STATUS OF THE EASTERN TAIGA MERLIN *Falco c. columbarius* IN THE UPPER MIDWEST

by

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The members of the committee approve the thesis of Thomas C. J. Doolittle presented on July 16, 1992

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The University of Wisconsin-Eau Claire, 1992
Under the Supervision of Dr. Terry Balding

Migration data from Upper Midwestern banding stations and migratory counts suggested a strong increase in merlin populations beginning in 1984. Since 1987, one hundred and two territories have been identified within a 1,858 km^2 area in Ontario, Minnesota, Wisconsin and Michigan. Merlins have produced 191 young with a mean reproduction rate of 2.9 young /successful nest (83% of the 78 active nests were successful). Merlin breeding densities were low (< 1 active pair/100 km^2), but aggregated within parts of the study areas (>5 active pairs/10 km^2). Eighty-nine breeding adults (57, males and 32 females) were captured and banded. The turnover of adult male merlins was estimated at 86%.

Usually, merlins selected corvid nests in white pine trees (_Pinus strobus_) as nesting sites. Nest woods with multiple nests were more stable than territories with a single nest. Most nests were within 150 meters of a dominant edge. The edge was usually a lake with an

irregular shoreline exceeding 161 km in length.

The lack of periodic fire may jeopardize the long term maintenance of the conifer and boreal communities used as nesting areas by merlins. Other factors such as the deterioration of aquatic habitats due to anthropogenic toxins and a decline in the prey base is, or could be a local problem. However, present merlin populations throughout the region seem to be increasing. One factor augmenting population growth is their ability to nest in urban environments. Urban areas offer a large choice of suitable nests because of abundant crow populations and coniferous trees. Another factor that may contribute to their population increase is their use of artificial nesting structures. Lastly, a significant increase of american crow (*Corvus brackyrynchos*) populations in the Upper Midwest may have created more available nests on shorelines for merlins to use. This may be the most important factor for the regional increase of merlins.

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INTRODUCTION

A merlin is striking in appearance, and an agile and compact falcon. The name merlin is a french derivation of the word *esmerllion* (Clark and Wheeler, 1987) meaning energetic or active (Atkins et al., 1962). The latin nomenclature (Falco columbarius) means dove like falcon (Lewis et al., 1958).

In the old world six races exist, while there are three recognized sub-species found in North America (Palmer, 1988 and Temple, 1972a). The first of the North American sub-species is the richardson's merlin (Falco c. richardsoni), which is distributed in the prairie parkland environments of Saskatchewan, Alberta, Southwest Manitoba, Montana, the Dakotas and Wyoming. A second North American sub-species is the black merlin (Falco c. sucklei) whose primary range is the humid coastal district of British Columbia (Cade, 1982). The latter may be expanding its range South into Oregon, Washington and North to the panhandle of Alaska (Beebe, 1974). The last of the North American sub-species is the eastern taiga merlin (Falco c. columbarius), which inhabits primarily boreal plant communities in the transitional zones between the deciduous forest, conifer forest and tundra biomes of North America.

This thesis descibes some aspects on the status and ecology of the eastern taiga merlin (Falco columbarius

columbarius Linneaus) in the Upper Midwestern United States and associated border regions of Canada.

Prior to 1900 the eastern taiga merlin was generally considered an extralimital breeder in the Upper Midwest, though exceptions probably were the northeastern counties of Minnesota and Isle Royale, Michigan. Raptor banding stations and migratory counts at Hawk Ridge, Duluth, Minnesota and Cedar Grove Ornithological Research Station, Cedar grove, Wisconsin have monitored migrant merlin populations since 1951. A decline in merlin numbers was noted at Cedar Grove and Hawk Ridge around 1961 followed by a marked increase occurring in 1984 (Figure 1.). These data suggested a regional increase of merlin populations and subsequent potential breeding in the Upper Midwest.

Migratory data collected at Cedar Grove Ornithological Research Station also suggested that the merlin population took a more dramatic overall decline than the population of tundra peregrine falcons (Falco peregrinus tundrinus) and received little attention by raptor researchers in comparison (George Allez, 1992). Furthermore, to my knowledge, no current research on the species status has been done in the Upper Midwest.

Final justifications in doing this study were: the merlin is a unique member of the Lake Superior ecosystem and other large watersheds in the region, also it is a specialized member in a mosaic of food chains. Therefore

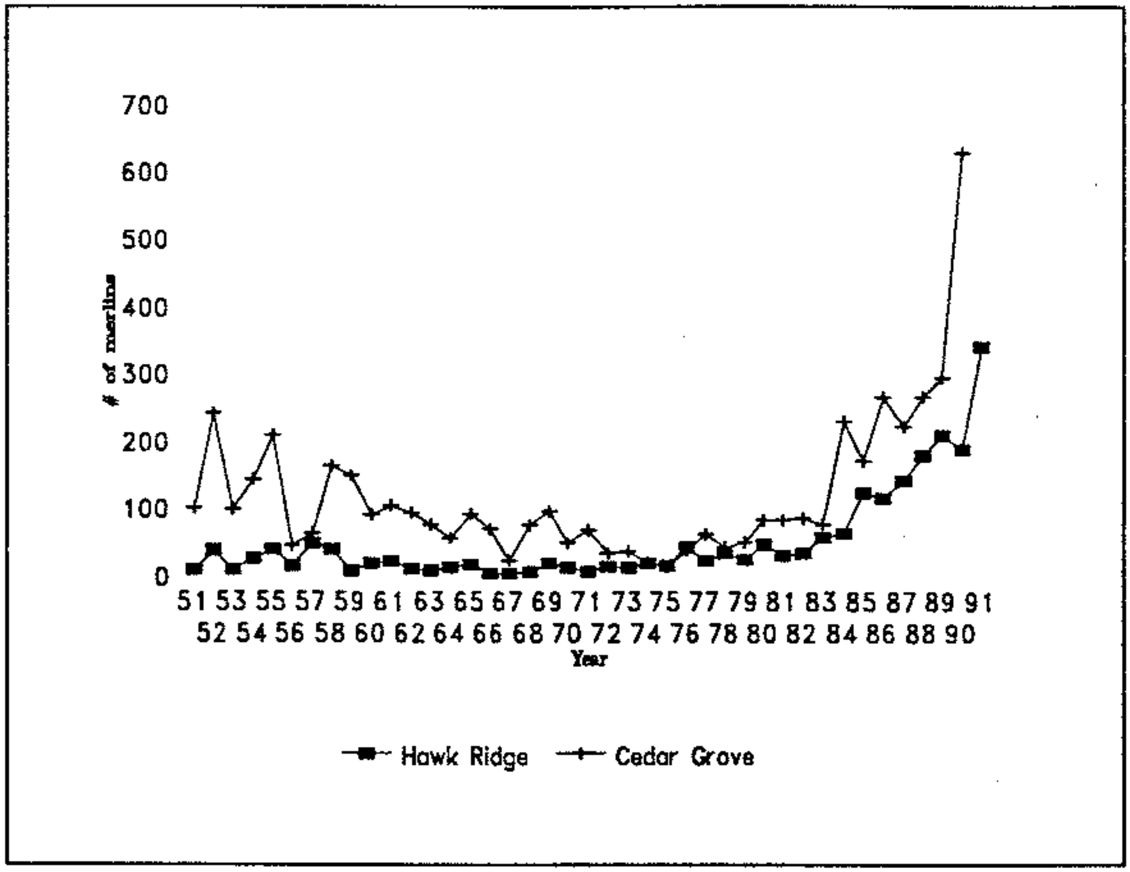

Figure 1. A comparison of migratory volume of merlins between Cedar Grove Ornithological Research Station and Hawk Ridge

the merlin, by its own merit as a top order consumer in the Upper Midwest warrants research.

In the summer of 1987 this study was initiated to determine the status of the eastern taiga merlin in the Upper Midwest. This research project was terminated on 1 June 1992. The objectives of the study were to determine the population status and distribution of merlins in the Upper Midwest and note aspects of merlin breeding ecology.

STUDY AREAS

The study area locations were in Michigan, Minnesota, Ontario and Wisconsin. The specific study areas were 1) Voyageurs National Park, Minnesota and associated Boundary Waters, Ontario CANADA 2) Isle Royale National Park, Michigan 3) the urban locales of Duluth, Minnesota and Superior, Wisconsin 4) Apostle Islands National Lakeshore and Chequamagon Bay area, Wisconsin 5) Pictured Rocks National Lakeshore, Michigan and 6) the Turtle Flambeau Flowage, Wisconsin (Figure 2.). The study areas combined have 2,595 km of shoreline and a total area of approximately 1,858 km^2.

The weather during the study (April - July) from 1987 - 1991, was warmer than normal and precipitation was normal, except in 1991 where precipitation was above average (NOAA, 1991a). Isle Royale had the lowest mean temperatures about 5^{o} C cooler monthly averages for the region, but below average precipitation (NOAA, 1991b).

Voyageurs National Park, Minnesota, and the associated border regions of the province of Ontario, are located in the Superior province of the Canadian Shield. Pleistocene glaciation is responsible for all the surface feature present in the area. The park's land area is 543.4 km^2 and includes a mosaic of large and small lakes. The largest lakes within the park are Kabetogema, Crane, Sandpoint, Namakan and Rainy. The total shoreline length of these

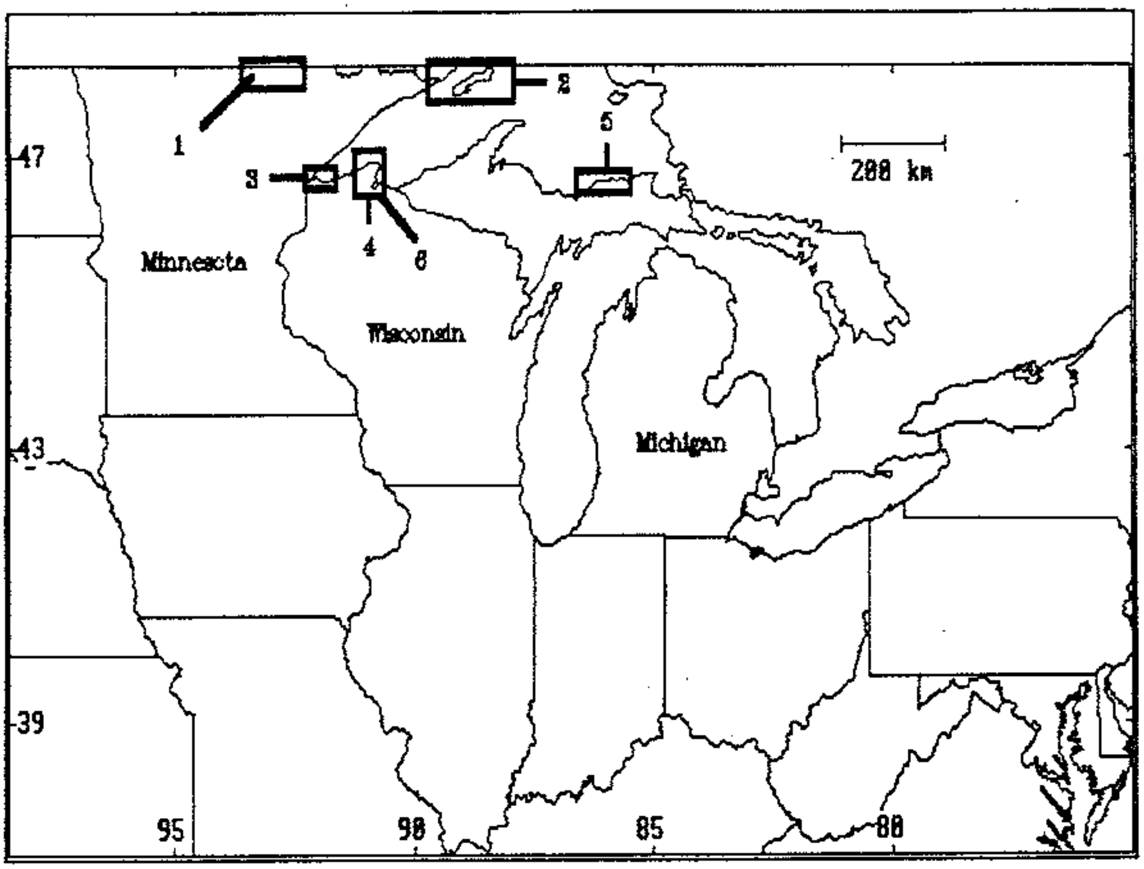

Figure 2. Study locations in Upper Midwest

Map Key:

1 - Voyageurs National Park, Minnesota
2 - Isle Royale National Park, Michigan
3 - Duluth, Minnesota and Superior, Wisconsin
4 - Apostle Islands National Lakeshore and Chequamagon Bay area, Wisconsin
5 - Pictured Rocks National Lakeshore, Michigan
6 - Turtle Flambeau Flowage (Iron County), Wisconsin

lakes (including the Ontario shore) is 1,025.2 km (Minnesota DNR, 1992). The lakes are part of the 38,591 km^2 Rainy Lake Watershed which form the headwaters of the Winnipeg River, a part of the Hudson Bay drainage pattern. The area's climate is strongly influenced by continental polar air masses from the North and continental dry air masses from the prairies (National Park Service, 1991). Voyageurs National Park is at the convergence point of the conifer forest and deciduous forest formations.

Isle Royale National Park, Michigan, is located in the northwest quarter of Lake Superior. The island is 72 km in length and 14 km at its widest point. The island's land area is 544 km^2 with approximately 477 km of shoreline. The island has abrupt ridges and valleys running along a northeasterly axis. These surface substrates are interbedded volcanic and sedimentary rocks. Isle Royale has a mid continental climate that is greatly tempered by the surrounding water of Lake Superior (Peterson, 1977). The island's boreal communities are primarily in the northern 1/3 of the island, on the 200 peripheral islands and on the northeastern shoreline of the main island. The interior of Isle Royale is mostly northern hardwoods (Bieck et al., 1985).

The urban locales of Duluth, Minnesota and Superior, Wisconsin are located at the western shoreline area of Lake Superior. These twin ports are divided by the St. Louis

River, which creates a large convoluted harbor and estuary. The two cities encompass a 290.8 km^2 area and the shoreline length of Lake Superior sections within city limits and St. Louis harbor is 166 km. The climate of these urban areas is similar to Isle Royale's, the Apostle Islands, and the Chequamagon Bay area. All of these areas have a humid continental climate that is greatly tempered by Lake Superior. The vegetation is a mixture of native and exotic species and existing plant communities are fragmented by human impacts.

The Apostle Islands National Lakeshore is located off the tip of northwestern Wisconsin's Bayfield peninsula. The National Park Service has jurisdiction over 21 of the 22 islands. This archipelago juts outward approximately 48 kilometers into Lake Superior. The land area within National Lakeshore boundaries is 171.6 km^2, including a 19.3 km mainland segment. Madeline Island (the largest of the Apostle Islands) is not managed by the National Park Service but was included in all surveys. Therefore, the total area surveyed was 219 km^2 and the total shoreline length of the 22 Apostle islands is 310.2 km. The area is at or near the convergence point of two continental biomes. They are hemlock/white pine hardwood forest and circumpolar boreal forest (National Park Service, 1989).

The Chequamagon Bay area is the mainland shoreline lying mostly south and west of the Apostle Islands. The shoreline segment studied extends from Lost Creek, near Cornucopia, Wisconsin (Bayfield County) eastward to the Ashland County/Iron County boundary. The shoreline length of this study area was 157 km. The shoreline is partially developed and includes the small towns of Cornucopia, Red Cliff, Bayfield, Washburn, Ashland and Odanah. The shoreline vegetation is less homogeneous than the Apostle Islands shoreline due to more recent human disturbances.

Pictured Rocks National Lakeshore, Michigan is located in the North central region of the Upper Peninsula along the southern shore of Lake Superior. The bedrock structures are precambrian granites and cambrian sandstones. The latter rocks are the deep red quartzites that create the vignette of colorful cliffs that make this area famous. The lakeshore is 136.9 km^2 and the Lake Superior section of shoreline length is 60 km. Pictured Rocks has a humid continental climate. The area is in the eastern deciduous forest formation and there are elements of boreal, grassland, beach, dune and cliff community types (National Park Service, 1981).

The final study area was the Turtle Flambeau Flowage located near Mercer, Wisconsin in Iron County. This area is under Wisconsin Department of Natural Resources jurisdiction. The Turtle Flambeau Flowage is Wisconsin's third largest interior Lake. It has a shoreline length of 340 km (Martin, 1992). The vegetation of the area consists of a mixture of northern hardwood and conifer community types.

PHYSICAL CHARACTERISTICS AND HABITS

Like all members of the family <u>Falconidae</u>, merlins are large headed, dark eyed and have long pointed wings with a medium length tail (Clark and Wheeler, 1987). There are 37 members of the genus <u>Falco</u>, comprising all the true falcons. Characteristically, they don't vigorously expel their droppings and all falcons lay eggs with a reddish buff cast to the inside of the shell. All falcons moult their primaries in the same ascendant order with the molt initiating with the loss of the # 4 primary (Brown, 1976). A merlin flies in a strong and direct manner. In comparison to the other falcons they seem to beat their wings with shorter strokes and elevate their body slightly above the horizontal plane of their wings while in flight (Evans, et al., 1974). Merlins are one of the smaller, partially nomadic falcons that fly and hunt much like a miniature version of a gyrfalcon (Beebe, 1974 and Dunne, 1988).

As with many birds of prey the females are larger than the males. The linear dimensions of the males are approximately 92 % those of the females. The size difference is not as distinctive in merlins as in other small, bird eating diurnal raptors, such as the sharp-shinned hawk (<u>Accipiter</u> <u>striatus</u>) (Cade, 1982). Eastern taiga merlins have sexually dimorphic plumage. The males have slaty blue dorsal and crown plumage. They have a weakly expressed facial pattern, whitish throat, pale rufous to buffy undersides with dark vertical streaks and bars, and the slightly rounded tail has a cream tip, broad blackish sub-terminal band, and a series of less distinct black bars set against a dark slate background (Cade, 1982). The female is uniformly brown and generally more drab. She has the same vertical baring and streaking as the male. First year males and females are similar to the adult female, but males lack the grey rump and upper tail coverts (Cade, 1982). Beebe (1974) noted that juveniles have streaked flanks and are a dark brown, adult females are usually a more faded brown. Generally both sexes of merlins are 25-30 cm in length with 50-62 cm wing spans. Usually, weights range from 140 - 180 grams for males and 180 - 250 grams for females (Palmer, 1988). When perched they look no different in size than the american kestrel (Falco spaverius), although they are are almost twice as heavy.

In North America the most frequently used nest sites are the nests of other birds, primarily corvids, such as the american crow (Corvus brackyrynchos), northern raven (Corvus corax), and magpie (Pica pica). Nests in Iceland and some in Newfoundland are on high cliffs like the peregrine falcon (Falco peregrinus), while in Eurasia and in the sub-arctic parts of North America they nest on the ground among herbaceous vegetation and under dense low hanging tree branches (Cade, 1982; Schempf and Titus, 1989). There are some records in the eastern United States of merlins nesting in cavities (Bent, 1937) and on a haystack in Kazakstan (Dementiev, 1951).

Merlins are only surpassed by peregrine falcons with regard to site fidelity (a process of territorial occupancy from one year to the next, but not necessarily by the same pair). Some merlin nest sites in the British Isles have been occupied for more than 100 years (Newton, 1979). Rowan (1921) noted that merlin pairs were shot for 19 successive years with never an egg hatching at the nest location.

DISTRIBUTION

All races of merlins have a northern holarctic breeding distribution that seldom occurs below the 42 degree parallel. In North America their present breeding range rarely encompasses Oregon and Idaho, while they are historically noted to breed in Montana, the Dakotas, Wisconsin, Michigan, Minnesota, Ontario, Quebec, the Maritimes and Maine (Cade, 1982). In the Upper Midwest (Figure 3.) southern limits may have extended into, Illinois, and Iowa (Anderson, 1907 and Vos Burgh, 1913). Their Northern range extends northward to the limit of trees in Northern Canada and Alaska.

Throughout this vast range, merlins nest wherever

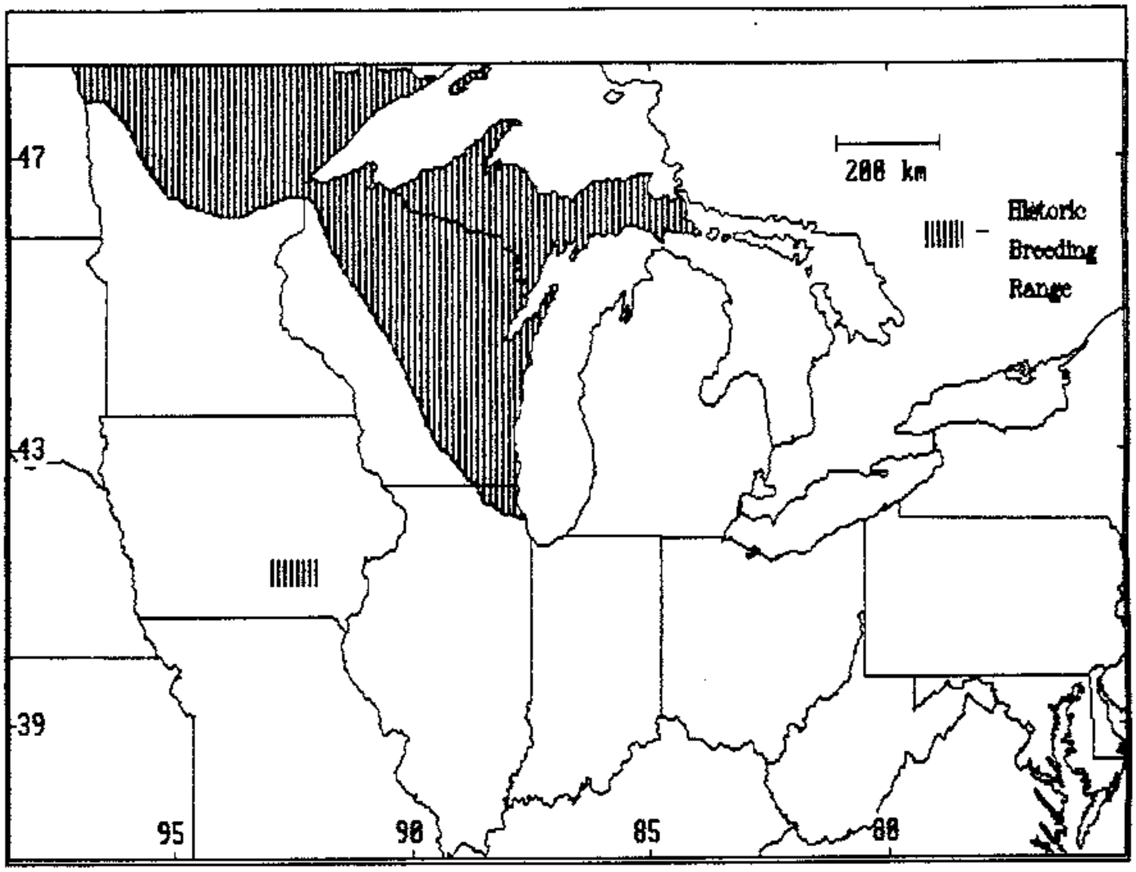

Figure 3. Historic breeding range of the eastern merlin in Minnesota, Wisconsin, Michigan, Illinois and Iowa

forest and scrublands are broken by expanses of open country. In boreal regions they favor habitats at or near the latitudinal and altitudinal limits of the coniferous forest, but can be found around expansive lakes, bogs, old forest burns, along major rivers, in prairie parklands and forest-steppes (Cade, 1982). Recently, merlins have moved into suburban environments (Oliphant, 1974).

In Minnesota there were nine confirmed breeding records and two locations that had probable breeding between 1935 and 1985 (Figure 4.). The two locations with probable breeding suggesting range extremes were in Marshall County

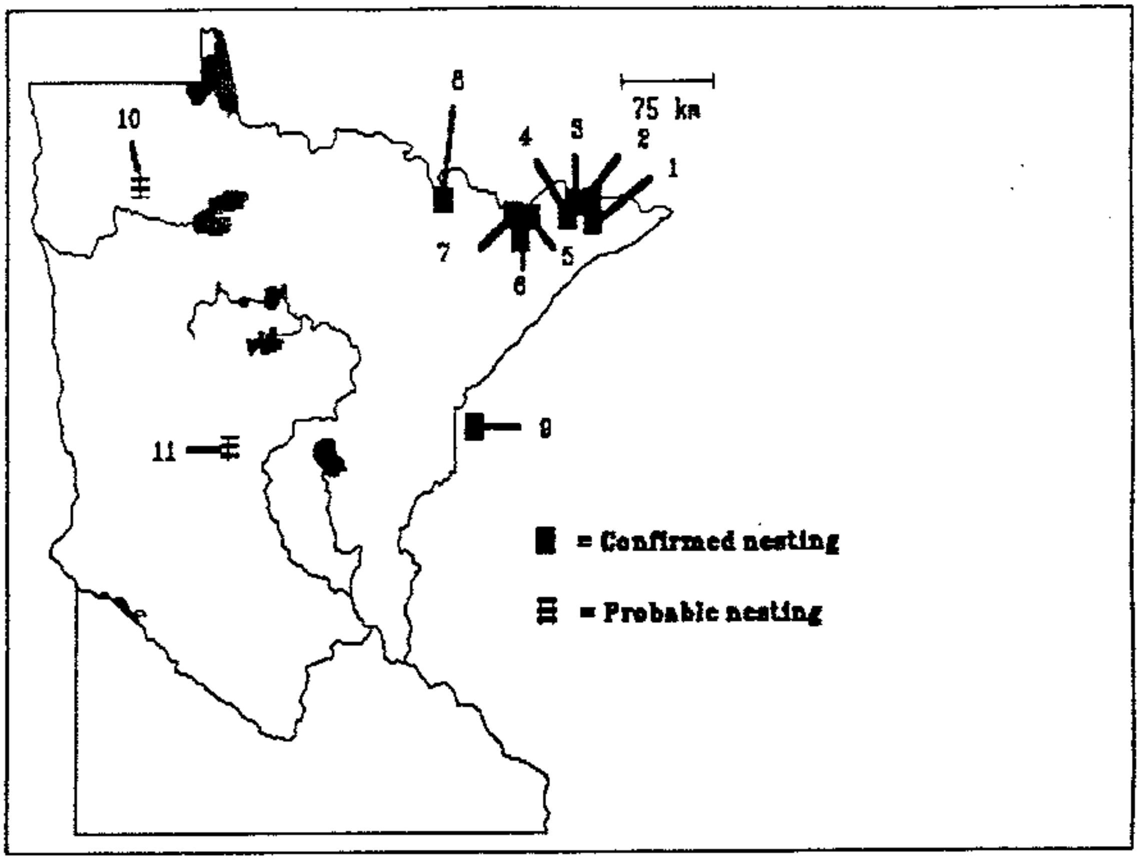

Figure 4. Merlin breeding locations in Minnesota from 1935-1985

Map Key:

	Location	Source
1 -	Gunflint Lake (Cook Co.) in 1935	Craighead and Craighead (1940)
2 -	Big Saganaga Lake (Cook Co.) in 1935	Craighead and Craighead (1940)
3 -	Big Saganaga Lake (Cook Co.) in 1935	Craighead and Craighead (1940)
4 -	Saganaga Lake (Cook Co.) in 1937	Breckenridge and Errington (1938)
5 -	Basswood Lake (Lake Co.) in 1952	Beer (1966)
6 -	Basswood Lake (Lake Co.) in 1959	Beer (1966)
7 -	Harriet Lake (Lake Co.) in 1984	Wilson (1985)
8 -	Near Ely (St. Loius Co.) in 1981	Johnson (1982)
9 -	Minnesota Point (St. Louis Co.) in 1952	Johnson (1982)
10 -	Lake Agassiz (Marshall Co.) in 1985	Wilson and Shedd (1986) - not confirmed
11 -	Wadena County (1963)	Oehlenschager (1963) - not confirmed

at Agassiz National Wildlife Refuge (Wilson and Shedd, 1986) and in Wadena County (Oehlenschager, 1963). Johnson (1982) compiled a summary of merlin breeding records in Minnesota that covered a period from 1935 - 1981.

