				8:45-9:00			
4:00-4:15				6:30-6:45				9:00-9:15			
4:15-4:30				6:45-7:00				9:15-9:30			

Comments:Use back of form as needed.

NIGHTHAWK MIGRATION MONITORING PROGRAM

INSTRUCTIONS FOR DAILY REPORT FORMS

Thank you for your interest in the Nighthawk Migration Monitoring Program. If you have any questions about these instructions please write or call us at Longwood College.

Daily report forms from the NMMP are available to all who request them.

GENERAL INSTRUCTIONS: Use one data sheet for each day's observations. Fill out the form as completely as you can. The daily nighthawk totals are important but the more other data you record the more valuable your observations are. Do not try to supply data that you are not sure about. Please provide *any* additional information that you think is noteworthy, such as weather changes that occur, interesting bird behavior, changes in direction of flight.

Always enter a weather code for the first 15 minutes of observation. For the following 15 minute blocks enter a weather code only if the data changes. Enter the number of nighthawks seen in the appropriate block. If zero are seen then record a "0". Leave blocks empty for times when you are not in the field.

Write in notes if needed on site on the back of the sheet. Send the completed forms to Nighthawk Migration Monitoring Program, Department of Natural Sciences, Longwood College, Farmville, VA 23909.

OBSERVER: Write in names of all observers. If you move your location during any one day, or if your group splits its operation to cover the passage of nighthawks from more than one vantage point at a time, use a separate report form for each post. The separate forms will help provide information about the effects of time of day and changing weather conditions on migration and flight paths.

DATE: Spell out the month when recording the date, e.g. 21 August 1997.

LOCATION: Give your observation site a distinct name which would separate it from any other observation site. An example would be "dam, Briery Creek Lake, Prince Edward County, VA." If you have reported from here before, use the same locality name but note changes, e.g. a change in the field of view. Record the nearest town or prominent map feature, county or township, and locality name. Enter the state by abbreviating with capital letters. Record latitude and longitude to the nearest minute if known.

Remember to use a separate form if moving location or if your group splits.

FIELD OF VIEW: Field of view is an estimate of the percentage of the entire sky visible from your observation site. If you were standing in the middle of a flat plain with no trees in sight, or on a ship in the middle of the ocean, you could see the entire sky (100%). If you were standing in a thick forest you might not see any of the sky (0%). Most sites will allow visibility of much of the sky, but not all. Estimate the percentage of the sky visible from where you do your count and check the appropriate line.

AIR TEMPERATURE: Record in Celsius. To convert from Fahrenheit to Celsius, subtract 32, multiply by 5, and divide by 9. Note any changes in temperature.

START AND END TIMES: Record the time at which you started and ended your count for the day.

DIRECTION OF FLIGHT: Record the direction toward which the birds are moving when they are directly above or to the side of the count point. If different birds follow markedly different courses note the variations on the back of the form. Enter only an abbreviation for direction such as N for North or SE for Southeast.

WIND SPEED: Describe wind speed using numerical codes from the table on the next page. These are from the Beaufort wind scale; they are not miles per hour.

WIND DIRECTION: You can use a flag or a strip of ribbon to determine wind direction. Enter only an abbreviation, such as N for North or SE for Southeast, in the appropriate box. Do not use radio or television information because they can change over short distances.

SKY CONDITION: Using the table below enter the number(s) that best describes the predominant condition. If no code appropriately describes the current conditions then mark a "C" in the blank and elaborate on the back of the form.

NIGHTHAWK TOTALS: Record the number of nighthawks seen in the appropriate block. If you do not see any nighthawks in a given time period then record as a "0". If large flocks prevent accurate counts write "e" after the estimated total, e.g. 200e.

UNUSUAL SIGHTINGS: Please note the passage of all unusually large groups, with information about the time of appearance and disappearance, numbers, and behavior. Note anything else you think is unusual on the back of the report form.

SUPPLIES AND EQUIPMENT: Topographic maps are useful for locating possible new lookouts and for finding the latitude and longitude of your location. Don't forget a watch, something to write with, and a thermometer. A strip of ribbon or flagging tape acts as a good indicator of wind direction.

It is best to use the report forms in the field but you may also wish to carry a notebook to keep your notes for the day. A notebook will allow you to be as detailed in your notes as you want to be and it leaves you with a permanent personal record.