It is interesting that there were no historic records in Minnesota prior to 1935 (Roberts, 1932), considering there were earlier records as far south as Grinnell, Iowa (Figure 5.) (Anderson, 1907). In Wisconsin, Kumlein and Hollister (1903) reported merlins nesting as far south as Racine, Wisconsin and there may have been a nesting in Zion Park, Illinois (Figure 6.) (Vos Burgh, 1913).

Michigan had no confirmed breeding locations of merlins until after 1951 (Barrow, 1912; Wood, 1951 and Payne, 1983). Though evidence provided from specimens collected on Isle Royale and the Porcupine Mountains, Ontonagon County in summer prior to 1950 suggested nesting (Wood, 1951). There was a record of probable breeding noted in the Porcupine Mountains, where an adult and three young were observed on 24 July 1904 (Barrow, 1912). From 1951 - 1982 merlins were noted as breeders in five Upper Peninsula counties (Payne, 1983). These locations were Keweenaw County, Marquette County, Schoolcraft County, Mackinac County, and Luce County (Figure 7.). The best documentation of merlin breeding in Michigan was acquired from National Park Service files at Isle Royale National Park. These files suggested signs of breeding activity annually since 1966. The Michigan

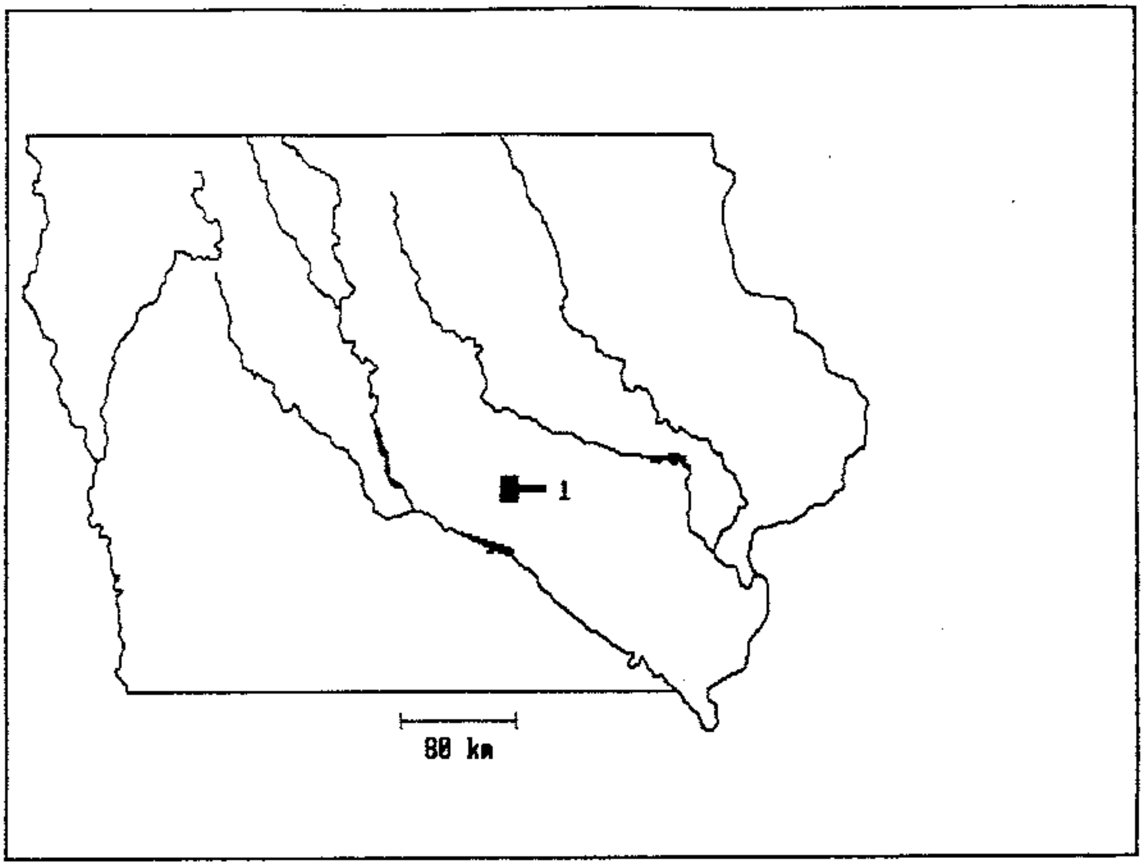

Figure 5. A historic merlin breeding location in Iowa

Map Key:

Location	Source
1 - near Grinnell, Iowa	Anderson (1907)

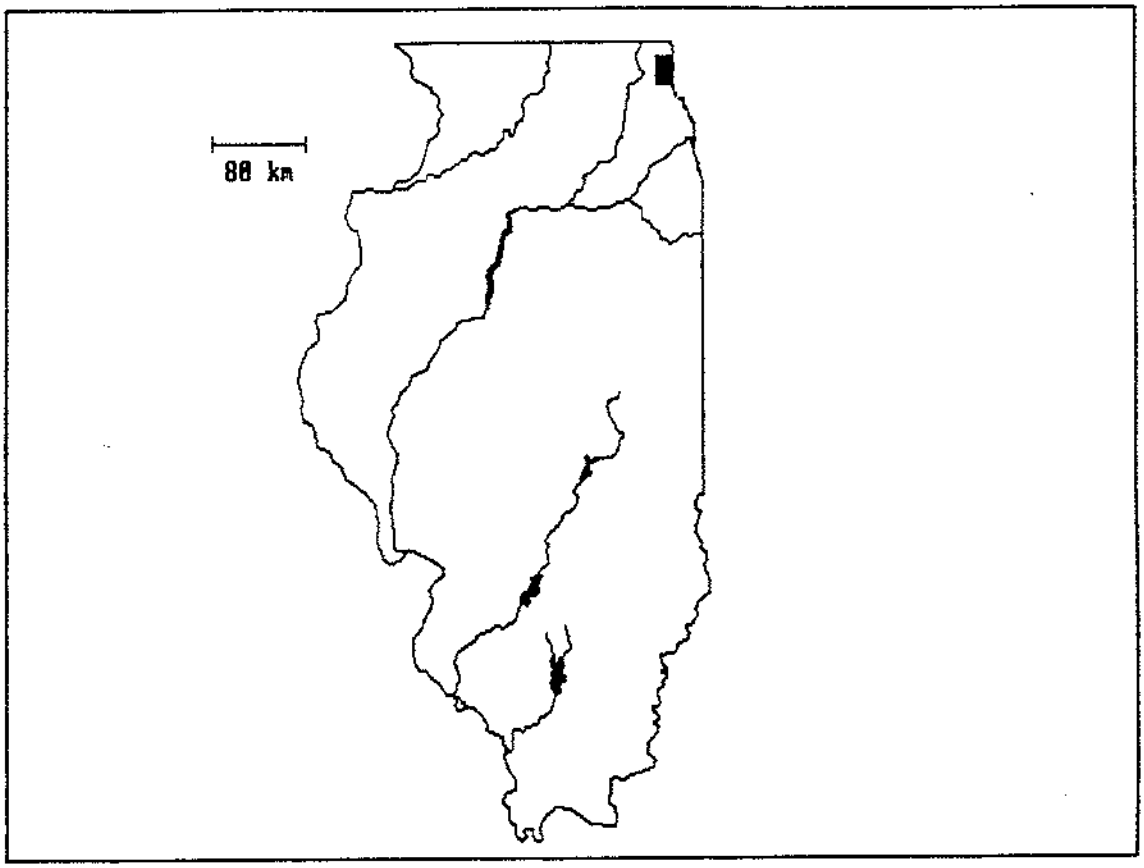

Figure 6. A possible merlin breeding location in Illinois

Map Key:

Location	Source
1 - Zion City (Lake Co.)	Vos Burgh (1913)

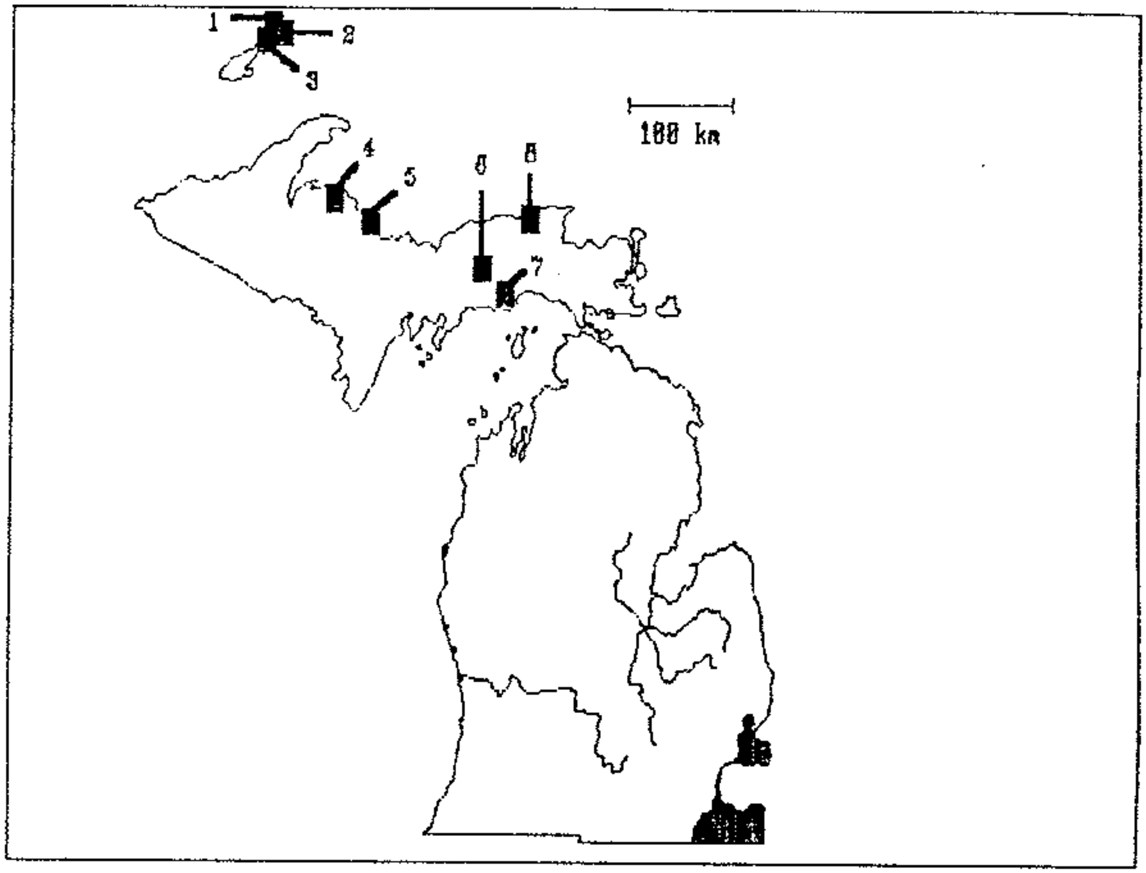

Figure 7. Probable merlin breeding locations in Michigan from 1951 - 1982

Map Key:

Location	Source
1 - Isle Royale (Keweenaw Co.)	Coble (1966)
2 - Isle Royale (Keweenaw Co.)	Johnson (1967)
3 - Isle Royale (Keneenaw Co.)	Goodwin (1977)
4 - Huron Mountains (Marquette Co.)	Payne (1983)
5 - Marquette (Marquette Co.)	Payne (1983)
6 - Seney (Schoolcraft Co.)	Payne (1983)
7 - South of Gould City (Mackinac Co.)	Payne (1983)
8 - East of Deer Park (Luce Co.)	Payne (1983)

Breeding Bird Atlas (1983-1987) suggested probable nesting in six Upper Peninsula counties and a possible nesting for 15 counties, including Atrim County (Figure 8.) in the Lower Peninsula (Mcpeek, 1988). In 1987, four merlin young were banded in a nest at Indian Lake, Schoolcraft County (Postupalsky, 1988).

In Wisconsin the most reliable records for breeding merlins prior to 1986 are shown in Figure 9. Wisconsin's southern most and earliest breeding record was in Racine County (Hoy, 1852).

There were no adult merlin specimens collected for any pre - 1939 records. However, a confirmed Wisconsin nesting was recorded from the Plains of Armstrong in Oconto County, where three eggs were collected (Schoenbeck, 1897). These eggs are housed at the Stevens Point Museum at the University of Wisconsin, Stevens Point.

The field notes from the journal Passenger Pigeon (1940 and 1941) noted merlins during the summer months at Green Bay and summer records exist for Sawyer, Forest and Rusk Counties (Miwaukee Public Museum Records, 1990).

Records since 1960 at Devils Island and Stockton Island within the Apostle Islands are probably reliable. Beals (1967) saw a nest and a single fledgling on 2 August 1966. However, since this record comes late in their normal breeding phenology it could be from another location. In 1985, Sumner Matteson and Neil Howk noted a fledged young at

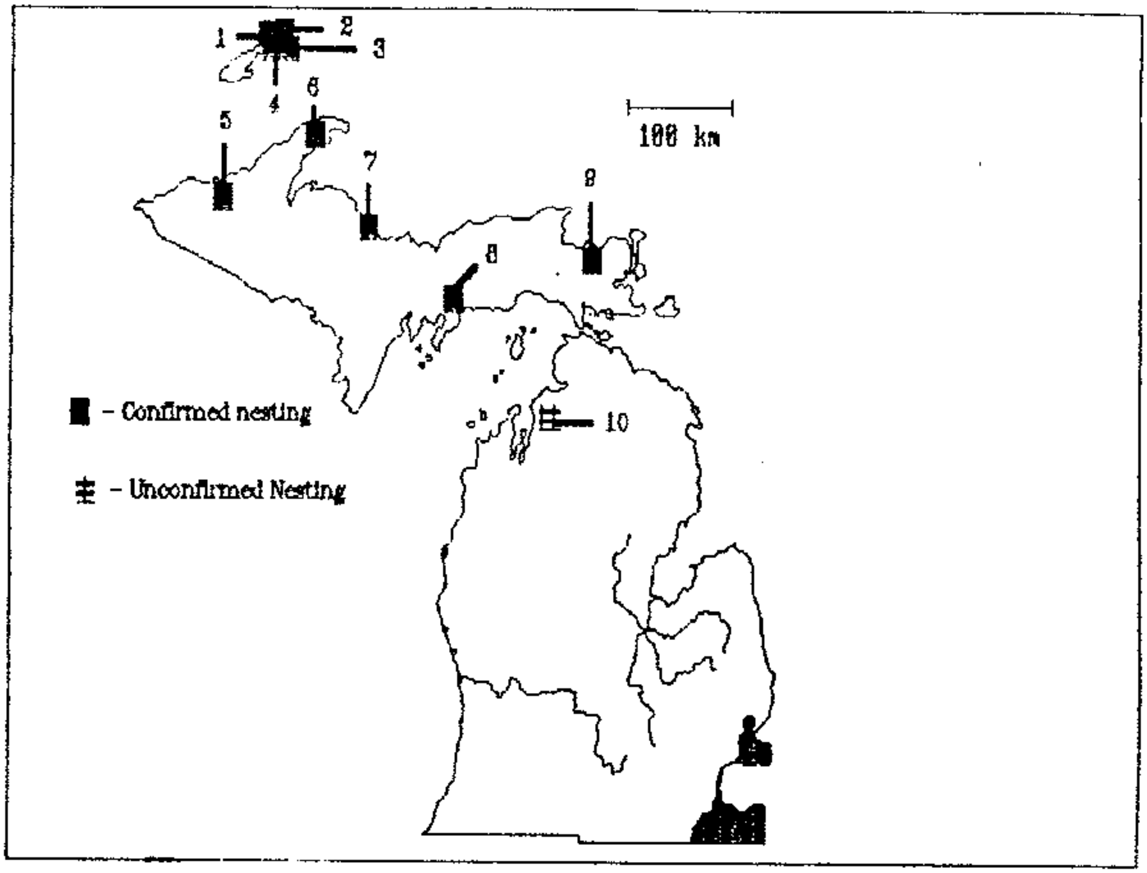

Figure 8. Probable merlin breeding locations in Michigan from 1983 - 1988

Map Key:

Location	Source
1 - Isle Royale (Keweenaw Co.)	Martin (1983)
2 - Isle Royale (Keweenaw Co.)	Martin (1984)
3 - Isle Royale (keweenaw Co.)	Weber (1987)
4 - Isle Royale (Keweenaw Co.)	Nemo (1986)
5 - Ontonagon County	Mcpeek (1988)
6 - Keweenaw County (peninsula)	Mcpeek (1988)
7 - Marquette County	Mcpeek (1988)
8 - Indian Lake (Schoolcraft Co.)	Postupalsky unpublished banding record (1988)
9 - Chippewa County	Mcpeek (1988)
10 - Atrim County - not confirmed	Mcpeek (1988)

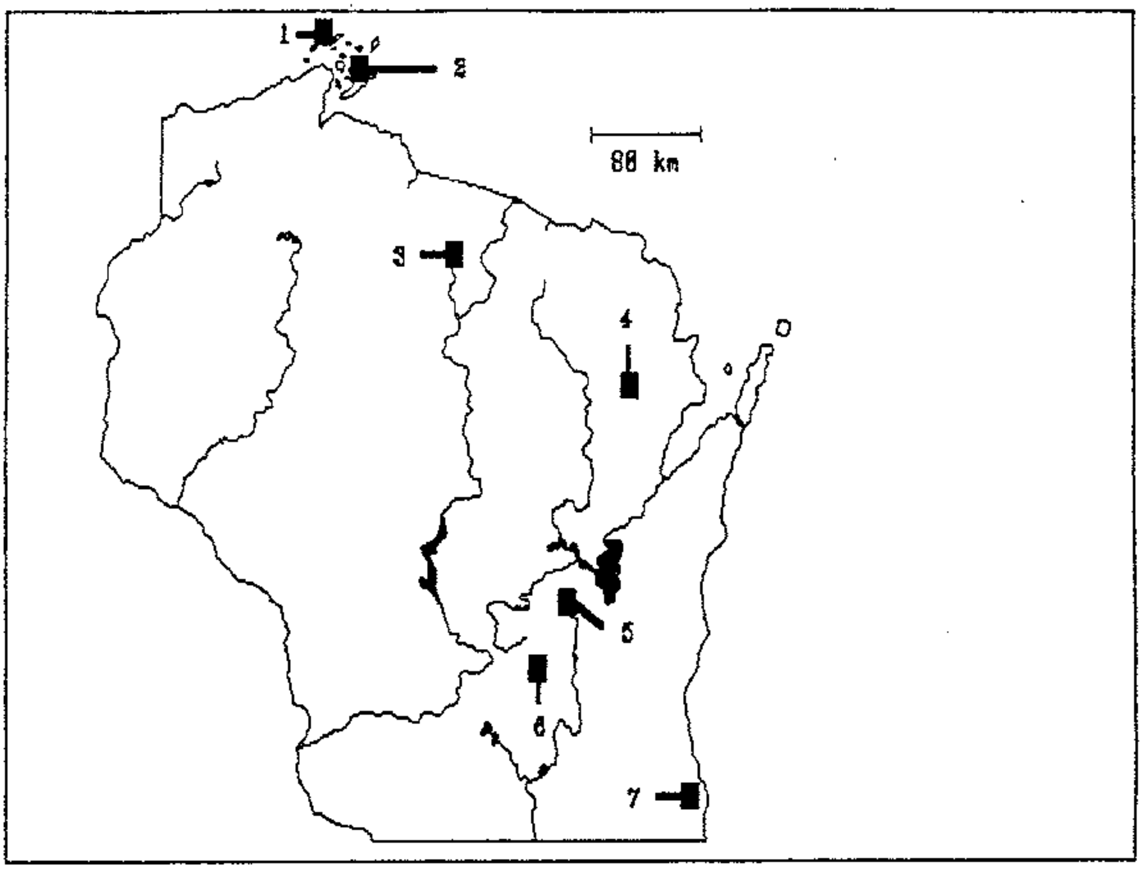

Figure 9. Merlin breeding locations in Wisconsin from 1852-1986

Map Key:

Location	Source
1 - Devils Island (Ashland Co.) in 1966	Beals (1967)
2 - Stockton Island (Ashland Co.) in 1985	Howk and Matteson (1985)
3 - Rainbow Fowage (Oneida Co.) in 1966, 67	Sidelar and Jacobson (1981)
4 - Armstrong plains (Oconto Co.) in 1897	Schoenbeck (1897)
5 - Southwest of Pine Bluff (Green Lake Co.)[1]	Lowe (1915)
6 - Cemetary in Columbus (Columbia Co.)[2]	Vos Burgh (1932)
7 - City of Racine (Racine Co.) in 1852	Kumlein and Hollister (1903)

(1) two nests in a tamarack swamp
(2) possible nesting in 1901, 1902, 1930, 1932 and 1939 (Milwaukee Public Museum records)

Anderson Bay, but a nest was not located (National Park Service files, 1985). Additionally, Sindelar et al. (1981) found a nest and fledged young on the Rainbow Flowage (Oneida County) in 1966 and recorded signs of activity in 1967.

The subjectiveness of historic documentation is an important bias to note, especially as there were so few historic records for merlins in the region. Upon review of the literature it is difficult to determine whether the merlin is re-occupying a former range or is colonizing a new region. The earliest historic evidence suggests that merlins were common breeders in the great pine forests of northern Wisconsin, as merlins were frequently observed hunting the northern lake shores and they were especially numerous in spring and fall (Hoy, 1852). Other southern records were from Green Lake County (Lowe, 1915), and Columbia County (Vos Burgh, 1932). These southern records are questionable as the descriptions were vague and the reporters deceased. Vos Burgh also recorded possible nestings in 1901, 1902, 1930, 1932 and 1939 in Columbia county (Milwaukee Public Museum records, 1990). Inventories conducted by Louis Agassiz's (1850) expedition commonly noted screaming kestrels on rocks along the shores of Lake Superior. With our knowledge of merlins and kestrels, we believe they were probaly merlins and not american kestrels. In conclusion, Upper Midwest forest communities and subsequent merlin nesting habitat have continually gone through dramatic changes, which have undoubtedly affected merlin populations. Most of the evidence collected establishes a measure of historic merlin presence and range, though nothing in regards to historic densities.

METHODS

In 1987, a cursory survey of the Wisconsin study area was conducted to assess the feasibility of researching the merlin in the Upper Midwest. The primary effort of the study was conducted on all study areas from 1988-1990, except Pictured Rocks National Lakeshore, Michigan, which was not surveyed in 1989 or in later years and Isle Royale National Park which was not surveyed in 1990 or 1991. In 1991, only the Wisconsin study areas were visited and a general survey of the Duluth, Minnesota and Superior, Wisconsin population was done. Additionally, no adults were captured in 1991, but young were banded and habitat analyses were done at the Chequamagon Bay study area and Voyageurs National Park. In March of 1992, the artificial nests were refurbished and checked for occupancy in June.

Postupalsky (1973) stressed that two checks (preferably three) of each occupied nest per breeding season should be conducted; one during early incubation to note the number of territorial pairs, and the second just prior to fledging to count the number of young raised. I chose to do a third visit between the two visits Postupalsky suggested. This additional visit proved valuable, as it verified active nests, gave additional time to find nests, created more time to collect prey remains, and resulted in the capture of one of the adults, generally the male.

The purpose of the initial survey of this study was to search for signs of breeding activity and occupied nests and this was done from 1 April through 6 June for all years. It was recorded as an occupied nest when two adults were present defending a nest. However, it was considered an occupied territory (sign of activity) when at least one adult defended an area, but no nest was found. These initial surveys were concluded by 15 May, except at Isle Royale where they were conducted in late May and early June for logistical reasons. From 10 June through 28 June a second survey was conducted, returning to determine active nests and to attempt the capture of adult males. The criteria for determining active nests were locations where incubation was observed. A third was made from 24 June through 21 July to determine site success, capture and band adults and young.

Captured adults were banded with standard aluminum U.S. Fish and Wildlife Service leg bands, weighed, photographed, aged, sexed, and assessed for current physical condition. Physical condition was judged by examining their state of molt, crop fullness, fat reserves, parasite presence, breast fullness, cere color and leg color. The young were banded in the nest, aged, measured and assessed as to their physical condition. The young were aged using reference photographs provided by the U. S. Fish and Wildlife Service, Division of Raptor Management studies, Juneau, Alaska in 1989. Pen and ink renditions from these photographs and additional photographs of merlin young at known ages have been included as an aging key (Appendix I.).

During each visit prey remains and molted feathers were collected, while un-hatched eggs and dead young were collected only during the third visit. All eggs and dead young were sent to the Wisconsin Department of Natural Resources pathology laboratory in Madison, Wisconsin for contaminant analyses. All prey remains were analyzed at the Cable Natural History Museum, Cable, Wisconsin using a reference collection. All data collected were entered on banding visit data sheets (Appendix II.).

Playback recordings were used to locate signs of merlin breeding activity. The recorded vocalizations were of an adult female distress call or a male's delivery chatter. They were played from a stereo cassette recorder at 100 decibels from the speaker. The sounds were produced by Cornell University, Laboratory of Natural Sounds, Ithaca, New York. To my knowledge playback recordings have not previously been used as a survey technique for taiga merlins. Oliphant (1988) had previously used tapes to find territorial richardson merlins in Saskatchewan, Canada. Playback recordings are known to be effective in initiating responses from woodland raptors (Balding, 1984, Mosher, 1987 and Rosenfield et al. 1985).

The vocalizations were played intially in areas of known merlin habitats as described by Temple (1969) and Craighead and Craighead (1940). Generally, these were areas with conifers near a large body of water, especially on islands and peninsulas.

The adult female distress call was the primary recording used and was played for 120 seconds followed by silence for 60 seconds to listen for merlin responses. This pattern of playing and silence was repeated three times before moving to another location. Usually the recording was played from a boat < 50 meters from shore. The preferable time period for using the recordings were the morning hours (0500-0800) when wind velocities and subsequent wave action were low. This increased the observer's chance of hearing a response.

In 1989, recordings were tested for general effectiveness by playing them at varying chosen times during the breeding season and at different times of the day to five active merlin nests. The distance a merlin would respond to the playback was tested by playing the recording during optimal weather conditions (noted above) from the stereo cassette recorder at distances of 2000, 1000, 750, 500, 250, 100, 50, and 25 meters from the merlin nests. Responses (positive or negative) were recorded for the corresponding distance.

It is important to note that some nest locations were not found using playback recordings. Sometimes park personnel, fisherman and others would report a merlin sighting. Additionally, during the initial survey period some merlin territories were located by scanning large dead snags along shoreline areas, edges of large terrestrial openings and on islands. This survey technique was especially useful on cool clear mornings. At these times females were seen sunning near or in the nest woods. Males were seen in snags also, but were not as indicative of an actual nest woods as many of their perches were used for hunting. I observed later in the breeding season that females used the same perches as during the intial survey when the young could thermoregulate.

Craighead and Craighead (1940) found all nests during the fledgling period by hearing and seeing food exchanges and by climbing trees to check nests for occupancy. On occasion I was able to use this technique, but territories found in this manner were usually confirmed by playback recordings. Nests were easier to locate if a food delivery was occurring. I observed that after a food delivery the female would feed in close proximity to the nest. Nests were not checked to determine clutch size, because of the possible harmful effect of human disturbance.

Aside from the study area, other shorelines were surveyed between 1 May 1989 and 15 May 1989. The purpose was to have a more absolute check for numbers of suitable nests on shorelines and to more extensively inventory Wisconsin for breeding merlins. Volunteer groups ranging in size from 15-25 persons transected the study areas. Playback recordings were used at 100 meter intervals and stick nests and merlin responses were recorded. Other volunteers in Wisconsin used playback recordings to survey the Chippewa Flowage, Turtle Flambeau Flowage, the Apostle Islands National Lakeshore, and interior agricultural sites near Ashland. Approximately 1,200 km of shoreline or edge habitat was surveyed in Wisconsin.

Adult merlins were captured using a great horned owl as a live decoy. Hammerstrom (1986) has used the same method to capture adult northern harriers (Circus cyaneus). The owl was positioned on a perch in an opening near a nest, in proximity to a food delivery perch or in a sunning area near the nest. A size CTX mist net was placed in front of the owl and each of the four tiers of the net were spaced only a foot apart to create a deeper than usual pocket. The free end of 30 yards of 60-lb test braided nylon fishing line on an automatic fly reel was affixed to a #4 Sampo snap swivel, which in turn was attached to the owls jesses. This gave the bander a means of moving the owl (by pulling on the line) which improved the chance of a merlin seeing it. The movement of the owl usually triggered an immediate defensive reaction from the merlin. The merlin(s) dove at the owl and was caught in the mist net. When the males were not in the immediate vicinity of the nest site or the trapping location was in thick cover and away from the immediate nest site, I would vocalize a barred owl (Strix varia) or a raven (Corvus corax) call to coax them over to the trapping location. The latter call was very successful.

A radio telemetry transmitter was used in this study. It was a 4 gram one stage type made by Wildlife Materials, Carbondale, Illinois. It was affixed by imping it into the #1 retrix. The imping needle was made from tonkin bamboo and the adhesive was Duro super glue. The antennae as made by the manufacturer were too long and were cut to match the bird's tail length. A video of this attachment method was made and can be requested from Wisconsin D.N.R., Bureau of Endangered Resources, Madison Wisconsin. The merlin fitted with the transmitter was a male from Michigan Island. Unfourtunately the transmitter failed within 48 hours after attachment.

Artificial nesting platforms were placed at several locations in northwestern Wisconsin. The objective was to determine if merlins would use artificial nest structures.

There were four nesting platforms placed on the Turtle Flambeau Flowage (Figure 10.) and five placed on the south

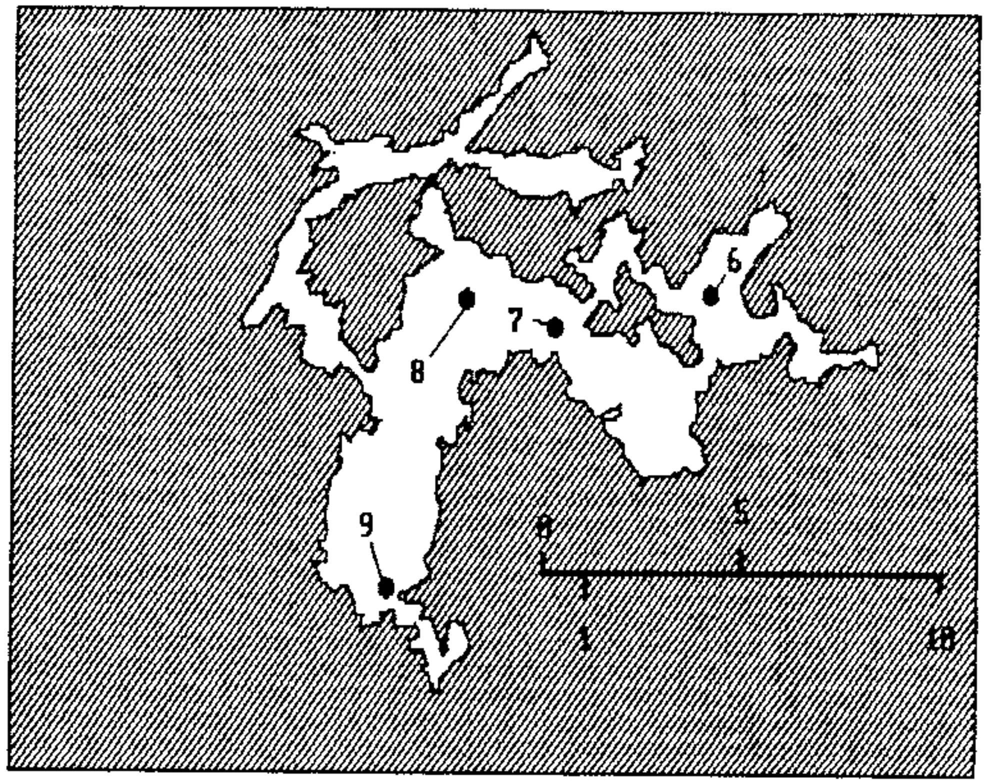

Figure 10. Locations of four artificial merlin nests on the Turtle Flambeau Flowage (Iron County), Wisconsin

Map Key:

Location

1 - East of Bonnie's Mound
2 - SSE of Fishermans Landing
3 - SSW of Norway Point
4 - South of Campground

shore of Lake Superior (Figure 11.). The artificial nests were made of three components: a cup (20" diameter x 8" deep), nest material, and attachment items (cooper wire, hex screws, washers, and plastic cinches). Two types of cups band nest linings were tested. The cups were a dark stained wicker cup or red osier dogwood, while old crow nests and wood chips were the two linings tested. The cups were a wicker fruit basket design (Siler, 1988).

When crow nests were used as the nest lining they were fumigated with insecticide to kill blow fly larvae and other parasites and partially sealed into the wicker basket with silicon caulking. The wood chips were placed as a base nest lining substrate in the cups, while white pine needles were sprinkled on the top to form a softer layer upon the chip base.

The nests were placed in the last suitable crotch in a conifer tree top. Plastic cinches and/or copper wire was used to attach the nest to the surrounding horizontal branches and the trunk (Figure 12.).

Structures were placed in March to avoid use by great horned owls (Bubo virginianus), which nest earlier. Additionally, placement of nests in exposed areas of shorelines and the relatively small nest size in the tree top deters use by owls.

Nesting habitat data were gathered at 52 locations within urban and forested sites by noting nest tree species,

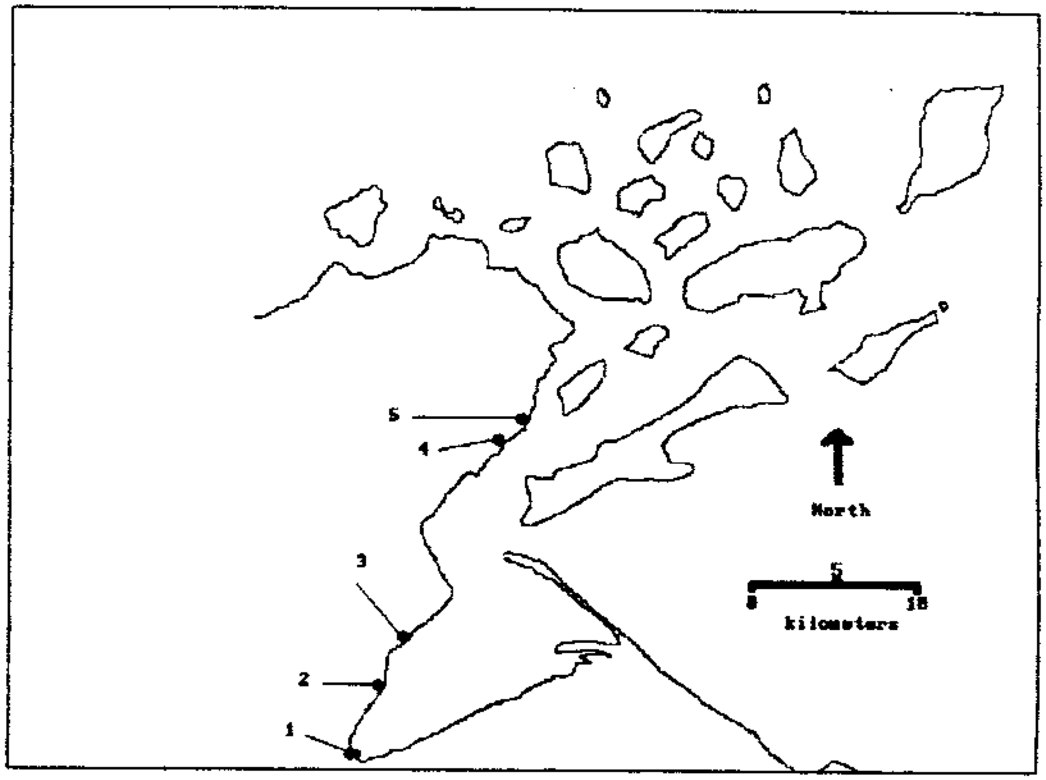

Figure 11. Locations of five artificial merlin nests in the Chequamagon Bay area

Map Key:

Location

5 - Peterson House (Bayfield Co.)
6 - S - Curve (Bayfield Co.)
7 - Washburn (Bayfield Co.)
8 - Pine Hurst (Bayfield Co.)
9 - Swevel (Bayfield Co.)

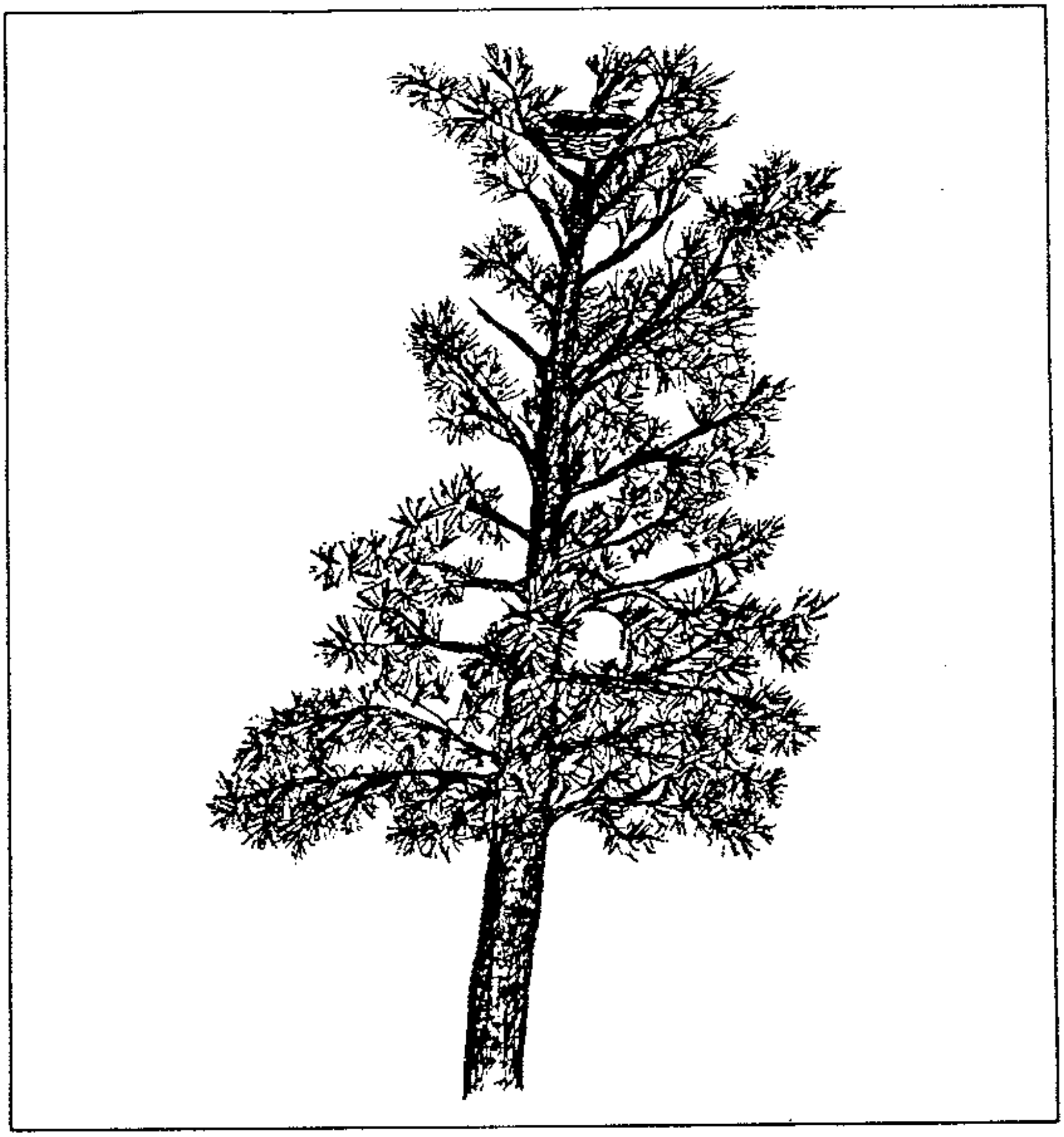

Figure 12. Placement of artificial merlin nest in tree

size (dbh), nest placement, height, condition and the number of other suitable nests in the nest woods.

Forest vegetation analyses were conducted at 40 traditional (non-urban) nest woods in 1991 using the quadrat method (Greg-Smith, 1964). Each nest woods community was sampled once by using a merlin nest tree as the sample plot locus. Each 1/100 of a hectare circular plot was conducted from the nest tree locus and within all quadrats tree species (with a dbh > 10 cm), and presence of saplings (with a dbh ≤ 2.5 cm) was recorded by species. The distance of the nest to a dominant edge (i.e. shoreline, field edge) and significant perturbations were also recorded for all plots. Additionally 65 randomly picked non-nesting areas, which were representative of the area, were surveyed at Voyageurs National Park and the Chequamagon Bay area. The non-nest areas were sampled to provide a comparison of merlin nests woods to the surrounding vegetative communities. There were eight non-nest areas at Voyageurs National Park with a total of 40 randomly chosen plots (Figure 13.) and five non-nest areas and 25 randomly picked plots at the Chequamagon Bay area (Figure 14.). The non-nest plots were sampled using the same technique that was used in merlin nest woods. Relative density for each tree species were determined for merlin nests woods and non-nest areas. Sapling data will assist in predicting the next generation of tree species to determine the stability of the forest communities merlins use.

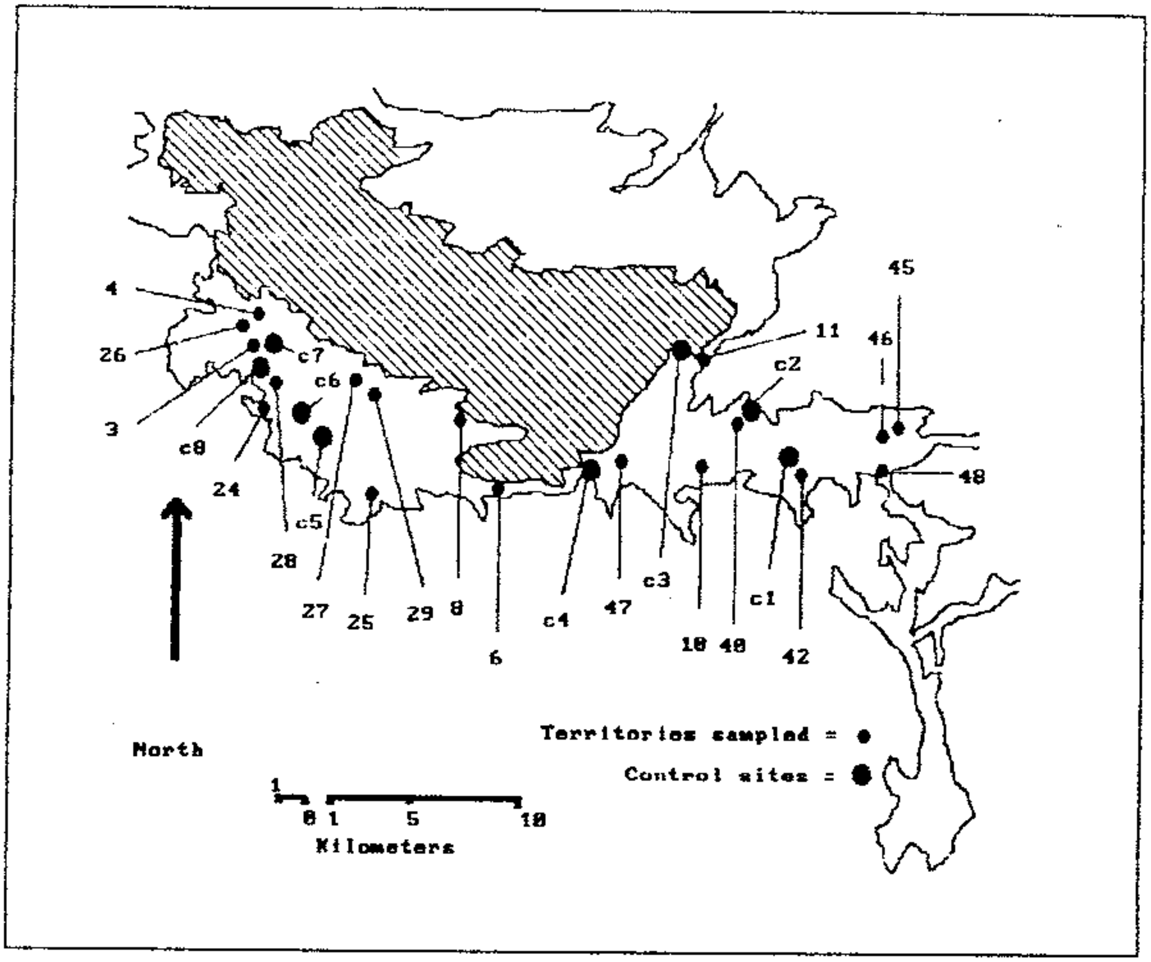

Figure 13. Locations of habitat analysis plots at Voyageurs National Park

Map Key (for non-nest sample areas)

Location

c1 - NAM Pike Island
c2 - NAM N. of Blackstone (Ontario Mainland)
c3 - NAM West of Mica Island
c4 - NAM S. of Blind Indian Narrows
c5 - KAB Harris Island
c6 - KAB Largest Sheep Island
c7 - KAB Eastern 3 - Sister
c8 - KAB S. of Wooduck (Yew)

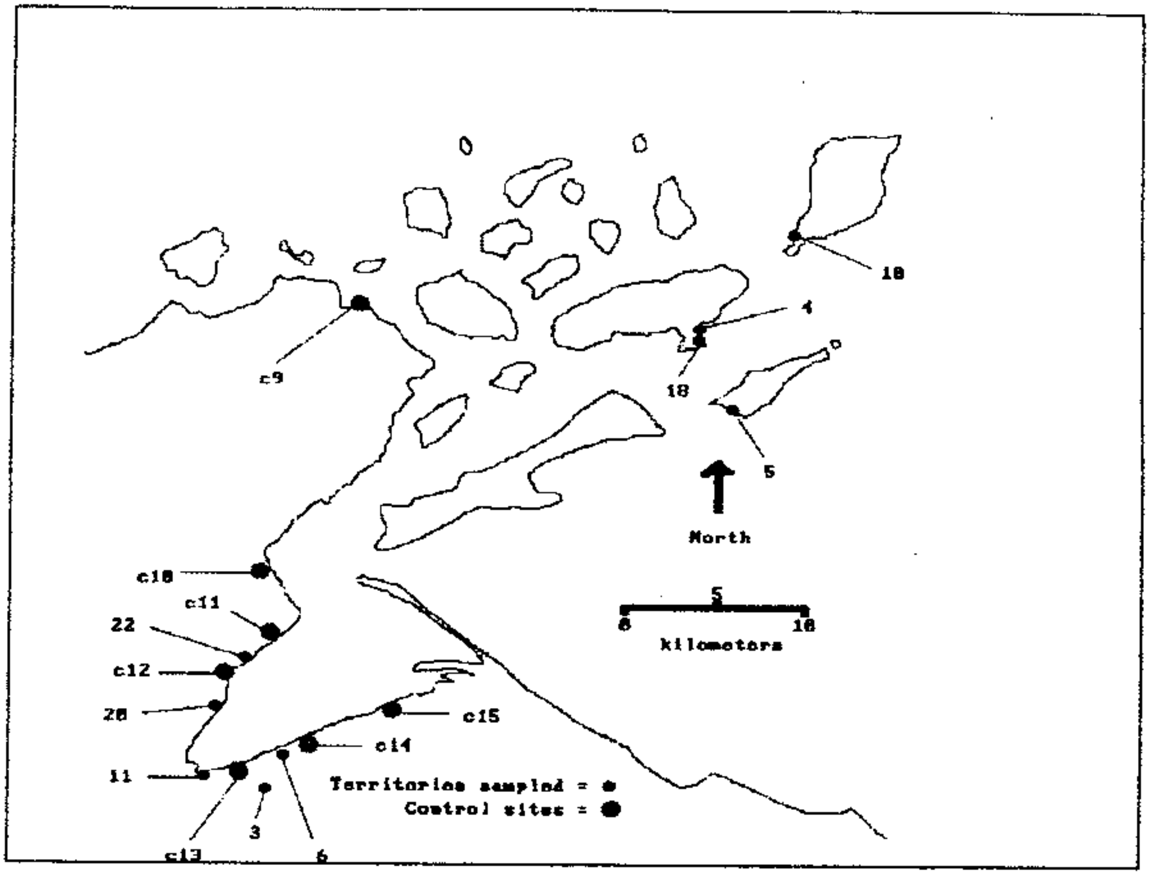

Figure 14. Locations of habitat analysis plots at the Apostle Islands and Chequamagon Bay area

Map Key (for non-nest sample areas)

Location

c9 - Raspberry Point (Bayfield Co.)
c10 - Kjarvik Road (Bayfield Co.)
c11 - Gary Road (Bayfield Co.)
c12 - Vandeventer Bay (Bayfield Co.)
c13 - Sanborn Ave. (Ashland Co.)
c14 - Lake Park (Ashland Co.)
c15 - End of Bay Front Road (Ashland Co.)

Available literature notes that merlins use a broad spectrum of breeding habitats throughout their northern holarctic distribution. However, in the Upper Midwest, breeding habitats are associated with nest availability in conifers with an affinity to a large edge, and not the interior woodlands. Generally, in this study the dominant edge was a shoreline. Furthermore, it was found that if the perimeter of the shoreline was irregular and exceeded 161 km one is more likely to find breeding merlins. Areas with dense aggregations of lakes, or a large lake with an irregular shoreline with many islands seemed ideal. Therefore, merlin distribution within the study areas was not uniform and it is not representative to give a measure of density by merely dividing breeding pairs by the total area of study. A more logical means is used in this study, expressing density as the mean number of breeding merlins/km of shoreline. However, the pattern of nest distribution per km of shoreline is aggregated not random. Thus, in this study a second and more traditional method to express density is also used, the mean spacing of nests.