WIND SPEEDS

0 Less than 1 km/h; smoke rises vertically
1 1-5 km/h (1-3 m/h); smoke drift shows wind direction
2 6-11 km/h (4-7 m/h); leaves rustle, wind is felt on face
3 12-19 km/h (8-12 m/h); leaves, small twigs in constant motion; light flag extended
4 20-26 kn/h (13-18 m/h); raises dust, leaves, loose paper; small branches in motion
5 29-38 km/h (19-24 m/h); small trees and leaf sway
6 39-49 km/h (25-31 m/h); larger branches in motion; whistling heard in wires

SKY CONDITIONS

0 Clear; 0-15% cloud cover
1 Partly cloudy; 16-50% cover
2 Mostly cloudy; 51-75% cover
3 Overcast; 76-100% cover
4 Wind-driven sand, dust, snow
5 Fog or haze
6 Drizzle
7 Rain
8 Snow
9 Thunderstorm, with or without precipitation

Nighthawk Migration Monitoring Program
Department of Natural Sciences
Longwood College
Farmville, VA 23909
E-mail: nighthwk@longwood.lwc.edu
(804) 395-2731

NIGHTHAWK MIGRATION MONITORING PROGRAM

Nighthawk Count Report Form

Return to: NMMP, Department of Natural Sciences, Longwood College, Farmville, VA 23909

Observer(s) name Gerri Butcher
Day 28 Month 8 Year 97
Location: Observation site 5 s EAST of Calloway
County/Township Franklin Co.
Locality name Calloway State Va.
Latitude/Longitude to nearest minute: Latitude 37° Longitude 80° 5 min.

Field of View: (Check one)
___0-25%
___25-50%
X 50-75%
___75-100%

To your knowledge, do nighthawks breed within one mile (1.6 km) of your observation site? _____yes _____no ?
If so, estimate the number of pairs _____ -

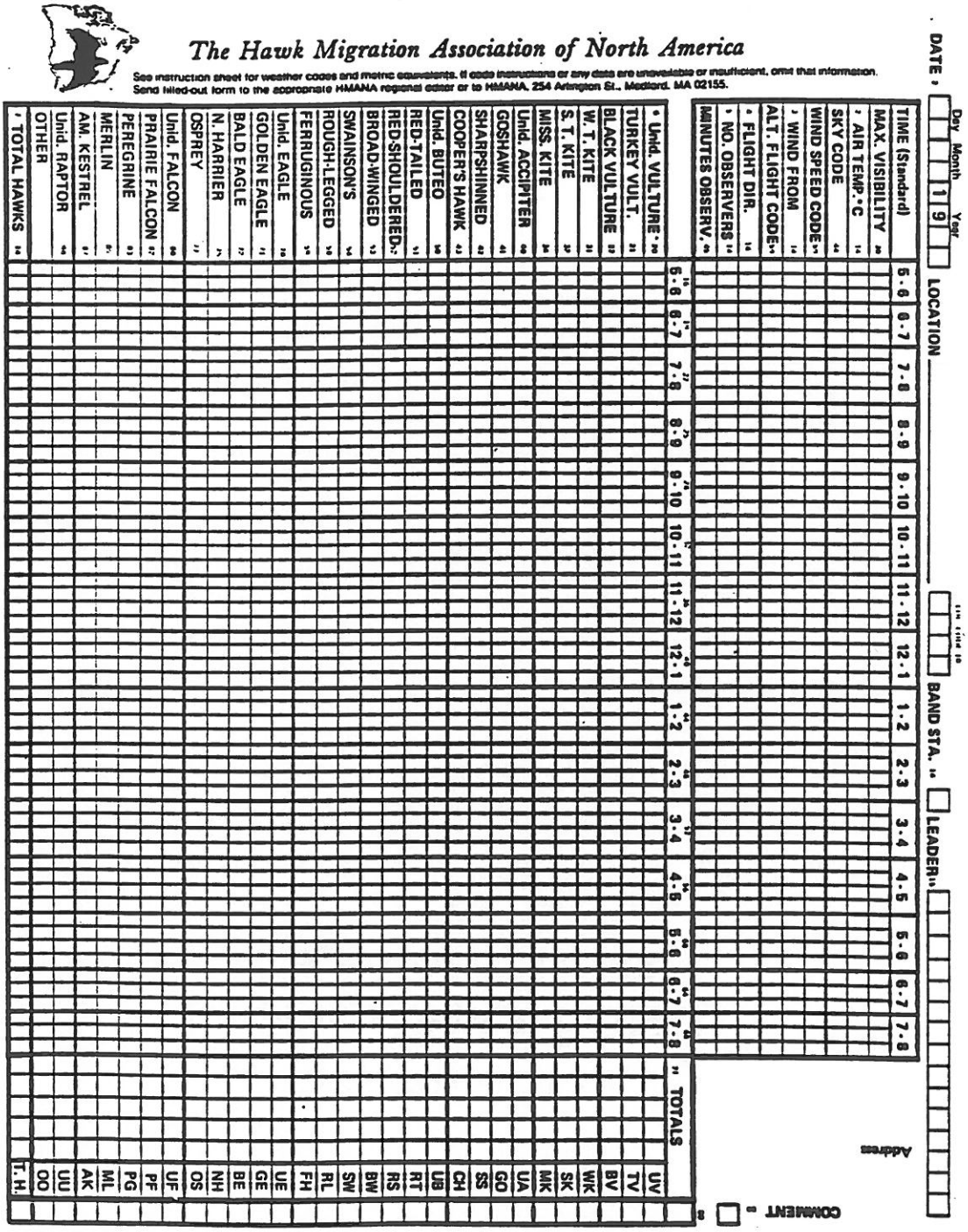
Start time: 6:30 End time: 7:30
Temperature: _____
Direction of Flight: SW