A breeding population estimate for Minnesota and Wisconsin was determined by isolating lakes, within the known breeding range of the state, which had a shoreline configuration $\geq$ 161 km. The total available shoreline for the state was divided by the mean number of merlin pairs/km of shoreline for all study areas.

RESULTS AND DISCUSSION

A. Banding Results

Sixty-five adult merlins (36 males; 29 females) were captured from 1987-90. The mean weight for males was 148.6 gm and females averaged 219.7 gm. Six breeding females were second year birds. There were only two occurrences of ecto-parasites on adults, both were on females and were louse flies in the family, Hippoboscidae. Mean breast fullness (on a 5 point scale) was 3.8 for males and 4.2 for females; their placement on this scale indicates that the birds were healthy.

A female which was originally caught in 1989, was recaptured the following year in a different territory (Appendix III). Another banded female was seen in a new territory at Voyageurs National Park in 1990, but was not captured. On seven occasions it was observed that when the same territory was reoccupied in a subsequent year it was by a different female. These data indicate that females show no indication of site fidelity, but apparent degrees of regional fidelity.

Of seven territories where males were caught in 1988 only one male was recaptured in 1989 on the same territory.

Similarly, of 21 males caught on their respective territories in 1989, only 3 were recaptured in 1990. In 1990, new males were caught at 4 territories which had been occupied by a different male a year earlier. This low site fidelity results in an estimated annual turnover of 86% is exceptionally high. A similar turnover rate of adults was noted at Denali National Park, Alaska (Schempf and Titus, 1989). However, there is a problem in accurately determining turnover of adults, because of the small sample size of adults captured and the short duration of the study. The sample is small, because it is not always possible to capture all adult birds to mark them for later recognition and if the bird is captured and marked, it may become difficult to recapture. Capture and recapture is made more difficult, because some birds initially defend an area and then abandon it within a few days. The reason for a bird defending a nest area and then leaving remains unknown. An example is a banded male that arrived in his territory at Voyageurs National Park and was defending a site where the nest had blown out. I had banded a male at this location on the previous two years. He defended the site for a short period of time and disappeared. Similar events happened at other sites and I never found alternate nests. Therefore, I feel the 86% turnover of breeding males is lower than my banding data reflects. Additionally, I realize there is not enough banding data to be definitive about merlin population dynamics for the region, but continued banding efforts (especially the capture of adults) would in time provide needed knowledge on merlin breeding ecology.

Even though the same merlins did not occupy the same nest in subsequent years other merlins usually did. This high rate of re-occupancy was evident at 31 nests where banding occurred from 1987-90. Twelve nests were occupied for 3 successive years, while 9 and 10 were occupied for 2 years and 1 year respectively. Presently, some territories have been occupied for five consecutive years. Only 2 of 31 nest sites were successful for three consecutive years, while 10 sites were successful for 2 years, and 18 sites were successful for one year. One territory located at Michigan Island, Apostle Islands National Lakeshore was occupied for 3 years and failed each year. The chance of a merlin territory being successful for three consecutive years is poor. This poor nest success is almost directly parallel to the rate nests will deteriorate. Ninety percent of nests are not suitable within three years for merlin nesting due to physical deterioration.

Possible reasons for the high turnover rates and lack of nest success may be the synergistic functions of the merlins bio-energetics and behaviors. The energetics factors are related to body size and food requirements.

Merlins use a considerable amount of energy to lay eggs (almost 50% of their body weight) in comparison to a large species like a golden eagle (Aquila chrysaetos) (Newton, 1979), which uses only 3-5% of her body weight (Brown, 1980). Similarly, food requirements are higher for small raptors in proportion to their bio-mass (Craighead and Craighead, 1969). Data from captive raptors suggests that larger species are longer - lived (Newton, 1979). Though Steve Duecker (1989) of Danbury Iowa, has a captive male richardson merlin that is 10 years old and a female that is six. However on the average, wild merlins should have shorter life spans than captive merlins. Prior to laying and during incubation, weather and food availability can have a great effect on the reproductive success of small species. These factors would have to be exceptionally dramatic to affect a large raptoral species (Brown, 1976).

Low nest success and high rate of turnover may be related to the behavioral trait of merlins not building their own nests. The nest structure itself degrades usually within three years, because it is not refurbished. Also merlins utilize nests that occur in exposed areas and therefore are more prone to detrimental effects of climate prior to egg laying and during incubation.

Additionally, this sub-population of merlin may have a higher turnover, because they are more nomadic and do not exhibit a strong sense of site fidelity. Also, the study area is at the southern range of the taiga merlin and subsequent high turnovers may be due to marginal habitat. Lastly, nests may be occupied on a first come first serve basis in areas of high breeding densities.

None of the 140 young banded since 1987 has been recaptured as a breeding adult (Appendix III). However, as one half of the young were banded in 1989, they would not have been breeders until 1991 and there were no adults captured in 1991.

There were four band recoveries during non - breeding periods. There were no specific migratory patterns shown other than southern movement. The furthest distance travelled by a migrant merlin was a female banded in Iron County, Wisconsin, which was found dead in Florette, Alabama (Figure 15.).

B. Productivity

There were 145 areas with signs of breeding activity and these occured at all study locations for the years 1987-1991. There were 112 occupied nests and 65 were successful (Table 1.). All territories combined produced 191 young with a mean productivity of 2.9 young/successful nest (Table 2.).

Voyaguers National Park had the greatest production with

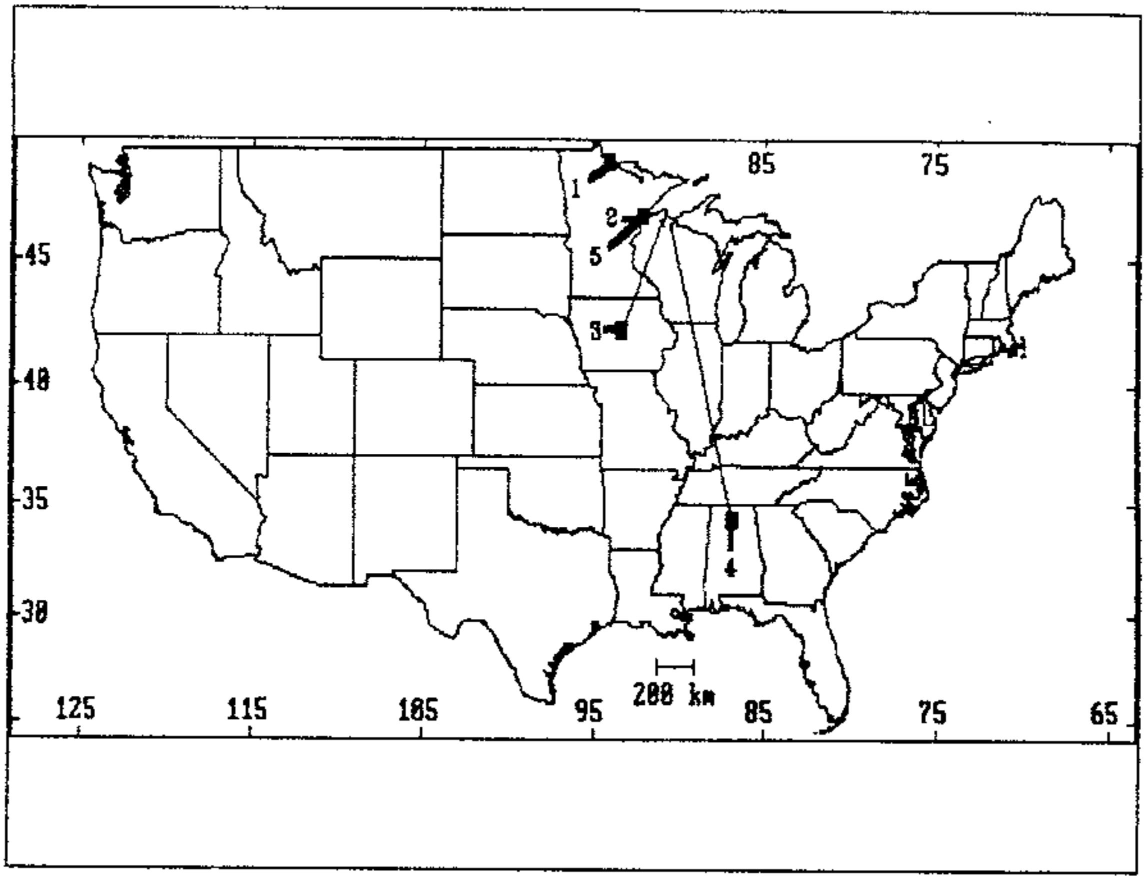

Figure 15. Band recoveries of merlins during non-breeding periods

Map Key:

Banded	Recovered
1 - Voyageurs National Park (St. Louis Co.), (Lake of the Woods Co.)	Minnesota Baudette, Minnesota
2 - Superior (Douglas Co.), Wisconsin	Superior (Douglas Co.), Wisconsin
3 - [1]South of Ashland (Ashland Co.)	Northwood, Iowa
4 - Turtle Flambeau Flowage (Iron Co.), Wisconsin	Florette, Alabama
5 - Duluth (St. Louis Co.), Minnesota	Hawk Ridge, Duluth (St. Louis Co.), Minnesota

(1) - banded by Neil Neimuth of Ashland, Wisconsin

106 young from 33 successful nests. The Chequamagon Bay area in Wisconsin, produced 47 young from 12 successful nests, although only four young were produced in a nest within the boundaries of the Apostle Islands National Lakeshore. The remaining 14 sites produced 34 young (Table 3.).

Table 1. Merlin productivity at 102 territories in the Upper Midwest

Year	# sign of activity	# occupied nests	# active nests	# successful nest	# of young
1991	16	14	14	11	22
1990	32	26	18	16	54
1989	54	42	28	23	74
1988	38	27	16	13	37
1987	5	4	3	2	4
Total	145	112	78	65	191

Table 2. Mean productivity for all study locations

Year	mean/ sign of activity	mean/ occupied nest	mean/ active nest	mean/ successful nest
1991	1.4	1	2	2.8
1990	1.7	2	3	3.4
1989	1.4	1.8	2.7	3.4
1988	1	1.4	2.5	2.8
1987	.8	1.3	2	4
Mean	1.3	1.7	2.4	2.9

Table 3. The number of merlin young produced and total nests for each study area from 1987-1991
( ) = # of successful nests

Year	Duluth Superior	Cheq. Bay and Apostles	Turtle Flambeau	Voyageurs	Isle Royale
1991	13(5)	6(2)	3(1)	-	-
1990	6(2)	20(5)	2(1)	26(8)	-
1989	-	18(4)	-	53(17)	3(1)
1988	-	3(1)	-	27(8)	7(4)
1987	-	4(1)	-	-	-
Total Nests	7	13	2	33	5
Total Young	19	51	5	106	10

The highest mean productivities were within the Chequamagon Bay area and the Apostle Islands study areas with 3.7 young/successful nest being produced. Voyageurs National Park produced 3.2 young/ successful nest. Isle Royale, the Turtle Flambeau Flowage and the urban populations of Duluth and Superior produced 2.4, 2.5 and 2.8 young/successful nest respectively. The sample of nests from the latter locations were too small to detect trends.

Of 106 young produced at Voyageurs National Park, Kabetogema Lake was the most productive with a mean of 3.6 young/successful nest, while Rainy Lake had the least of 2.9 young/successful nest (Table 4.). Rainy Lake and Namakan Lake were very close in overall production. Sand Point and

Crane Lake had no signs of breeding activity. The reasons for the absence of merlins on Sand Point and Crane Lake may be that both lakes have a less convoluted shoreline and abrupt slopes rising from their shores.

Table 4. Comparison of mean productivity between lakes at Voyageurs National Park

Year	Kabetogema	Namakan	Rainy	mean/year
1990	3.6	3	3	3.2
1989	3.1	3.4	2.8	3.1
1988	4	3	3	3.3
mean for all years				3.2
mean/lake	3.6	3.1	2.9	

Recently merlin populations have shown a marked decline in some areas in Great Britain (Newton et al., 1981; Meek, 1988). Olsson (1980) from a sample of 53 successful nests recorded a mean of 2.6 young/nest, which was considered a stable merlin population. In a declining population of merlins in Northumbria, Great Britain, the average production was 1.9 young/nest (Newton, 1986). In Wales changes in habitat were associated with poor nest success of 1.5 chicks fledged/pair annually (Bibby and Nattrass, 1986). This contrasts to a Northumberland population in Great Britain that had a mean brood size of 3.3 young/nest and exhibited a marked improvement from 1971 -1976 coinciding with a reduction in the use of organochlorines (Newton, 1978). Schempf and Titus (1989) from a sample of 16 nests in Denali National Park, Alaska recorded 3.2 young/active nest. Temple (1972b) in a sample of 19 successful nests in Newfoundland noted a mean brood size of 3.0/nest, and that this population may be exhibiting deleterious effects of organochlorine biocides. Healthy richardson merlin nests (n=47) produced a mean of 4.0 young/successful nest (Oliphant, 1978). Prior to 1947, productivity from a sample of 15 nests in eastern Canada was noted to be 3.8 young/nest (Temple, 1972b).

During this study in the Upper Midwest 65 nests produced a mean of 2.9 young/ successful nest. Compared to the literature cited above this suggests a stable population. It should be noted that some areas studied in the Upper Midwest had excellent productivity. Roberts (1983) found that only 22.7% of active pairs produced young within his study area at North Wales in the United Kingdom. In this study, eighty-three percent of active nests in the Upper Midwest produced young. In my opinion the latter figure indicates adequate nest success.

C. <u>Contaminants</u>

Merlins, like other bird eating raptors, showed marked declines in egg shell thickness, since the post 1945 introduction of organochlorine biocides (Newton et al.,1982; Newton, 1973). To date only one egg collected at Michigan Island on 27 July 1987 has been analyzed for anthropogenic toxins. Analyses showed PCB levels of 2.3 ppm and levels of dieldrin, toxaphene, and para DDE were .16 ppm, 1.0 ppm and 2.4 ppm respectively. These organochlorine values are considered low. This sample (n=1) is inadequate to determine any contaminant impacts upon Upper Midwestern merlin populations.

Organochlorines may affect birds under nutritional stress due to the redistribution of these substances within the body in connection with starvation (Holt et al., 1978). Elevated Heptachlor and DDE residues were found in a merlin that died after migrating (Henny et al., 1976). Therefore populations under nutritional stress may be more prone to the effects of organochlorine biocides.

Of notable concern were merlin nests visited on Isle Royale and the Apostle Islands where there were nest failures and poor condition of young. The merlin young's cere and leg color were pale (chalky), and they were dirty and weak. Runts were found in three nests at Voyageurs National Park in 1989. Although they could be the result of latent eggs (Brown, 1976). There was a high incidence of nest desertion and poor chick survival associated with an abundance of dragonfly remains at nests, the reason is not known. Anthropogenic toxins remain as a possibility for nest failure, although most raptor species in North America exhibit higher productivity and marked population comebacks since the ban on DDT in 1972 (Evans, 1982).

D. Present Distribution, nest spacing and density

During the study period merlins were shown to nest in Minnesota as far South as southern St. Louis County (Duluth). In Wisconsin the southern limits of breeding were recorded in Sawyer County and in Michigan there was an unconfirmed southern breeding record (Michigan breeding bird Atlas, 1988) in Atrim County (Figure 16.).

1. Voyageurs National Park

At Voyageurs National Park, Minnesota from 1988-1990 there were fifty territories that had signs of breeding activity during the initial survey in April. These territories were subsequently occupied for one or more years. The mean distance between areas with signs of activity for all years was 5.4 km, while the mean distance between active nests was 10.3 km. However, the closest triad of active nests was 2.6, .75, 1.9 kilometers. During the initial visit, Voyageurs National Park appeared to be saturated with merlins and some pairs were only .5 km apart. During the second visit there was a noticeable

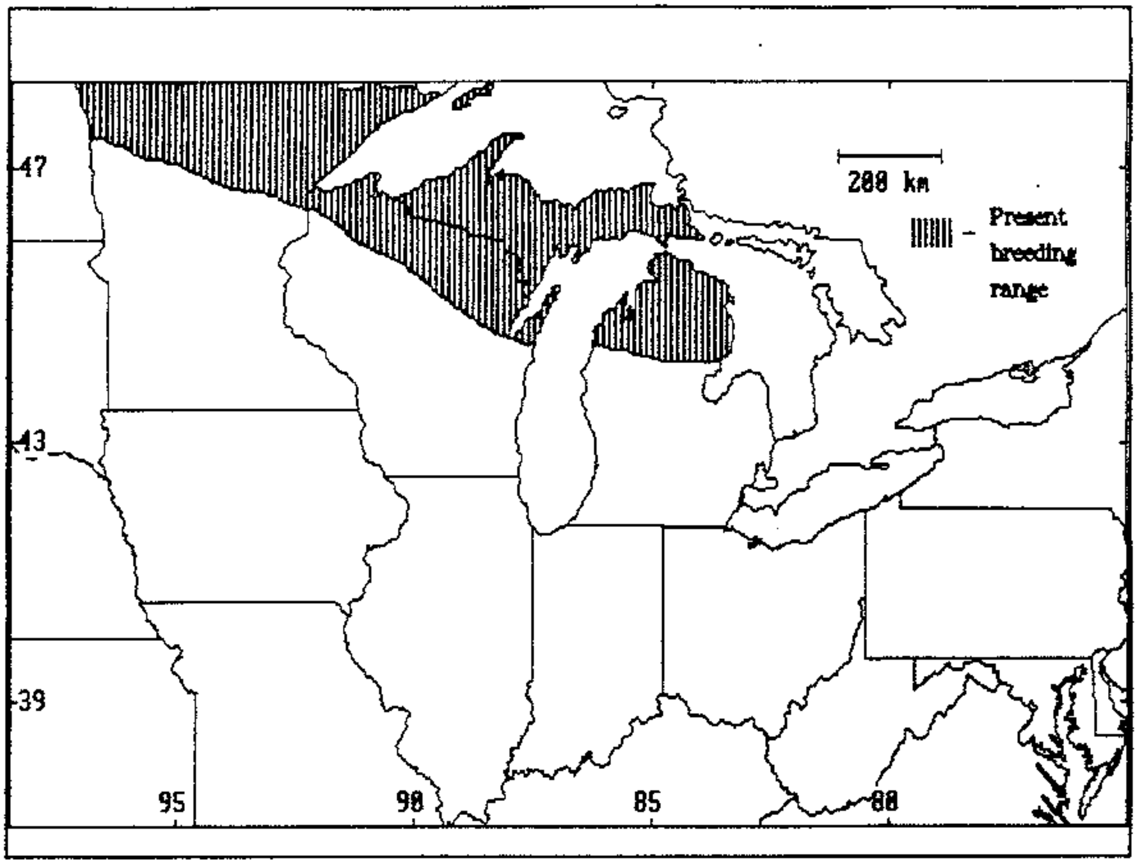

Figure 16. Present breeding range of the eastern merlin in Minnesota, Wisconsin and Michigan

decrease in the number of active nests (Figures 17 - 22.). The density for all years for active nests was calculated at a pair/49.8 km^2. A second, and perhaps a more meaningful measure of density was an active merlin nest recorded for every 94 km of shoreline (Table 5.).

2. Chequamagon Bay area and the Apostle Islands

The sample on the Apostle Islands was very small with a mean of 2 areas exhibiting signs of activity/year, while

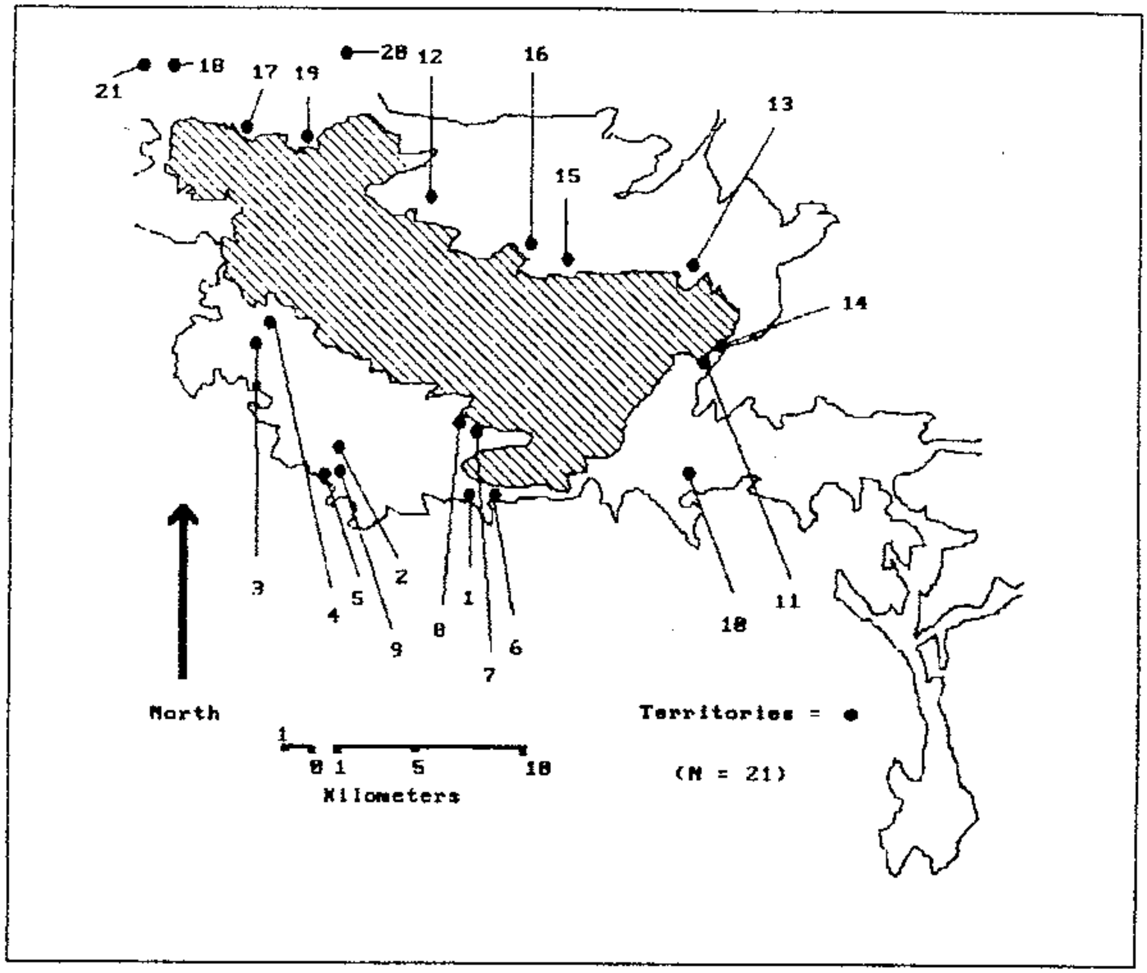

Figure 17. Locations of merlin territories at Voyageurs National Park in 1988

* Numeric code will match with apppendix IV for further information

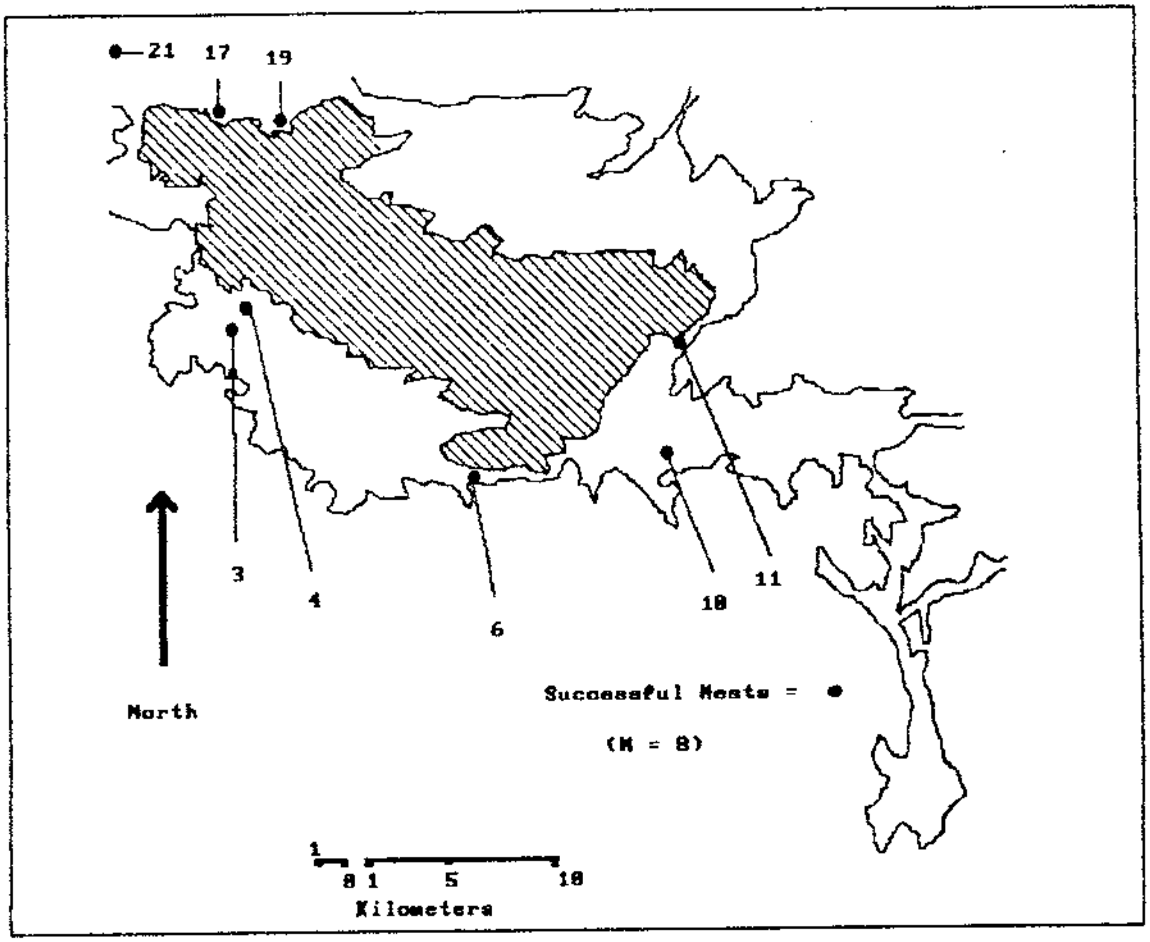

Figure 18. Distribution of active merlin nests at Voyageurs National Park in 1988

* Numeric codes will match with appendix IV for further information

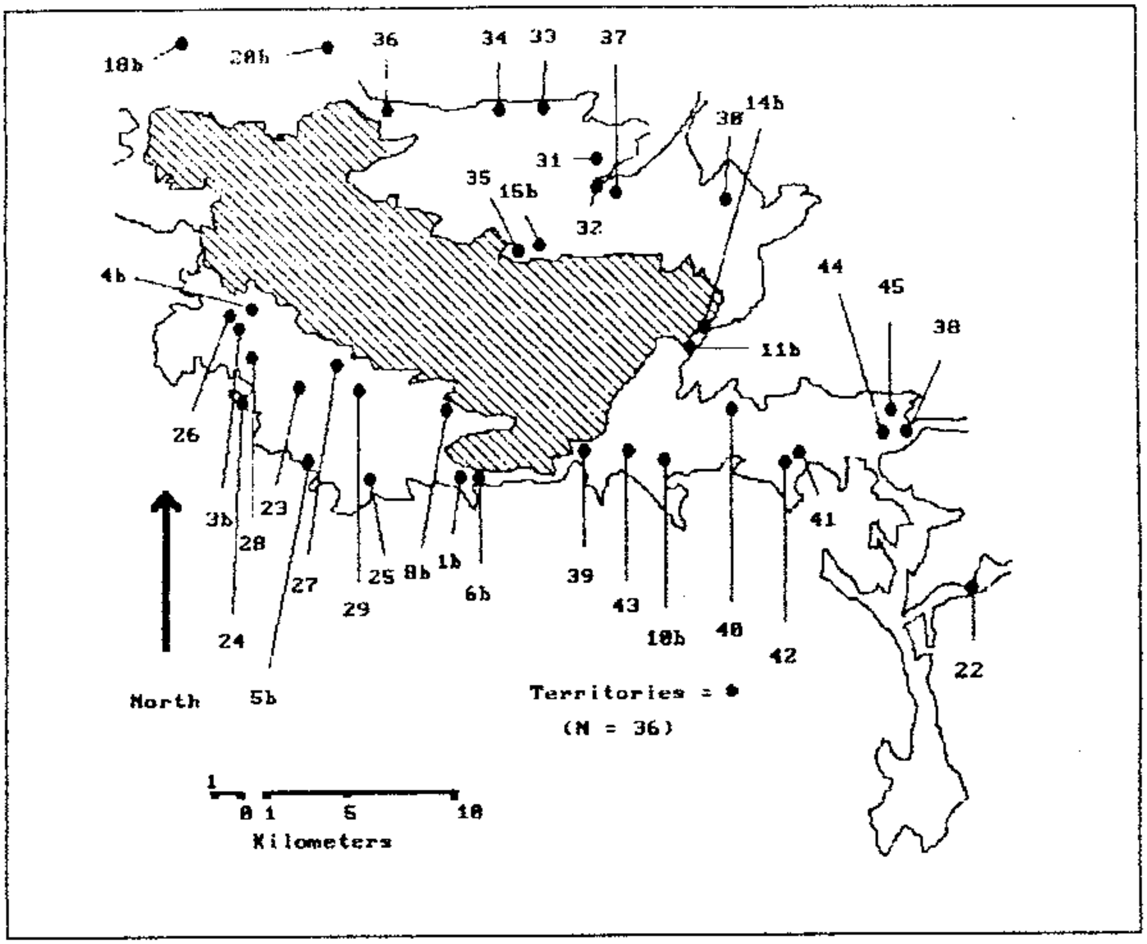

Figure 19. Locations of merlin territories at Voyageurs National Park in 1989

* Numeric code will match with apppendix IV for further information

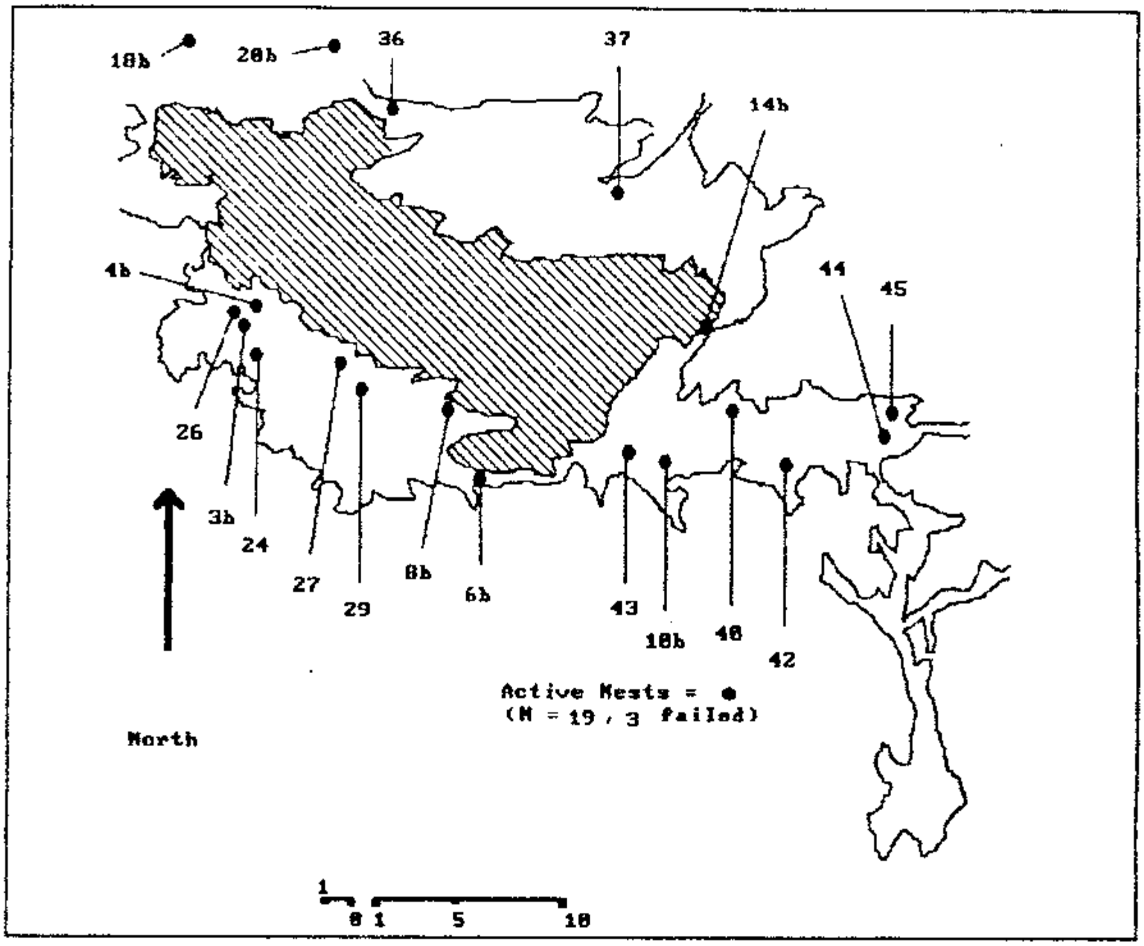

Figure 20. Distribution of active merlin nests at Voyageurs National Park in 1989

* Numeric codes will match with appendix IV for further information

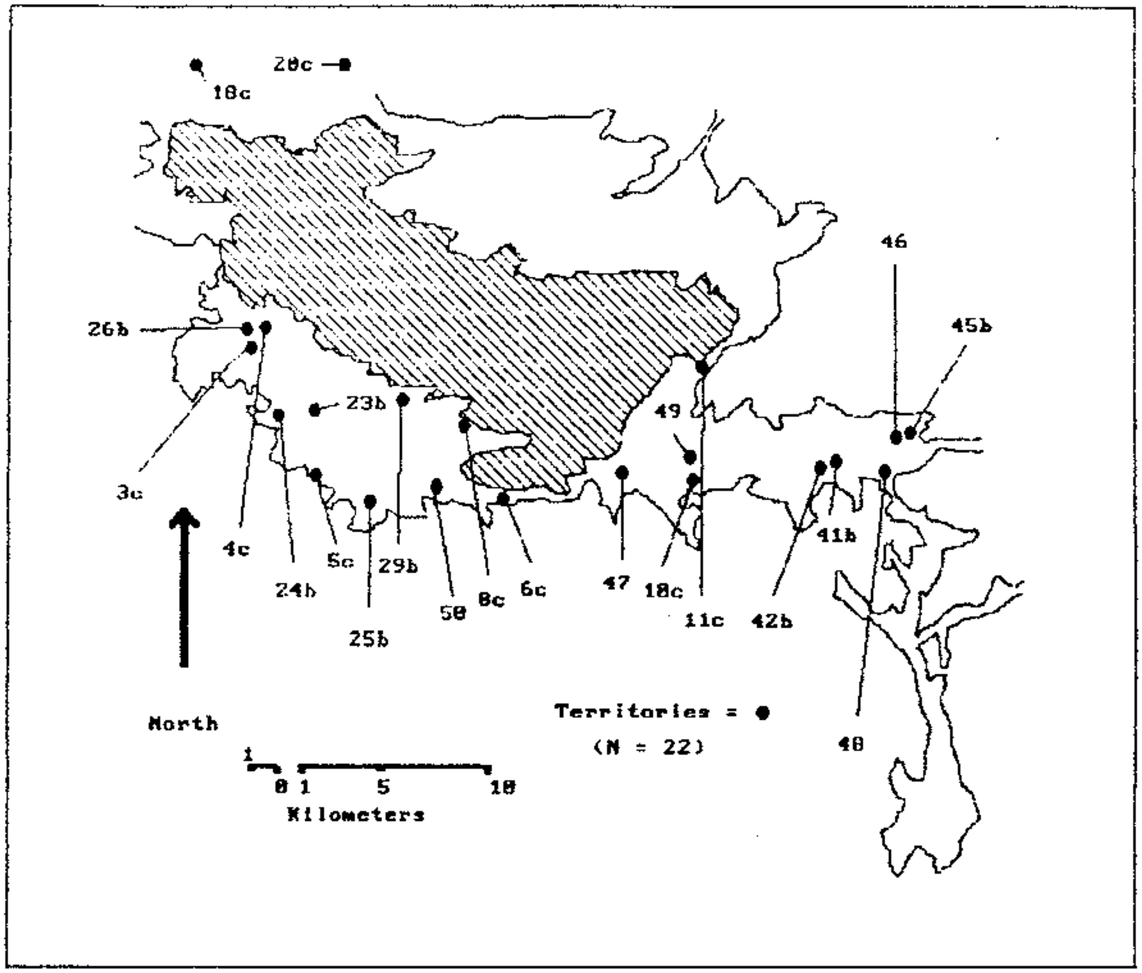

Figure 21. Locations of merlin territories at Voyageurs National Park in 1990

* Numeric code will match with apppendix IV for further information

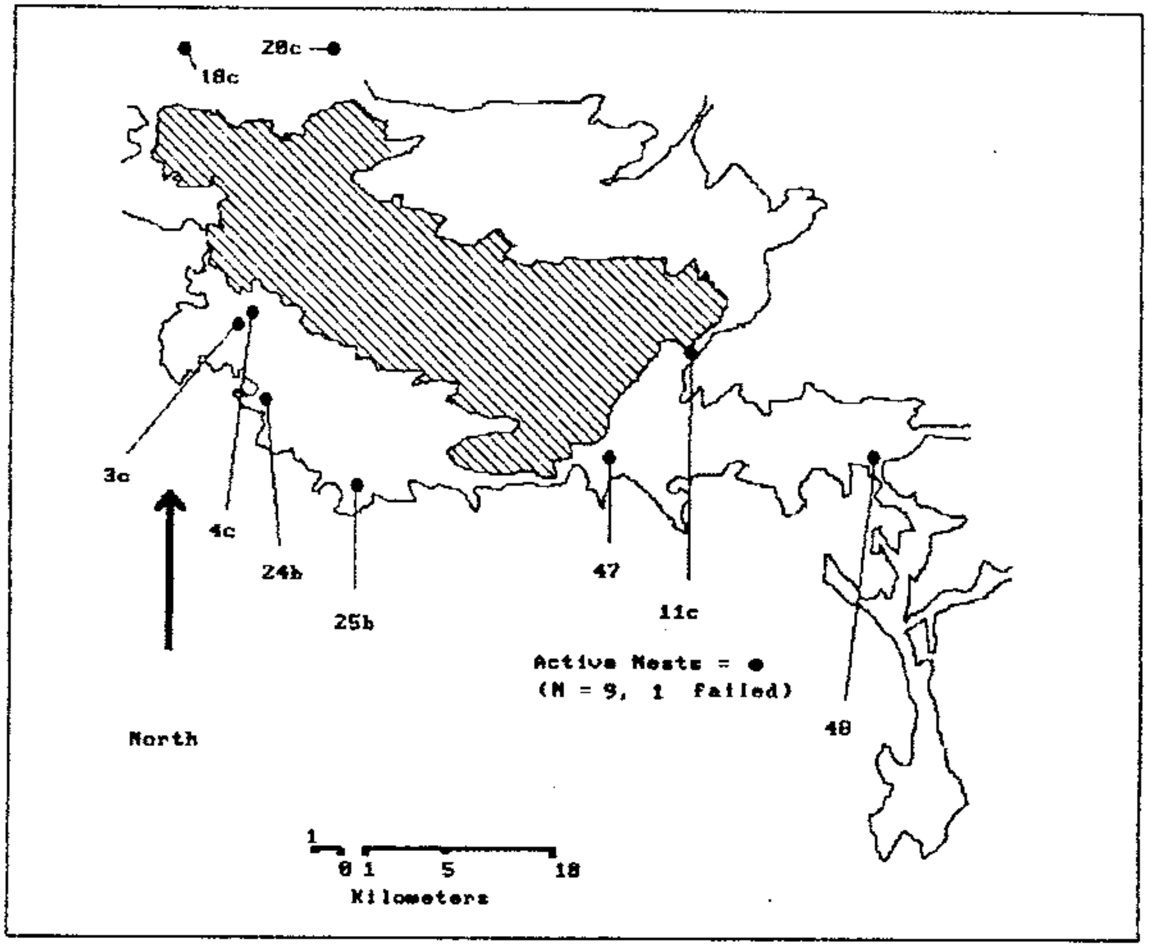

Figure 22. Distribution of active merlin nests at Voyageurs National Park in 1990

* Numeric codes will match with appendix IV for further information

Table 5. Spacing (km), density (km^2) and merlin pairs/kilometer of shoreline for areas with signs of activity in comparison to active nests at Voyageurs National Park

Year	mean spacing of areas with signs of activity (km)	mean spacing of active nests (km)	density (km^2) for areas with signs of activity	density (km^2) for active pairs	km of shore/ merlin for areas with signs of activity	km of shore /merlin for active nests
1988	6	11.1	25	60.4	48.8	114
1989	4.3	6.7	15	28.6	28.5	54
1990	6	13	24.7	60.4	46.6	114
Mean	5.4	10.3	21.6	49.8	41.3	94

only one of seven nest attempts was successful. Possible reasons for this poor nest success will be given later within the Isle Royale section. The Chequamagon Bay coast was more productive than the Apostle Islands averaging an active nest/56 km of shoreline (Figure 23.). For both the Chequamagon Bay area and the Apostle Islands National Lakeshore, Wisconsin, the mean spacing for active nests was a mean of 22.9 km (Figure 24.).

3. Turtle Flambeau Flowage, Wisconsin

The Turtle Flambeau Flowage in Iron County, Wisconsin has a shoreline length of 340 km and had a mean of 1.6 areas with signs of activity, while only one pair was active each

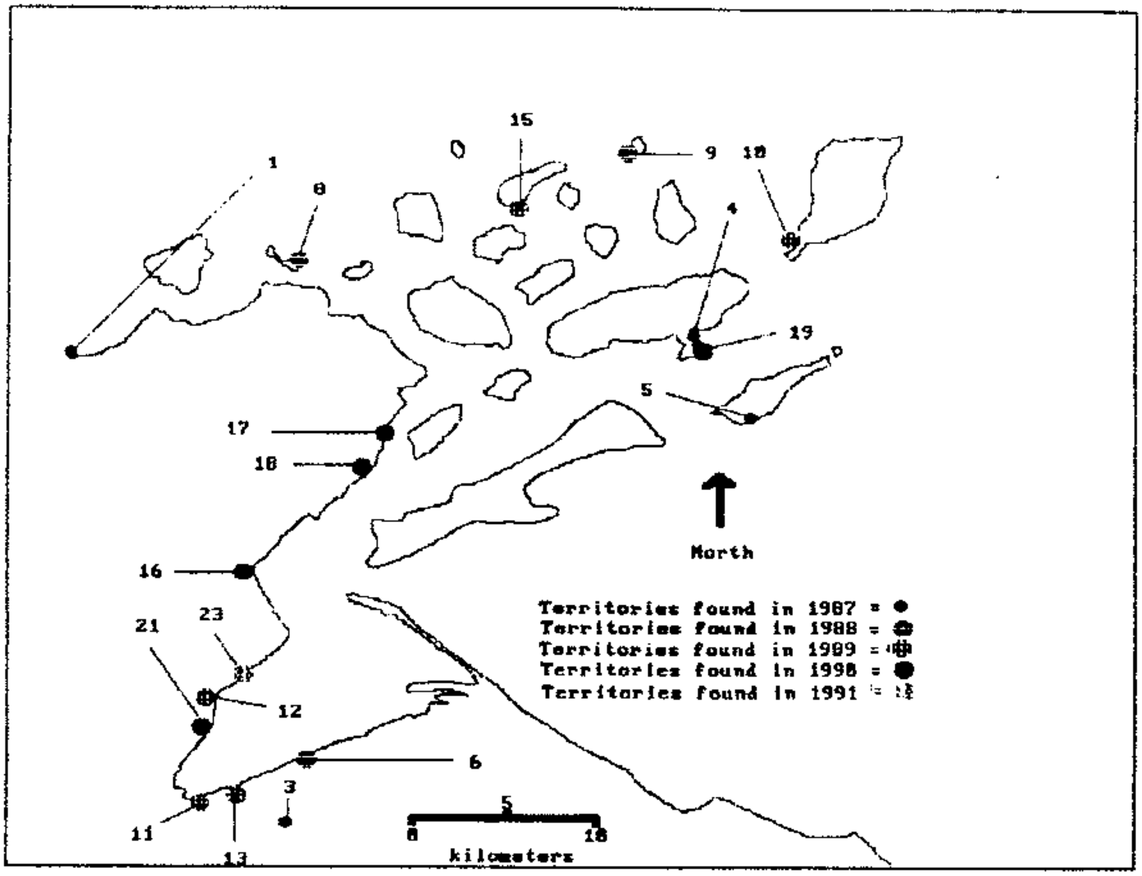

Figure 23. Areas with signs of activity (n=18) at the Apostle Islands and Chequamagon Bay area from 1987 - 1991

Map Key:

Location/Status

1 - Lost Creek (Bayfield Co.), Sign of Activity
3 - Pierce Road (Ashland Co.), Successful Nest
4 - Stockton Julian (Ashland Co.), Successful Nest
5 - Michigan Island (Ashland Co.), Active Nest
6 - Second Landing (Ashland Co.), Successful Nest
8 - York Island (Bayfield Co.), Occupied Nest
9 - North Twin (Ashland Co.), Sign of Activity
10 - Outer Island (Ashland Co.), Active Nest
11 - Prentice Park (Ashland Co.), Successful Nest
12 - N. of S - Curve (Bayfield Co.), Occupied Nest
13 - East Ashland (Ashland Co.), Successful Nest
14 - Rocky Island (Ashland Co.), Sign of Activity
16 - Sioux River (Bayfield Co.), Successful Nest
17 - Red Cliff (Bayfield Co.), Successful Nest
18 - Bayfield (Bayfield Co.), Successful Nest
19 - Julian Bay # 2 (Ashland Co.), Active Nest
21 - S curve (Bayfield Co.), Sign of Activity
23 - Washburn (Bayfield Co.), Active Nest

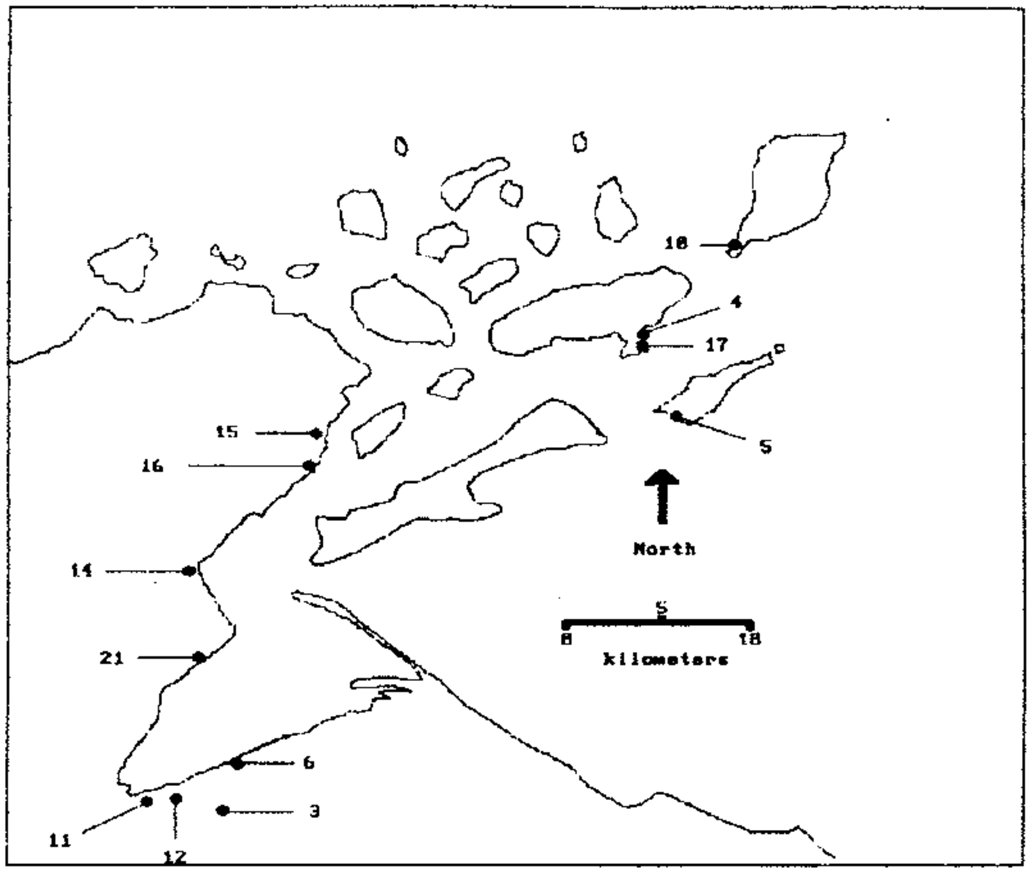

Figure 24. Location of active merlin nests (n=12) at the Apostle Islands and Chequamagon Bay area from 1987 - 1991

Map Key:

Location	Year(s) active
3 - Pierce Road (Ashland Co.)	1987 and 1989
4 - Stockton Julian (Ashland Co.)	1987
5 - Michigan Island (Ashland Co.)	1987 - 1989
6 - Second Landing (Ashland Co.)	1988 - 1991
11 - Prentice Park (Ashland Co.)	1989 - 1991
13 - East Ashland (Ashland Co.)	1989
16 - Sioux River (Bayfield Co.)	1990
18 - Bayfield (Bayfield Co.)	1990
17 - Red Cliff (Bayfield Co.)	1990
19 - Julian Bay # 2 (Ashland Co.)	1990
10 - Outer Island (Ashland Co.)	1991
23 - Washburn (Bayfield Co.)	1991

year (Figure 25.). Other areas with signs of activity were at the Doolittle Farm on the North side of the Bibon Swamp (Bayfield County) in 1987 and on the Chippewa Flowage (Sawyer County) in 1988 and 1989 (Figure 26.).

4. <u>Isle Royale National Park</u>

Isle Royale National Park, Michigan had a mean of a nest/136.3 km of shoreline for 1988-1989. The mean spacing between nests was 14.2 km. Most active territories were located in the northeastern sections of the islands, where the shore was the most irregular (Figure 27-29.).