Time	WS/ WD	SC	Number Observed	Time	WS/ WD	SC	Number Observed	Time	WS/ WD	SC	Number Observed
2:00-2:15				4:30-4:45				7:00-7:15	1 N	0	1
2:15-2:30				4:45-5:00				7:15-7:30			0
2:30-2:45				5:00-5:15				7:30-7:45			
2:45-3:00				5:15-5:30				7:45-8:00			
3:00-3:15				5:30-5:45				8:00-8:15			
3:15-3:30				5:45-6:00				8:15-8:30			
3:30-3:45				6:00-6:15				8:30-8:45			
3:45-4:00				6:15-6:30				8:45-9:00			
4:00-4:15				6:30-6:45	1 NW	0	3	9:00-9:15			
4:15-4:30				6:45-7:00			0	9:15-9:30			

Comments: Use back of form as needed.

APPENDIX III

The NMMP report form was modeled after the Hawk Migration Association of North America's data form which is on the following page. The HMANA form is for reporting raptors observed in North America, while the NMMP form was created for reporting only one species, the Common Nighthawk.



The Hawk Migration Association of North America

See instruction sheet for weather codes and metric equivalents. If code instructions or any data are unavailable or insufficient, omit that information.
Send filled-out form to the appropriate HMANA regional editor or to HMANA, 254 Arlington St., Medford, MA 02155.

DATE • Day Month Year [1][9] LOCATION _____ BAND STA. LEADER

Address

COMMENT

TIME (Standard)	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	TOTALS	
MAX. VISIBILITY																	
AIR TEMP.°C																	
SKY CODE																	
WIND SPEED CODE																	
WIND FROM																	
ALT. FLIGHT CODE																	
FLIGHT DIR.																	
NO. OBSERVERS																	
MINUTES OBSERV.																	
Unid. VULTURE*																	UV
TURKEY VULT.																	TV
BLACK VULTURE																	BV
W. T. KITE																	WK
S. T. KITE																	SK
MISS. KITE																	MK
Unid. ACCIPITER																	UA
GOSHAWK																	GO
SHARPSHINNED																	SS
COOPER'S HAWK																	CH
Unid. BUTEO																	UB
RED-TAILED																	RT
RED-SHOULDERED																	RS
BROAD-WINGED																	BW
SWAINSON'S																	SW
ROUGH-LEGGED																	RL
FERRUGINOUS																	FH
Unid. EAGLE																	UE
GOLDEN EAGLE																	GE
BALD EAGLE																	BE
N. HARRIER																	NH
OSPREY																	OS
Unid. FALCON																	UF
PRAIRIE FALCON																	PF
PEREGRINE																	PG
MERLIN																	ML
AM. KESTREL																	AK
Unid. RAPTOR																	UU
OTHER																	OO
TOTAL HAWKS																	T. H.

Hawk Migration Association of North America (HMANA) hawk watch field form.

From: Dunne, P., D. Keller, and R. Knochenberg. 1984. *Hawk Watch: A Guide for Beginners.* Cape May Bird Observatory, New Jersy Audubon Society, p. 52.

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