Theoretically, Isle Royale as well as the Apostle Islands may be an ecological trap (Temple, 1988.). When the merlins first arrive during spring migration to these island environments there are many migrant passerines on which they depend for food; then after merlins establish a nest, the migrants leave. Besides the disappearance of a large prey base, the climate of any island associated with Lake Superior is widely known to be hostile. Evidence to support this concept is meager in that only 4 active nests were found. However, during the initial survey, observations of merlins hunting migrant passerines (especially on Passage Island) were common. When nest sites were checked during the second visit, prey items found consisted mainly of various bat (<u>Chiroptera</u>) species, dragonflies, (<u>Odonata</u>) and

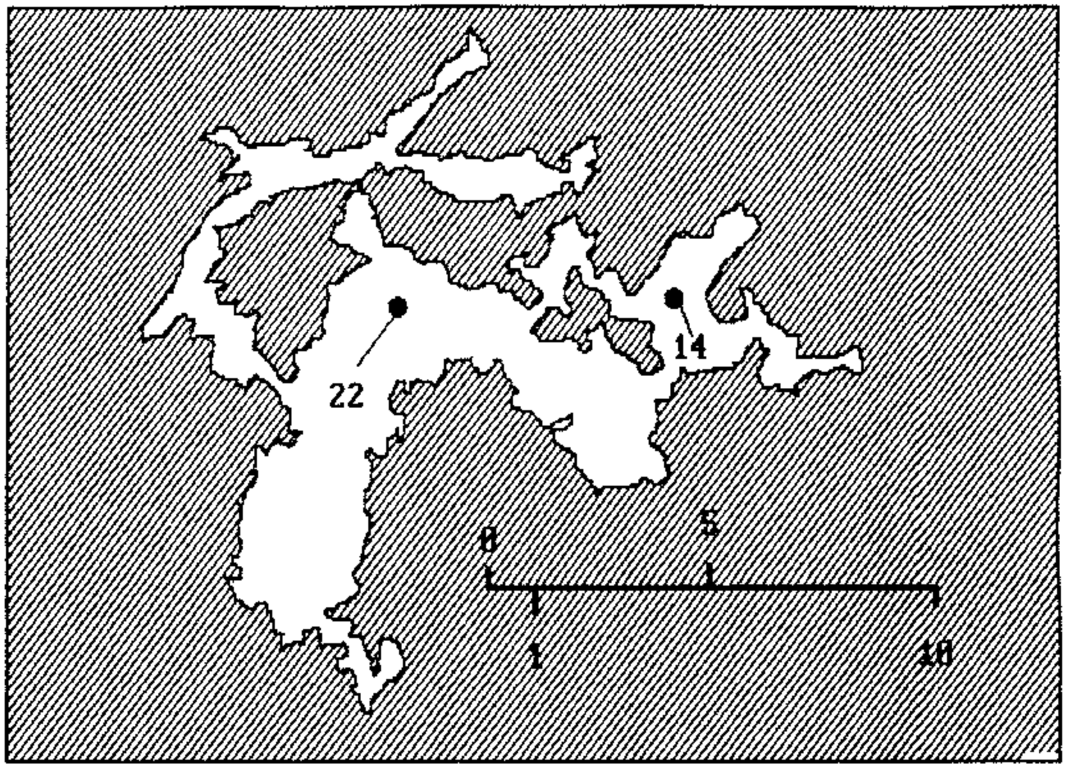

Figure 25. Locations of active merlin nests in the Turtle Flambeau Flowage, Wisconsin

Map Key

Location / Status

14 - Turtle Flambeau (Iron Co.), Successful
22 - Turtle Falmbeau (Iron Co.), Successful

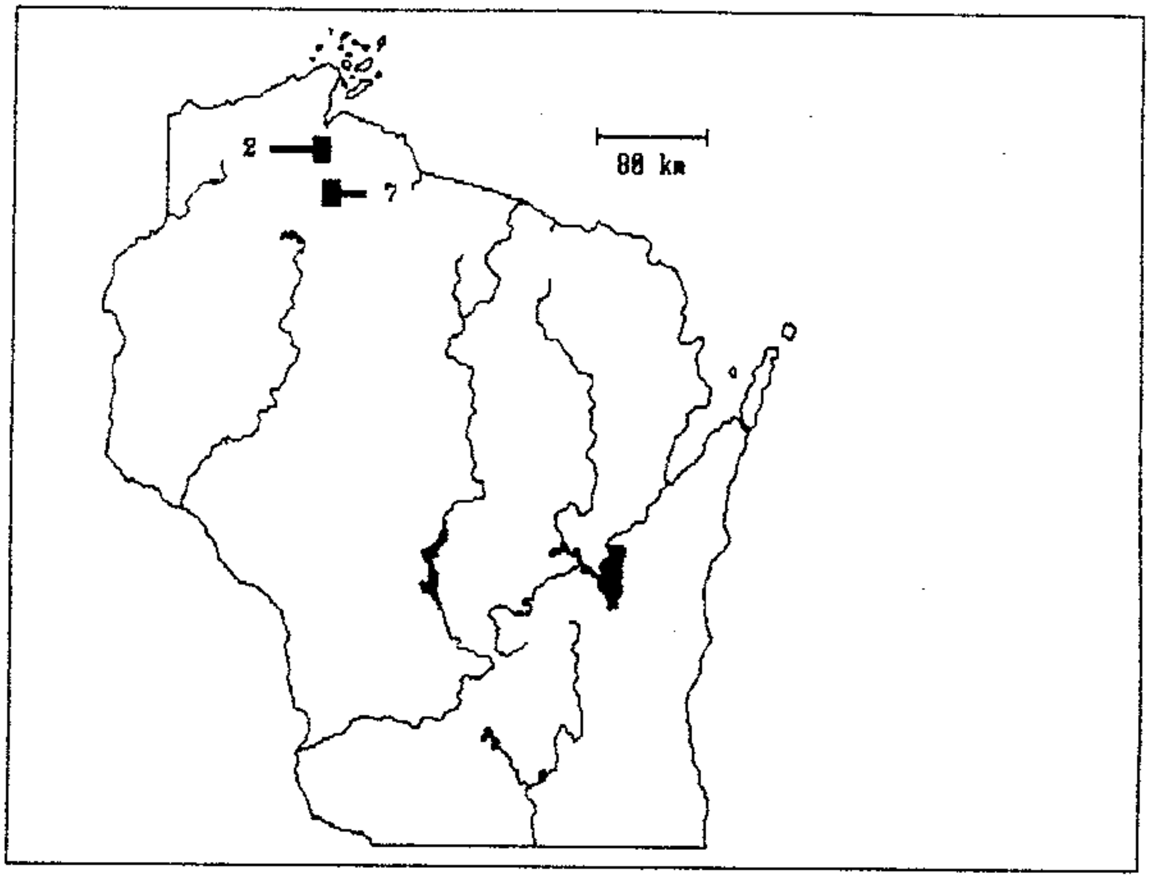

Figure 26. Miscellaneous merlin breeding locations in Wisconsin

Map Key:

Location

2 - Mason (Bayfield Co.), Wisconsin in 1987
7 - Chippewa Flowage (Sawyer Co.), Wisconsin in 1988

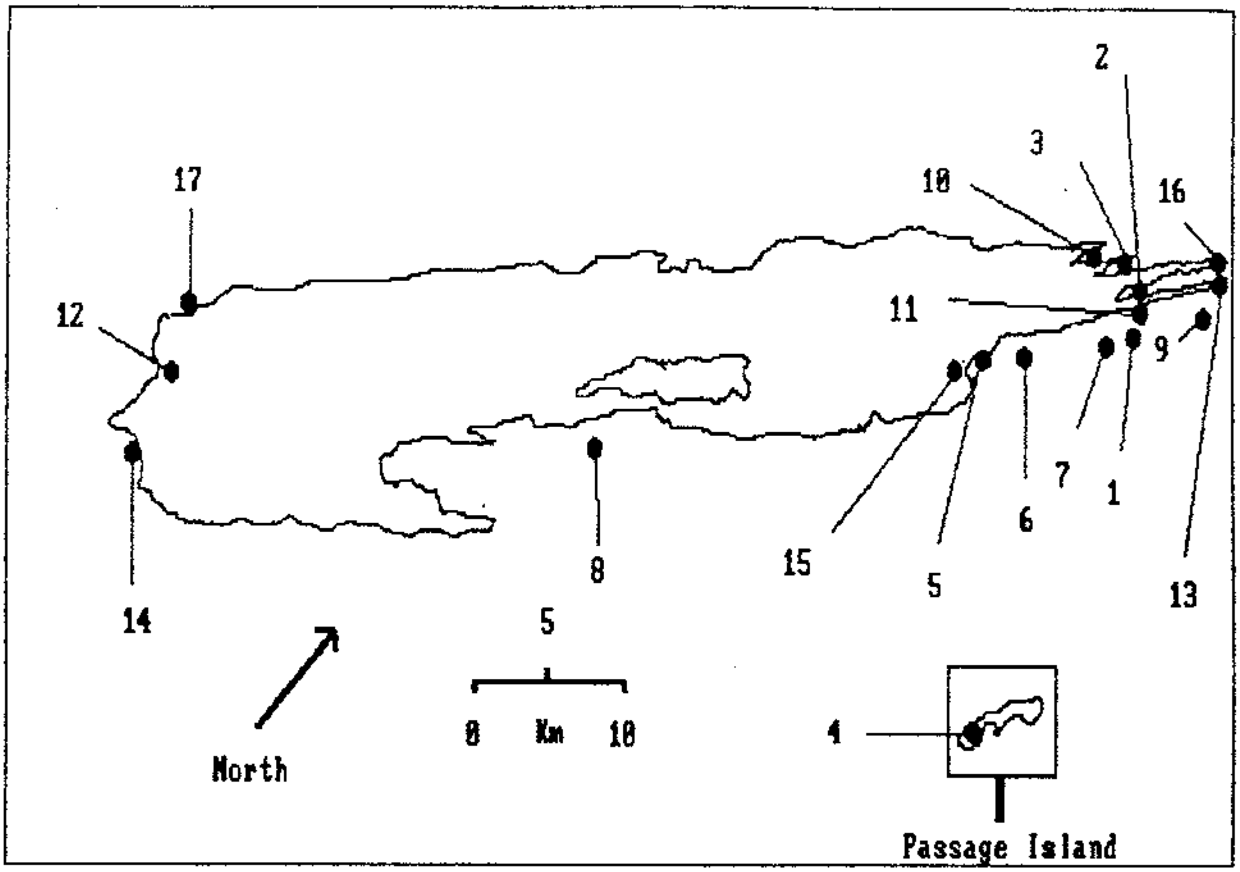

Figure 27. Locations of merlin breeding territories at Isle Royale National Park from 1988 - 1989

Map Key:

Location/Status

1 - Inner Hill Island, Sign of Activity
2 - Tobin Harbor (sea plane dock), Sign of Activity
3 - Duncun Bay Campground, Sign of Activity
4 - Passage Island, Occupied nest
5 - Daisy Farm, Sign of Activity
6 - Caribou Island, Occupied nest
7 - Mott Barge Cove, Occupied Nest
8 - Shiverette Island, Successful nest
9 - Edward's Island, Successful nest
10 - Belle Harbor, Successful Nest
11 - Suzie's Cave, Successful Nest
12 - Grace Creek, Sign of Activity
13 - Long Point, Sign of Activity
14 - Rainbow Cove, Sign of Activity
15 - Peterson Cabin, Sign of Activity
16 - Blake Point, Active Nest
17 - McGinties Cove, Occupied Nest

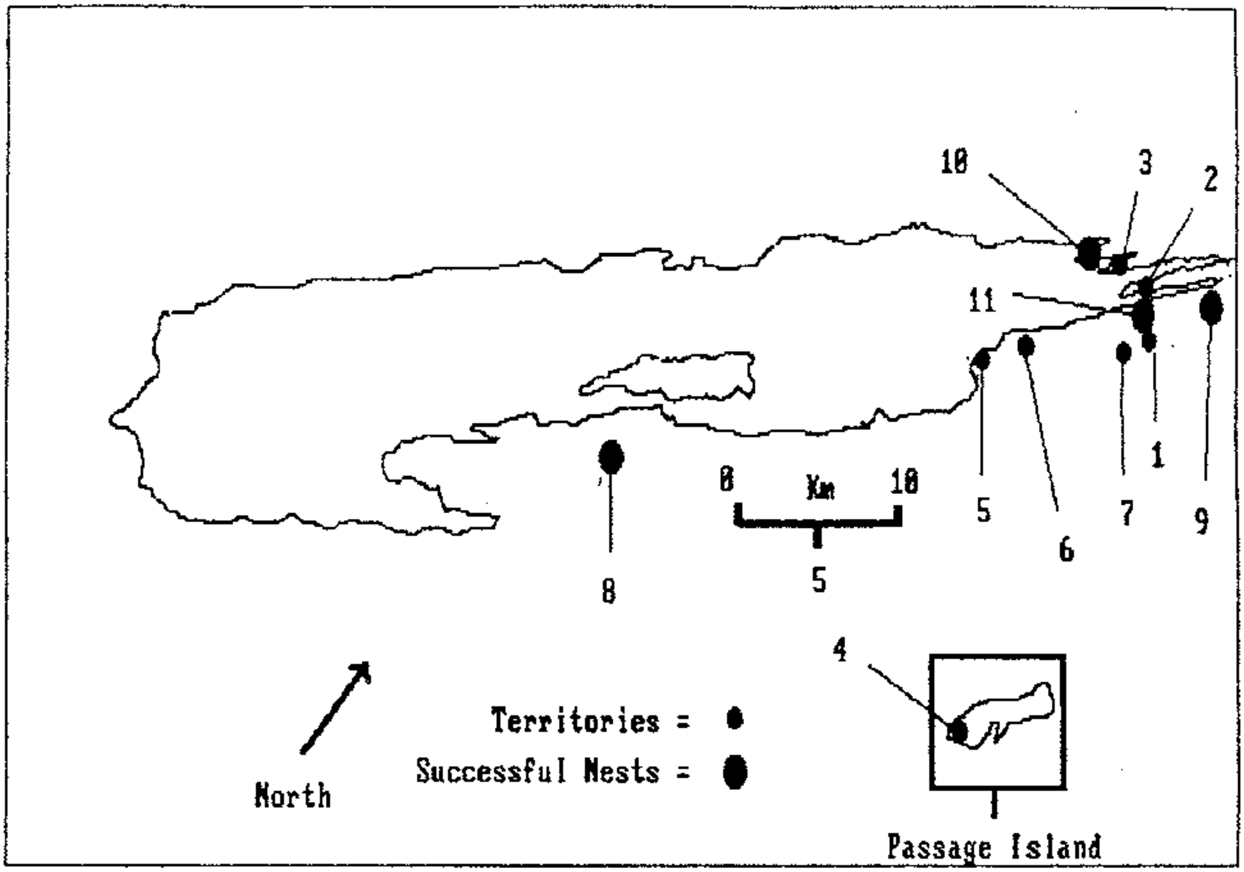

Figure 28. Locations of areas with signs of activity and successful nests at Isle Royale National Park in 1988

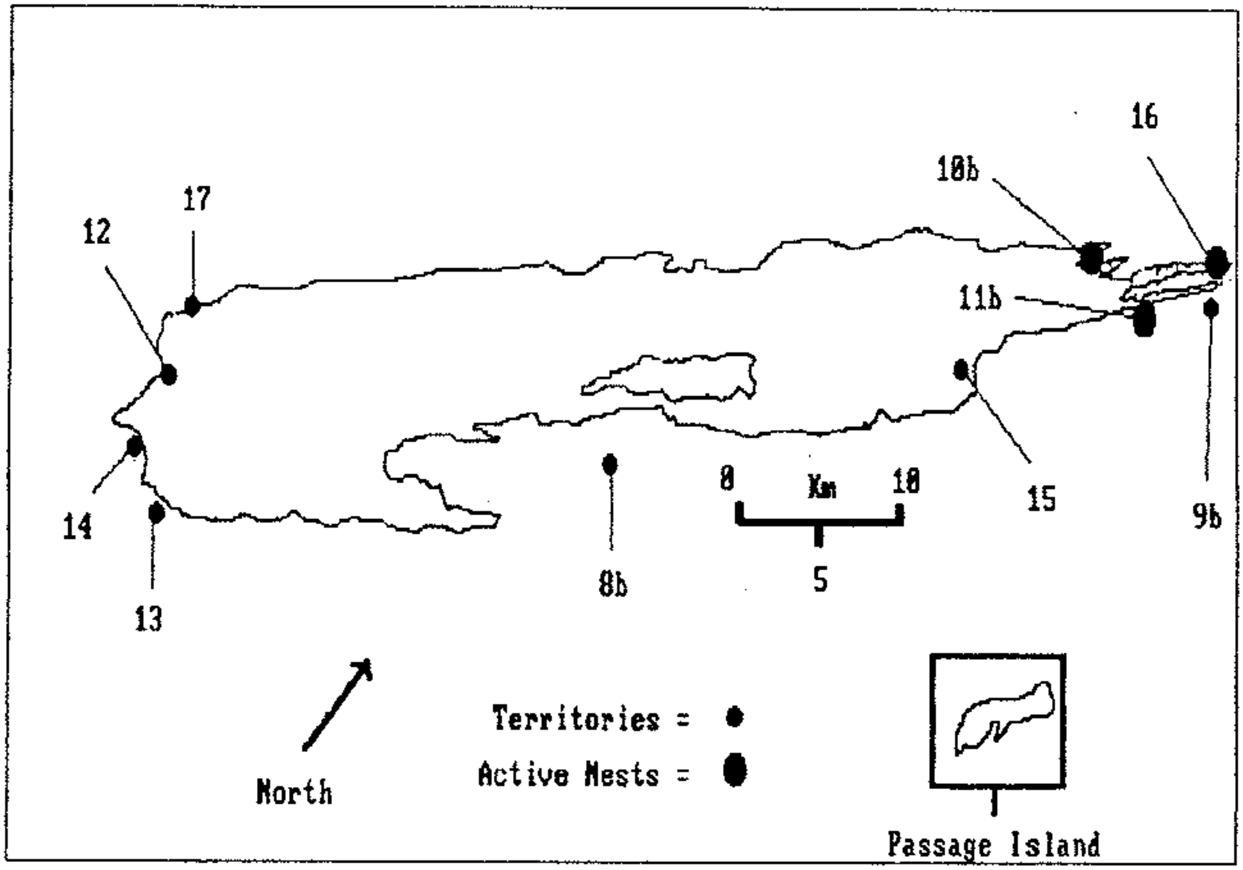

Figure 29. Locations of areas with signs of activity and successful nests at Isle Royale National Park in 1989

some passerine birds. Additionally, Isle Royale had a marked decrease in merlin breeding activity during the second visit in comparison to the other study areas. A third piece of data to support Temple's (1988) theory was that during the banding of young at the Belle harbor nest in 1989 and the Edwards Island nest in 1988 the adults were not present. At all other nest locations visited during the study, one or both adults were present to defend the site from intruders. I considered the lack of adult attendance at the Isle Royale nests abnormal, even though the location of the adults was not determined. A fourth indication that Isle Royale is an ecological trap is reflected by the low productivity of merlins. Isle Royale merlins had the lowest mean productivity within any study area of 2.4 young/successful nest. Interestingly, a similar phenomenon may be responsible for the high rate of failure on the Apostle Islands.

5. Pictured Rocks National Lakeshore

This study area was 136.9 km^2 in area, but had only 60 km of relatively linear (not convoluted) shoreline. Pictured Rocks was in marked contrast to the other study areas, because the area had so little shoreline. However, there were appropriate pine forest habitats on the shoreline. I visited this study area in 1988, and I found no signs of activity, therfore it was not studied further. One sign of activity was noted in July of 1988 by Sergei Postupalsky in the Beaver Lake area (Figure 30.).

6. Duluth, Minnesota and Superior, Wisconsin

In 1990-1991, the urban nests of Duluth, Minnesota and Superior, Wisconsin had a spacing of 5.4 km between active nests and exhibited the most dense aggregations of merlin breeding areas in the region (Table 6). This area, because of the close proximity of humans, was quite different than other study areas, but still had high aggregations with a triad of nests spaced at < 1 km apart. There was an active nest/27.6 km of shoreline (Figure 31.). This area had minimal survey effort and represents a minimal estimate. Other urban or town locations in which I have noted breeding merlins are Red Cliff, Bayfield, Washburn, and Ashland, Wisconsin. There is also a record of breeding merlins from Thunder Bay, Ontario (Escott, 1986) and merlins have been noted to breed in Hibbing and Virginia, Minnesota (Henderson, 1992).

7. Wisconsin Shoreline Search - 1989

In 1989, an intensive survey of Wisconsin shoreline sites was conducted. The survey resulted in no merlin responses to the playback recordings. Four stick nests were

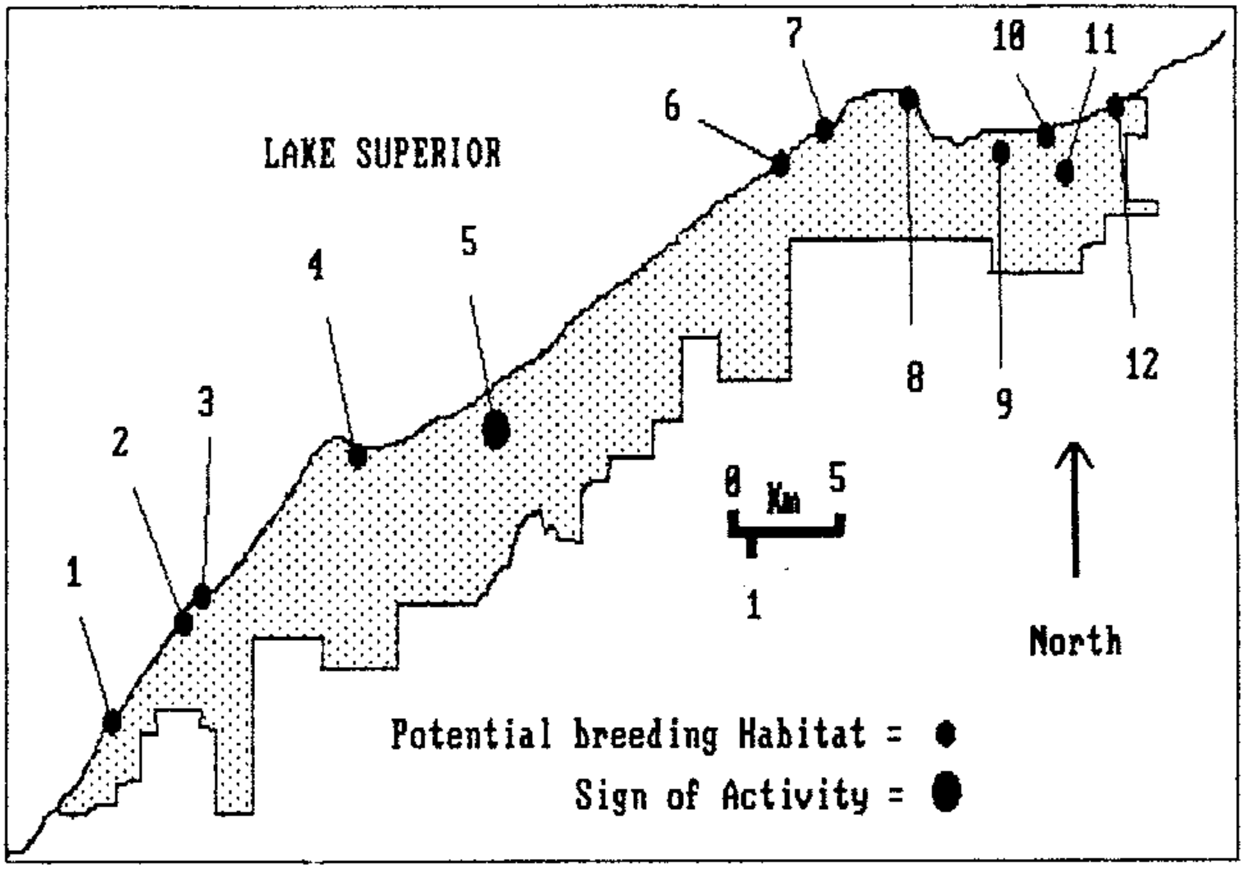

Figure 30. Locations with potential breeding habitat at Pictured Rocks National Lakeshore

Map Key:

Location

1 - Sand Point
2 - Miners Castle
3 - Beach zone East of Miners Castle
4 - Chapel Beach
5 - Northwest side of Beaver Lake, Sign of Activity [1]
6 - Twelve Mile Beach Campground
7 - Hurricane River Campground
8 - Au Sable Light Station
9 - Grand Sable Banks
10 - Sable Falls
11 - Grand Sable Lake
12 - Woodland Park

(1) - Postupalsky (1988)

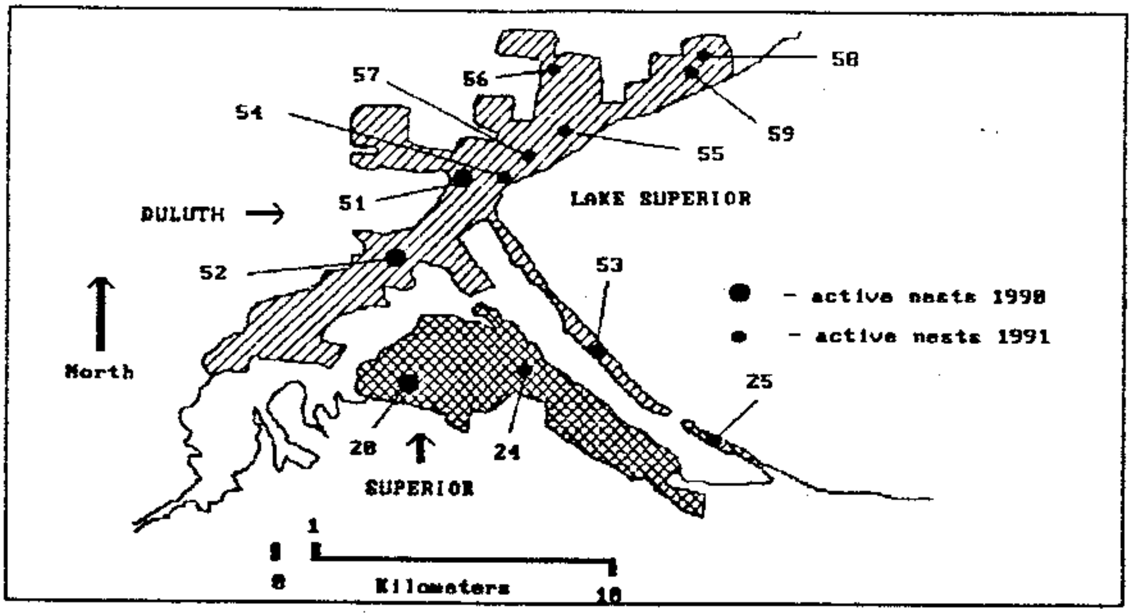

Figure 31. Locations of active merlin nests in Duluth, Minnesota and Superior, Wisconsin from 1990 - 1991

Map Key:

Location /Status

20 - Suskewahana (Superior, Wi), Successful Nest
51 - Duluth Heights (Duluth, Mn), Successful Nest
52 - West Duluth - Toilet (Duluth, Mn), Successful Nest
24 - Baxter (Superior, Wi), Active Nest
25 - Wis. Point (Superior, Wi), Successful Nest
53 - Park Point (Duluth, Mn), Successful Nest
54 - 35th Ave (Duluth, Mn), Successful Nest
55 - 46th (Duluth, Mn), Successful Nest
56 - Crista's Nest (Duluth, Mn), Successful Nest
57 - Maynard Eng (Duluth, Mn), Successful Nest
58 - Lester Park (Duluth, Mn), Successful Nest
59 - Sarah's Nest (Duluth, Mn), Successful Nest

found, however none suitable for merlins, as they were small and in poor condition. In addition to the Lake Superior shoreline search, the Chippewa Flowage (Sawyer County.), the Turtle Flambeau Flowage (Iron County), the Apostle Islands and the agricultural areas south and west of Ashland, Wisconsin were surveyed using playback recordings. The amount of edge surveyed was approximately 1570 km in length. In total, nine merlin responses were recorded. From the areas where the responses were recorded there were three active nests found. This represents about one sign of activity/173.3 km of edge.

8. Study Areas - Summary

In Montana, concurrent nestings of richardson's merlin were 17 km apart (Ellis, 1974). Craighead and Craighead (1940) noted merlins nested 3.2 km apart on the Minnesota-Ontario border. In Northumberland, Great Britain, spacing between nests ranged from one to six kilometers (Newton, 1978). Nest spacing in the mid 1960's was close in North Wales, with nearest neighbor means of .98 - 1.92 km (Roberts, 1983). The mean spacing in the Upper Midwest for active nests was 13.2 km. The mean active nest spacing of the Duluth - Superior population was 5.4 km and represented the most dense sub-population. Therefore the Upper Midwestern spacing data, as well as the data from the literature, indicate the merlin seems to be a widely spaced breeder in most regions exhibiting close spacing in select areas.

Table 6. Comparison of average spacing between active nests, mean density (km^2), and mean numbers of nests per kilometer of shoreline for all study areas

Location	mean nest spacing (km/sign of activity)	mean nest spacing (active nest/km)	mean density (km^2/sign of activity)	mean density (km^2/ active nest)	mean # of km of shoreline/ nest (sign of activity)	mean # km of shoreline /nest (active nest)
Voyageurs	5.4	10.3	21.6	49.8	41.3	94
Isle Royale	11.8	14.2	54.5	155.4	47.7	136.3
Apostle Islands	-	-	109	182.5	155.1	258.8
Apostle Islands/ Chequamagon Bay	18	22.9	-	-	80.6	116.9
Turtle Flambeau Flowage	-	-	-	-	212.5	340
Duluth, MN / Superior, WI	5.4	5.4	48.5	48.5	27.6	27.6
Pictured Rocks	0	0	0	0	0	0
mean	10.2	13.2	58.4	109.1	81.9	143

Throughout all study areas there was an active nest every 109 km^2; these are low densities in comparison to other studies. Newton (1978) noted densities in Northumberland of three-ten nests per 100 km^2. In Wales nesting densities averaged 12 pairs/100 km^2 (Williams, 1981). However, the United Kingdom's merlin habitat (open moors) is probably more homogeneous than the shoreline habitat used by merlins in the Upper Midwestern United States. Average km of shoreline per nest and average linear spacing between nests may be better determinants of density in the Upper Midwest.

E. Population estimates using shoreline habitats

All study areas combined represent 2429 km of shoreline. In locations where merlins breed in the Upper Midwest a sign of activity was noted per 81.9 km of shoreline. The mean number of shoreline areas with a sign of activity divided by the total available shoreline is a logical method to determine relative density considering the perimetric distribution of territories around large lakes. Most breeding merlins were found on midwestern lakes with convoluted shorelines that had perimeters exceeding 161 km. Contrary to the findings of this study were historic records of merlins nesting on lakes with shoreline lengths < 161 km. In Minnesota, Harriet Lake is an example (Wilson, 1985), having only 9 km of shoreline. Similarly, in Wisconsin the Rainbow Flowage (Sindelar and Jacobson, 1981) has a shoreline length of only 33 km. Harriet Lake and the Rainbow Flowage are adjacent to aggregations of other lakes.

These aggregations have open corridors and combined they have a tremendous amount of edge. An example would be Tomahawk Lake, Willow Flowage and the Rhinelander Flowage all near the Rainbow flowage in Oneida County, Wisconsin. They are close to one another and their cumulative shoreline lengths is 255 km. Therefore, areas with aggregations of smaller connecting lakes, or lakes with open corridors do create the 161 km of necessary edge for suitable merlin habitats. This study did not assess merlin populations in these areas.

In Wisconsin there are few large lakes with shoreline lengths exceeding 161 km. They are the Chippewa Flowage (Sawyer County), the Turtle Flambeau Flowage (Iron County) and the southern shore of Lake Superior, including the Apostle Islands. Combined there is approximately 1293 km of shoreline for these water bodies. Therefore an estimated population for these areas would be approximately 16 merlin pairs. The Door County peninsula, associated islands and the adjacient west shore of Lake Michigan South to Green Bay is approximately 488 km in length. I estimate this area of Wisconsin has the potential for approximately six pairs of merlins.

In Minnesota there are 11 border lakes with shoreline lengths exceeding 161 kilometers (Minnesota DNR, 1992). They are Leech (Cass County), Lake Superior (Cook County), Saganaga (Cook County), Basswood (Lake County), Crooked (Lake County), Lake of the Woods (Lake of the Woods County), Vermillion (St. Louis County), Whitchel (St. Louis County), Rainy Lake (St. Louis County), Namakan (St. Louis County) and Kabetogema (St. Louis County). The amount of shoreline on the Minnesota portions are approximately 4,225 km in length, which has the potential of supporting 52 merlin pairs.

The shoreline length data do not reflect the associated shorelines in Ontario, Canada, which would contain the majority of large lake habitat suitable for merlins. An estimate of breeding merlins in Minnesota and Wisconsin within the habitats defined in this study would be approximately 74 pairs.

F. Habitat and nest characteristics

In a sample of 76 nests, 62 were american crow and 9 were northern raven nests. A pair of merlins used an artificial platform on the Turtle Flambeau Flowage in northern Wisconsin in 1990. In 1988, witches broom in balsam firs were used at Shiverette Island, Isle Royale, Michigan and on Michigan Island, Apostle Islands, Wisconsin. Merlins used old bald eagle platforms at the Apostle Islands National Lakeshore, Wisconsin and at Voyageurs National Park, Minnesota in 1988 and 1989 respectively.

The common crow population has shown a significant increase in Minnesota, Wisconsin and Michigan from 1965-1979 (Robbins et al., 1986). In my opinion the increase in numbers of common crows and the subsequent increase of available nests for breeding merlins, may be the single largest reason for a population increase of merlins in the Upper Midwest.

All merlin nests in all study areas were in conifers. Of 86 nests sampled, 61 were white pines, _Pinus strobus_, while 11 were white spruce (_Picea glauca_). Other conifers where merlin nests were located included jack pine (_Pinus banksiana_), red pine (_Pinus resinosa_), white cedar (_Thuja occidentalis_), norway spruce (_Picea abies_), colorado spruce (_Picea pungens_) and balsam fir (_Abies balsamea_). All nests were located in the last suitable crotch nearest the tree's top. In a sample of 52 nests, the mean tree diameter (dbh) was 43.8 cm and the mean nest height was 15.1 m. Nest heights ranged between 4 and 23 meters. These data suggest crows were selecting slightly larger nest trees within a nest woods in comparison to other trees available in the nest woods.

A sample of 53 nests found between 1987 and 1991 were visited in August of 1991 to assess their condition. Two nests trees had blown down and only three of 29 active nests found in 1987-1989 were still in suitable condition by 1991.

Two of the three nests still suitable after three years were raven nests, which are more solid structures than crow nests. The data demonstrate that most merlin nests (90%) will not be suitable for re-occupancy within three years (Table 7.). Therefore if a territory has more than one nest, it is likely at least one or more nests would be suitable in the follwing year. Consequently, multiple nest territories are more likely to be reoccupied by merlins.

Table 7. Suitabilty of nests (n=53) used by merlins and their potential for re-occupancy by merlins

nest year class	sample size	# suitable nests	% of sample	% of Total (n=53)
1987	3	0	0	0
1988	8	1	12.5	1.9
1989	18	2	11.1	3.8
1990	15	4	26.6	7.6
1991	9	7	77.7	13.2

Nests in urban environments were usually in species of spruce (Picea spp.). These healthy trees had dense foliage suggesting they provide more suitable cover than nests in white pine or red pine that have a more open canopy. Additionally, the spruces were the most abundant conifer available in urban areas. In nest site selection by merlins in Montana using ponderosa pines (Pinus ponderosa), they tended to select sites with easy access coupled with maximum concealment of their nest (Sieg, 1990).

The nest trees were an average of 35 meters from a dominate edge (usually water) and the range was bewteen 0 and 155 meters. All merlin nests found in traditional forested areas occurred on lakes with convoluted shorelines that had perimeters exceeding 161 km. Merlins were also found nesting along the edge of a vast hay field south of Ashland, Wisconsin and in a farm windbreak surrounded by open fields near Mason, Wisconsin.

Interestingly, of 94 areas with signs of activity in Minnesota and Wisconsin at urban and traditional locations, 44 areas were near or at campgrounds, bald eagle nests, or close to human residents. I postulate that refuse left by humans and bald eagles provides a food source for scavenging birds such as crows. Subsequently, american crows may nest near their food supply. Prior to the study, it was suggested that these areas would be likely spots to find breeding merlins (Temple, 1988).

G. Habitat analyses

The non-nest and merlin nest woods sampled were representative of the plant communities of shoreline areas and islands at Voyageurs National Park and the coastal zones of the Apostle Islands and the Chequamagon Bay area. There were no non-nest areas sampled at any interior sites.

The non-nest area plant communities sampled on Kabetogema Lake islands and shoreline were characterized by a variety of species. Bur oak (Quercus macrocarpa) dominated the sample with a relative density (R.D.) of 80.5 %, while silver maple (Acer saccharinum), choke cherry (Prunus virginiana) and white pine each occurred at the same relative densities (4.9%) (Table 8.). The understory was dominated by choke cherry (R.D. = 53.6%), Bur oak (23.2%) and white birch (Betula papyrifera) (12.1%). I believe that the high occurrence of choke cherry and white birch in the understory is the result of intense browsing by herbivores, such as beaver (Castor canadensis) and white-tailed deer (Odocoileus virginianus). On many islands even the bur oaks were girdled and there was no sign of conifer regeneration.

Interestingly, the results of the Namakan Lake non-nest plots were strikingly different from those of Kabetogema Lake. On Namakan Lake the plant composition was dominantly conifer species and there was sufficient indication of conifer reproduction. Red pine dominated with a relative density of 26%, while white pine and jack pine shared equal dominance with relative densities of 19.3%. Balsam fir dominated the understory with a R.D. of 53.9% and white pine, white cedar and red pine also having high relative densities of saplings with 15.8 %, 9.2 % and 7%

respectively. These data indicate good conifer reproduction.

The Chequamagon Bay area non-nest plots were dominated by red maple (R.D.= 34.2%), quaking aspen (26.6%) and white pine (11.4%). The understory was dominated by red maple saplings (R.D. =38.1%) quaking aspen (Populus tremuloides) (18.8%) and black willow (Salix nigra) (11.9%). There were some white pine (R.D.= 8.7%) and red pine (5%) saplings found in one sample area.

Non-nest plots as a group (n=65) showed no dominance by a single species or group of species. Combined the relative densities of white pine, red pine and jack pine was 40.8 %, while bur oak, red maple (Acer rubra), and quaking aspen combined relative densities were 37% (Table 8.). Balsam fir (R.D. = 25%), red maple (16.3%), white pine (10%) and choke cherry (9.7%) dominated the understory.

The merlin nest woods sampled were in marked contrast to the non-nest samples, where merlin nest woods had a R.D. of conifer species of 75% (Table 8.). The merlin nest woods samples were dominated by white pine (R.D. = 47.8%), red pine (18.3%), white birch (9.7%) and white spruce (7.6%). At all merlin nest sites, balsam fir saplings were most common (R.D.= 31%), followed by white pine (20%), red pine (11%) and red maple (11%). Generally, for all merlin nest woods sampled there was natural reproduction of white pine.

The location with the least amount of white pine regeneration was Kabetogema Lake. The majority of white pine saplings noted on Kabetogema Lake were from a single merlin nest woods where the National Park Service had recently burned down a cabin. In both non-nest areas and merlin nest woods sampled, balsam fir is abundant (R.D = 31% and 25% respectively) in the understory.

Table 8. Relative densities of tree species and saplings at non-nest plots (n=65) at Voyageurs National Park and on the Chequamagon Bay coast in comparison to relative densities of tree species and sapling at traditional merlin nest woods (n=-40). R.D. = relative density (%)

Species	R.D. Kab. Lake tree	R.D. Kab. Lake sap.	R.D Nam. Lake tree	R.D. Nam. Lake sap.	R.D. Che. Bay tree	R.D. Che. Bay sap.	R.D. nest wood tree	R.D. nest wood sap.
Pinus strobus	4.9	0	19.3	15.8	11.4	8.7	47.8	20.4
Pinus resinosa	0	0	26	7	6.6	5	18.3	11.3
Pinus banksiana	0	0	19.3	.9	0	0	2	0
Picea glauca	0	0	1.2	1.8	0	0	7.6	2.4
Picea mariana	0	0	9.9	2.6	0	0	1	0
Thuja occidentalis	0	0	7.5	9.2	0	0	.5	1.3
Abies balsamea	0	0	3.1	53.9	0	6	2.5	30.8
Acer rubrum	0	0	2.5	2.6	34.2	38.1	4.1	10.8
Populus tremloides	0	0	8.7	1.8	26.6	18.8	.5	3.8
Quercus macrocarpa	80.5	23.2	0	0	0	0	3	3.3
Salix nigra	0	0	0	0	0	11.9	0	0

Betula papyrifera	2.4	12.1	2.5	2.6	8.6	2.3	9.7	3.3
Acer saccharinum	4.9	4	0	0	0	0	0	.5
Acer saccharum	0	0	0	0	4.8	2.8	0	.2
Populus grandidentata	0	0	0	0	4.8	0	0	0
Quercus rubra	0	0	0	0	1	3.7	0	.9
Prunus virginiana	4.9	53.6	0	0	0	0	.5	5.5
Ostrya virginiana	0	0	0	0	0	1.8	0	0
Betula alleghaniensis	0	0	0	0	1	0	0	0
Tilia americana	0	0	0	0	0	0	0	0
Ulmus americana	2.4	2	0	0	0	0	0	.2
Acer spicatum	0	5.1	0	1.8	0	0	0	.7
Acer negundo	0	0	0	0	1	.9	0	0
Fraxinus americana	0	0	0	0	0	0	2.5	2.2
Sorbus americana	0	0	0	0	0	0	0	2.4

Importantly, fire has been noted as a necessary factor in the perpetuation of white pine (Maissurow, 1935; Frissel, 1973; Gajewski et al., 1985 and Heinselman, 1973). The germination of seedling white pine is best in bare mineral soils that are not too dry. The build up of substantial litter and humus above the mineral soil may result in a higher incidence of white pine fungal infection (damping off) and increase predation on seeds by rodents (Smith, 1940). Fire's most advantageous effects on white pine regeneration are when they occur in the autumn, and when the white pine stands are near plant communities characterized by having high fire frequencies (i.e. oak savannahs). Fires prevent a massive build up of humus and maintain an open understory, but for fire to be beneficial it must burn through relatively mature stands and occur when the white pines set seed, which happens every 3 - 7 years. A fire frequecy that is too high will not allow the white pine to mature and reproduce properly (Jacobson, 1979).

Both natural pertubations and those caused by humans were noted in most non-nest plots and merlin nest site plots. In all merlin nest plots sampled the most common pertubation was fire, which occurred at 50% of the plots. The next most frequent was signs of logging (40%), followed by browsing sign by herbivores (35%), and firewood gathering (27.5%). Other disturbances included cabin removal, dock building, garbage dumps and lawn mowing.

There was a notable difference in pertubation types between areas. Merlin nest woods on Kabetogema Lake at Voyageurs National Park were greatly impacted by white-tailed deer browsing and by firewood gathering. Fire had a low rate of occurrence and evidence was noted at only three sites. However, Namakan Lake merlin nest site plots had more evidence of fire, and logging, while all plots sampled at the Apostle Islands National Lakeshore and Wisconsin nests site woods had signs of fire.

The perturbations noted in the non-nest samples were slightly different from the merlin nest site samples, where signs of logging were noted at 23% of non-nest plots, followed by fire, and firewood gathering. There were differences noted between the non-nest plots betweeen areas.

The Apostle Islands merlin territories sampled were mostly inter-dunal pine forest communities, which exhibit high fire frequencies (Swain, 1986; Swain, 1981). The Chequamagon Bay Coast shows significant evidence of fire impact, but human impacts of intensive logging and shoreline development are more obvious.

H. Prey Factors

Because there was not a sufficient amount of time to perform direct observations of nests to quantify the prey consumed, only randomly collected prey remains were examined. This is a qualitative measure and raptor diets can not be quantified solely by the collection of prey remains (Mersmann et al., 1992). Prey remains were done in or near the nest and they consisted primarily of passerine birds and dragonflies (Odonata sp.). In total 35 species of birds and two bat species (Vespertilionidae) were identified. Dragonflies had the highest frequency of occurrence (Table 9.).

Table 9. List of 37 bird and mammal species and 2 insect groups found as prey remains at 65 merlin nests for all locations from 1988-1989

Common Name	Scientific Name	Number Collected
mourning warbler	*Oporornis philadelphia*	1
nashville warbler	*Vermivora ruficapilla*	3
common yellowthroat	*Geothlypis trichas*	1
black-throated green warbler	*Dendroica virens*	1
yellow-rumped warbler	*Dendroica coronata*	3
northern parula warbler	*Parula americana*	1
ovenbird	*Seiurus noveboracensis*	1
american robin	*Turdus migratorius*	3
swainson's thrush	*Catharus ustulatus*	2
hermit thrush	*Catharus guttatus*	1
veery	*Catharus fuscescens*	1
black-capped chickadee	*Parus atricapillus*	2
blue jay	*Cyanocitta cristata*	1
brewer's blackbird	*Euphagus cyanocephalus*	1
downy woodpecker	*Picoides pubescens*	3
common flicker	*Colaptes auratus*	1
american goldfinch	*Carduelis tristis*	1
evening grosbeak	*Coccothraustes vespertinus*	1
northern saw-whet owl	*Aegolius acadicus*	1
common nighthawk	*Chordeiles minor*	1
cedar waxwing	*Bombycilla cedrorum*	7
eastern bluebird	*Sialia sialis*	2
red-winged blackbird	*Agelaius phoeniceus*	3
common grackle	*Quiscalus quiscula*	2
hairy woodpecker	*Picoides villosus*	1
cliff swallow	*Hirundo pyrrhonota*	4
tree swallow	*Tachycineta bicolor*	4

dark-eyed junco	*Junco hyemalis*	2
gray cat-bird	*Dumetella carolinensis*	1
chipping sparrow	*Spizella passerina*	1
white-throated sparrow	*Zonotrichia albicollis*	1
house sparrow	*Passer domesticus*	5
american woodcock	*Scolopax minor*	1
chimney swift	*Chaetura pelagica*	1
little brown bat	*Myotis lucifugus*	1
red bat	*Lasiurus borealis*	2
dragonfly	*Odonata sp*	78
luna moth	*Actias luna*	2
Total = 39 species		

Prey remains collected at Isle Royale National Park in 1988 contained red bat and little brown bat fur. Johnson and Coble (1967) had found red bat and Myotis spp. remains previously on Isle Royale. An interesting prey remain found at the Suzie's Cave nest in 1988 was an american woodcock, while at the Edwards Island nest, remains of luna moths were found. On Michigan Island, Apostle Islands National Lakeshore there were the prey remains of chimney swifts and a northern saw-whet owl. In Voyageurs National Park, remains of a common nighthawk and common flicker were found at the Deer Point Island nest and the Dryweed Island nest, respectively.

At merlin nests in Ashland, Wisconsin and Voyageurs National Park food caches were recorded. In a large white pine on an island in the Chippewa flowage (Sawyer County, Wisconsin), intact tree swallows were found neatly wedged within forked branches.

Pre-fledgling cliff swallows and nashville warblers were found as prey remains in merlin nests. Another notable prey remain was an intact white-throated sparrow egg in a merlin nest at Prentice Park, Ashland Wisconsin. These data suggest that young birds are taken from nests and that egg heavy females may be vulnerable to predation by merlins.

I. Weather and other factors

In 1989, Voyageurs National Park had the highest merlin density during the study period with 17 successful nests. In 1988 and 1990 there were only eight successful nests each year. Since weather conditions were normal for all three years it does not appear that weather had a direct detrimental effect on merlin breeding success.

During the summer of 1989 there was a peak of the eastern tent caterpillar (*Malacosoma americanum*) infestation of quaking aspen (*Populus tremuloides*) in northern Minnesota forests. Large areas can be affected by this pest. In Ontario, over 80 million acres were defoliated in the 1950's (Sippell, 1962). The infestations are cyclic and occur at about 10-15 year intervals (Batzer and Morris, 1971). Outbreaks usually last from 3-5 years (Rose, 1958). Because of defoilation by the tent caterpillar the canopy remains open for merlins to more efficiently hunt passerines for most of the breeding season. Hypothetically, merlin populations may exhibit cyclic population growth parallel to periods of eastern tent caterpillar invasions, and the data did support this hypothesis.

A pair of merlins with an average nest of three young will consume between 450 - 700 small birds during a breeding season (Brown, 1976 and Cade, 1988). At Voyageurs National Park there were an average of 11 nests/year from 1988 - 1990. Therefore one could project an average of 4,950 - 7,700 birds/breeding season were consumed at Voyageurs National Park alone. The 65 successful nests found in all study areas would have required between 29,250 - 45,500 small birds as prey items. These estimates do not include the non-breeding merlins of this region, or the impact of the birds remaining after the breeding season. It is apparent that merlins may have considerable impact on local avifauna and more importantly changes in the prey base could have dramatic impact on merlins. In my opinion a decrease in neo-tropical species, considering the high food demand o merlins may affect merlins in the traditional forested areas. As support for this opinion, I found that > 50% of the prey species found in merlin nest woods were neo-tropical migrants.

J. Play back recordings

Playback recordings were a vital tool in locating breeding merlins. In 1989, 43 of 59 detections of merlin breeding activity were located solely by playback recording. Playback recordings were effective during the courtship period (April 1 - May 20) and after hatching (June 24 - July 20). Males seemed to be more prone to respond to the tape at any time during the breeding season. Throughout the study I noted most females would not respond during incubation, or while brooding young. However, incubating females were pulled off their eggs by using playback recordings and caution should be exercised so as not to evoke too much disturbance. Some pairs did not respond to play back recordings. Playback recordings are an important tool, but should not be used as the only method of locating breeding merlins. Some reasons are that some breeding merlins when present did not respond to the playback. To the contrary non-breeders and migrants will respond and lead one to believe they are breeders.

On Kabetogema Lake five nests were used to test taped vocalizations. Admittedly this is a small sample, but no responses were recorded from merlins for a distance $\geq$ 1000 m and only one response was noted from a distance of 750 m. Four responses were noted at 250 m, while all five responded when playback recordings were played $\leq$ 100 meters. Therefore with this data in accompaniment with all playback work done during the study, it appears that speaker levels of 100 decibels envoke a response from merlins best at distances of 100 meters and not over 1000 meters. The ability to hear the bird respond may have some affect also.

K. <u>Migration and Other Behaviors</u>

Throughout the Upper Midwest there are many notable migratory flight locations where merlins are counted and banded. A review of migratory location records are vital to determining the historical status of merlins in the region. For example, it was the trend of increasing merlin numbers documented by midwestern banding stations that prompted this study. In the Upper Midwest, Hawk Ridge, Duluth, Minnesota and Cedar Grove Ornithological Station, Wisconsin (Figure 32.) have provided the most consistent migratory data. Data collected from lesser known lookouts and staging areas such as Outer Island of the Apostle Islands archipelago do not provide consistent migratory data, since they are not monitored regularly. However, they do provide records of unique behaviors, important to the understanding and management of merlins.

The staging merlins of Outer Island were first noted by Sheldon and Poole in 1919. They observed migration from 7 September through 16 September and shot 11 specimens. Poole

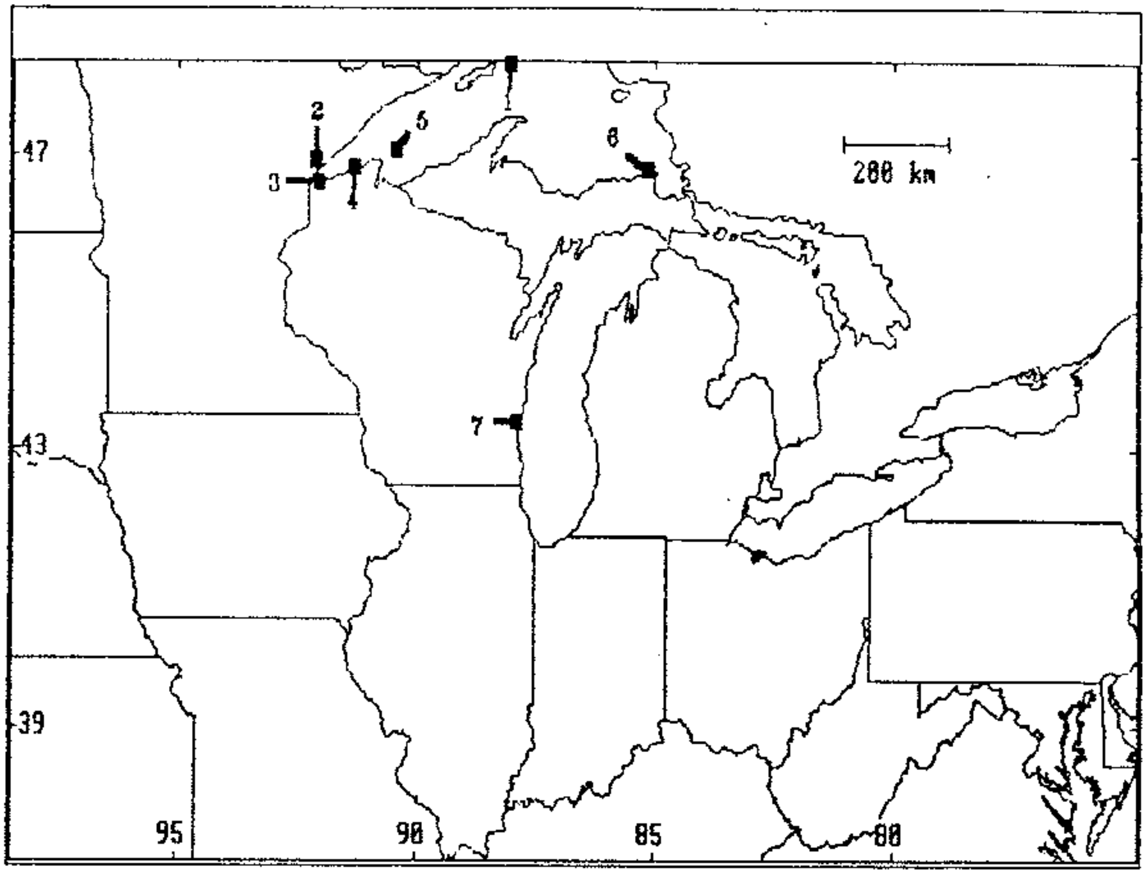

Figure 32. Locations of some migratory lookouts to observe merlins

Map Key:

	Location	Period
1 -	Passage Island, Isle Royale, Michigan	Spring/Fall
2 -	Hawk Ridge, Duluth, Minnesota	Fall
3 -	Wisconsin Point, Superior, Wisconsin	Fall
4 -	Bark Point, Herbster (Bayfield Co.), Wisconsin	Spring
5 -	Outer Island (Ashland Co.), Wisconsin	Spring/Fall
6 -	White Fish Point (Chippewa Co.), Michigan	Spring
7 -	Cedar Grove (Ozaukee Co.), Wisconsin	Fall

had problems collecting merlins, because they would perch on the blind, being too close to shoot. The contents of ten stomachs from these were saved and analyzed by Dr. Remington Kellogg at the Food Habits Laboratory, U.S. Biological Survey (Jackson, 1941). Harris (1977, 1978, 1980) also noted this unique staging area. Since the Harris studies, the merlins of Outer Island were only casually observed until the National Park Service, as part of a migratory bird monitoring program, systematically counted migrant bird numbers in the spring and fall of 1990 and 1991.

I observed and recorded in 1990 and 1991 many interesting hunting behaviors of the staging merlins on Outer Island. One classic observation noted by all observers from 1919 to the present was the constant harassment of common flickers by merlins. Jackson (1941) reported that the field men (Sheldon and Poole) failed to witness a single flicker kill in 1919. Interestingly, a common flicker kill was never recorded by any observer. The flickers, exude a distress call, flare out their tails and jab with their bills. These tactics, along with their larger size, seems to protect them from predation by merlins. This behavior does not appear effective during the breeding season, as common flickers have been found as prey remains in merlin nests (Johnson and Coble, 1967).

I observed numerous passerine birds killed by merlins by an array of hunting styles including cooperative hunts, direct chases, stoops (dives) from great heights, and short hard stoops from low altitudes.

1. Cooperative hunting

At 11:32 AM on 15 September 1990 I observed, seven merlins perched on pieces of driftwood at the tip of a sand spit. At 12:17 PM I noted five merlins chasing a passerine. There were 19 stoops prior to the capture of the passerine in that particular cooperative hunt. For the remainder of that afternoon six cooperative hunts with a merlin mob ranging between 3 and 5 birds were observed; all hunts were successful. I qualify this tactic as cooperative, as the prey were plentiful and the group hunts versus single hunts were more successful, although merlins did not share their kills with other merlins.

An interesting version of the cooperative hunt was interspecific between merlins and sharp-shinned hawks. They were noted to perch side by side with little conflict and hunted passerines in a quasi cat and mouse approach. The sharp-shinned hawks would flush a passerine out of thick cover into the open, where a merlin would continue the chase. The passerine in the process of escaping the merlin would head back towards cover. The sharp-shinned hawk would then proceed to chase the bird out of the cover and the cycle would continue.

In comparison, I observed 12 kills in 30 single bird hunts. Single bird hunts were recorded when one merlin made multiple (>2) stoops to capture prey. Up to eight stoops were noted by a single bird in an attempt to capture prey. Merlins that made kills often had full crops and subsequently cached their food. Caches of merlins and peregrine falcons were found at the base of and on drift wood logs embedded in the sand on the Outer Island sand spit tip. Yellow-rumped warbler, palm warblers (Dendroica palmarum), Red-eyed vireos (Vireo olivaceus) and dark-eyed juncos were most prevalent in the food caches.

2. Direct chase

The direct chase, combined with an element of surprise was the most common hunting tactic employed. The merlins would fly low and flat, using the beach as cover, then pop up and over the dune in order to surprise some unsuspecting passerine. There were so many passerines, the tactic was analogous to a technique where if you drove a car fast enough and long enough, one would eventually run into something. One immature female had a broken tail feather and so it was possible to identify and take detailed observations of her. She flew over 123 circuits of an estimated one kilometer section of beach chasing passerines.

This single hunting merlin probably flew up and down the same beach at least 246 km in a single day.

3. High altitude stoop

The more spectacular hunts were when a passerine attempted an exodus over the open water, whereupon a merlin would fly to a great height and stoop spectacularly down upon the prey. However, it appeared that the merlin would always stoop past their prey and attempt to grasp the prey on the upswing of the stoop. The upswing tactic was executed to perfection by an adult female in hunting cliff swallows off Outer Islands West shore in the Fall of 1990. The merlin would fly in a straight line out over the lake, where the cliff swallows would mob her. She then circled, while climbing and the swallow mob followed her to a great height. At this high point she plumetted in a spectacular stoop and the swallows continued to pursue her. The merlin was heavier and fell faster and when she was a substantial distance ahead of her pursuers, she threw out her wings, cutting upward through the descending swallow mob and plucked a swallow on the upswing. I saw her use this technique succesfully on two occasions. Similarly, Craighead and Craighead (1940) noted the same hunting tactic on tree swallows. The upswing tactic was attempted to a lesser degree in a direct chase, but the technique seemed to prevent the prey from heading downward and kept it in position for another stoop.

4. Low altitude stoops

Merlins would drive small birds into the water off the shores of Outer Island and would then pluck them from the surface. On three occasions herring gulls (Larus argentatus) took merlin kills out of the water and once a peregrine falcon did. Herring gulls were observed striking passerines with their wings to knock them into the water. The gulls would then take their prey from the water with their beak and consume the bird in flight.

5. Other behaviors

While the hunting behaviors observed on Outer Island was spectacular and plentiful, limited behavioral observations were recorded at nest woods. Six distinct vocalizations were noted by both sexes and the young. Females would use an incessant call like a food beg until the male left the nest woods or when he would initiate incubation. The female calls seemed lower in pitch and were more monosyllabic; close in sound to a young merlin's food begging call. The distress call of both sexes was high pitched and whining, although the female's seemed lower in pitch. When there was close physical contact there was an agitated high pitched chitter by both sexes. This call occurred during copulation and when contact was made during a food delivery. Another vocalization was the male's food delivery call, which was a fast rolling high pitched chitter. Upon arrival to a perch he would make a series of short deliberate "chips" possibly to entice the female off the nest to be fed. I noted this same "chip" call by a male when he landed in a recently selected nest.

Merlins generally were observed to have tenacious nest defense; mobbing bald eagles, american crows and northern ravens. Interestingly, intruding red squirrels (*Tamiasciurus hudsonicus*) were relentlessly attacked by a pair of merlins in defense of their young. I was struck by adults at seven of 65 successful nests I visited. Craighead and Craighead (1940) reported that they were repeatedly struck by merlins.

Limited house keeping behavior (areas defended with no young) were noted at Michigan Island in 1989 and at eight locations within Voyageurs National Park. This is an aberrant behavior, not previously recorded. It was not known if there were young near by and the active nest not found, although at most of these areas extensive searches were conducted to find young. The Michigan Island nest was monitored throughout the summer, and although no young were fledged, they continued to defend the site and remain active in the area until mid July.

While using the great horned owl as a lure to trap merlins an occasional additional male or males were attracted to the banding site. It is likely that the additional male was attracted to the trapping location by hearing the distress calls of the other defending adults. To my knowledge there are no reports of polygamy in merlins in the literature.

L. Artificial Nests

Nine artificial nest structures were placed to determine if merlins would use them. Five were placed on the South shore of Lake Superior and four on the Turtle Flambeau Flowage in 1990. Two have been used by merlins; one successfully on the Turtle Flambeau Flowage in 1990. The artificial nests were refurbished in March of 1992. At eight of these sites, american crows had built a nest adjacent (<50 meters) to the artificial structure. This was viewed as a positive event, since in 1992 three crow nests near artificial stuctures were being used by merlins.

The willow fruit basket design was the most sturdy, because the wicker basket material became soft and flimsy. A base lining made from an old crow nest was the substrate used by the successful merlin pair. The experimental wood chip base also used may have been too hard. At Memorial Park in Washburn, Wisconsin, I observed a female merlin in a nest basket flipping out wood chips with her beak. Therefore, in 1992, when the nests were refurbished I used a mixture of sticks, white pine needles, spanish moss and sphagnum moss to test a softer nest lining. Another use of artificial nests would be to use the willow nest cups as base supports for nests in poor condition. They could be placed under the crow nests during the banding period if the nest condition was critical. Another possibility would be to use the willow nest cup to support an existing nest as a stabilizing method prior to the next breeding season.

SUMMARY

Migration data from Cedar grove and Hawk Ridge, suggest a strong increase in merlin populations beginning in 1984. Within the 1,858 km^2 study area surveyed (2,595 km of edge), 102 merlin territories were located in Ontario, Minnesota, Wisconsin and Michigan. Throughout the region, productivity from 65 successful nests averaged 2.9 young/nest and 83% of active nests were successful. Notable areas of concern include high turnover rates of adult merlins, poor condition of young where high occurences of dragonfly remains occurred in nests, and poor nest success at the Apostle Islands and Isle Royale.

The present range of breeding merlins in the Upper Midwest is confined to the northern portions of Minnesota, Wisconsin and Michigan, although the species southern range may have originally extended to central Iowa and northern Illinois. Generally, merlins are found nesting at low densities with signs of activity of a pair/58km^2 and active nests spaced at a mean distance of 13 km. A sign of breeding activity was noted for every 81.9 km of shoreline searched. There were 54% more areas found with signs of activity than active nests. This suggests a substantial non-breeding population.

Voyageurs National Park and the urban areas of Duluth and Superior have the highest breeding densities. At Voyageurs National Park the mean spacing of active nests was 10.3 km, while the closest triad of active nests was 2.6, .75 and 1.9 km apart.

The use of playback recordings was a vital tool in surveying merlin populations, but not the sole method used to locate territories. Individual reports, searches for stick nests, and scanning dominant snags were important means of finding breeding merlins. Playback recordings are not entirely dependable, as non-breeding merlins and migrants may respond to the tape and some breeding merlins will not respond.

In traditional habitat, a majority of merlin nesting occured within conifer forests on shorelines of large lakes. These lakes typically had convoluted shorelines with perimeters exceeding 161 km. The merlins usually select crow nests most commonly in white pines. Within urban areas spruces were favored, perhaps because they were the most abundant species. Ninety percent of nests are no longer suitable for use within three years. Therefore, territories with several available crow nests are more stable and have a higher chance of re-occupancy. Importantly, the conifer forest used by merlins are maintained by periodic natural fires. In the National Park Service units, burn policies allowing natural fires will be important to the long term maintenace of shoreline conifer stands. In the coastal areas of Chequamagon Bay, planting of conifers will probably create the conifer forest of the future, as fires must be extinguished for the protection of private property. Herbivores, such as beaver and white-tailed deer are severely impacting the islands within Kabetogema Lake and subsequent white pine regeneration is poor. However, merlins exhibit the behavioral plasticity to prosper in anthropocentric environments.

At the nest six different vocalizations were recorded and there were distinctive calls between the sexes. Larger birds were mobbed in nest defense, also red squirrels were knocked off nest trees and I was struck by merlins on seven occasions.

The use of artificial structures to augment merlin populations appears promising. The practical uses would be to aid existing nests in poor condition, provide additional structures to stabilize territories and create new territories at appropriate locations.

In total, 35 bird species, two insect families and two bat species were identified as prey remains in merlin nest woods. Prey consumption to support the 65 successful nests noted in the study would have required an estimated 29,250 - 45,500 small birds. Thus merlins may have a considerable effect on local avifauna.

Outer Island of the Apostle Islands, Wisconsin provided one of the best opportunities in the Upper Midwest to observe solitary, interspecific and intraspecific hunting and staging behaviors of migrant merlins. The history of observing staging merlins at the Outer Island sand spit was first recorded in 1919. Interesting behaviors noted were cooperative hunts of up to five merlins, and cooperative hunts between merlins and sharp-shinned hawks. Other points of interest were food cacheing by merlins and peregrine falcons, and herring gulls foraging on live passerines.

Throughout the Upper Midwest there have been frequent changes in merlin habitat. It is my opinion the merlin has re-bounded due to factors in the Upper Midwest such as: afforestation of conifer communities due to natural regeneration or human plantings; the lessening of contaminant burdens since the 1972 ban on DDT; increased american crow populations, since their recent protection by the migratory bird act of 1972, coupled with the expansion of agriculture and human settlement; and the increase of exotic and edge loving bird species as available prey in urban and agricultural areas.

The merlin has increased due to a variety of habitat, behavioral, and prey related factors, but is not an abundant species. It does occur in high densities within certain locales, but this is not the general rule. Hopefully, legal protection and sound management strategies and consistent monitoring will assist in the merlins long term survival in the Upper Midwest.

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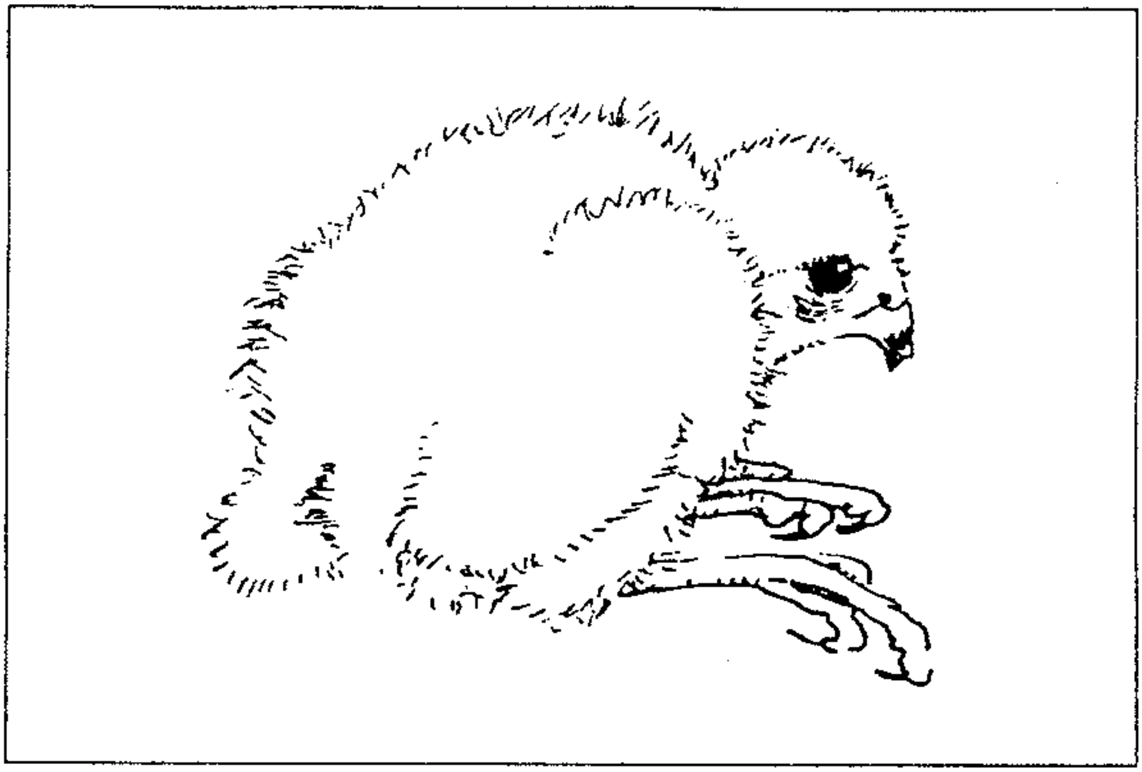
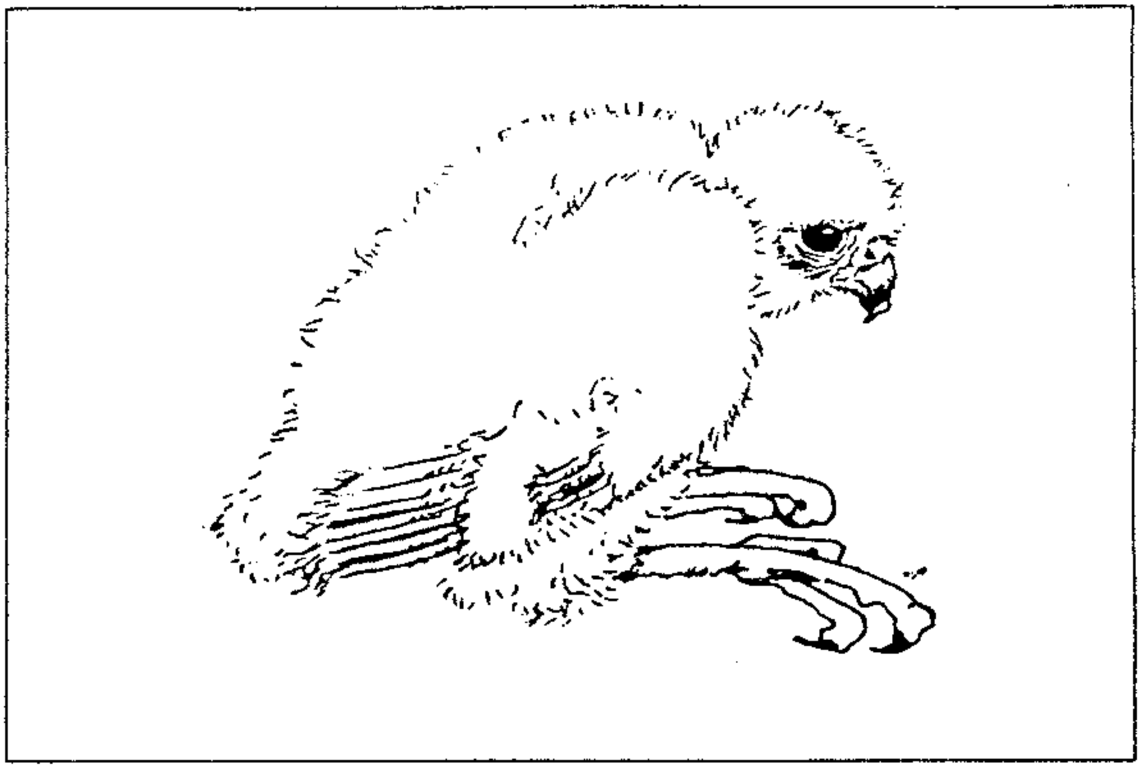
APPENDIX I. AGING KEY



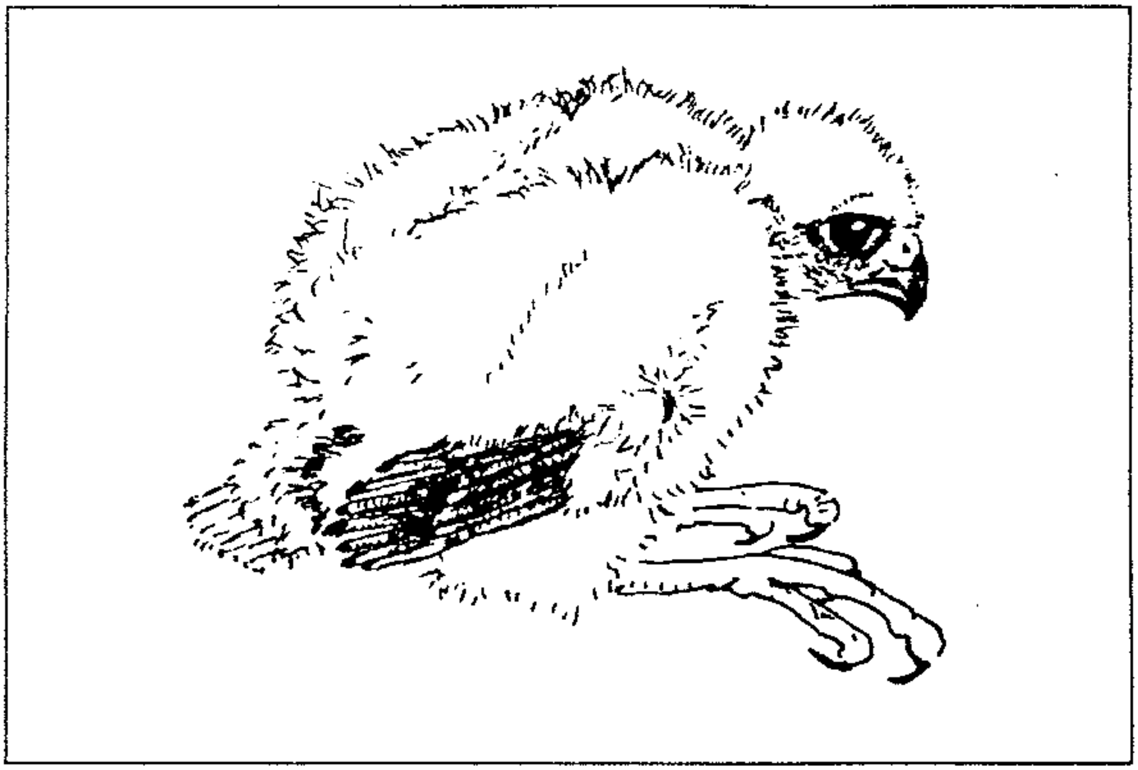
Merlin young at an age of 5 days

1. Covered entirely with natal down
2. No eruptions of tail feathers or primaries
3. Egg tooth very evident



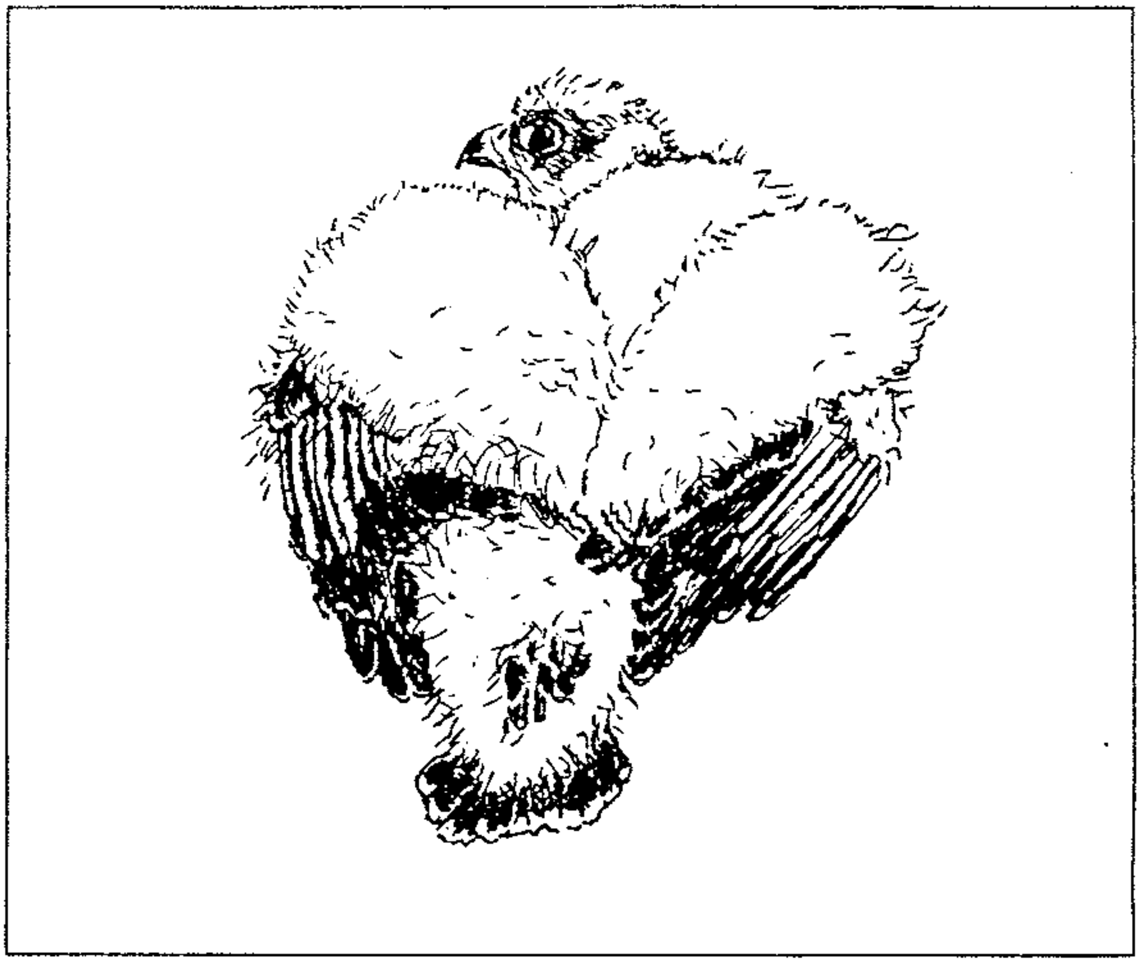
Merlin young at an age of 11 days

1. Still covered with natal down
2. Primary feathers erupted, but still in sheaths
3. Secondary feathers erupted, but still in sheaths
4. Tail feathers not erupted
5. Hint of egg tooth may be apparent



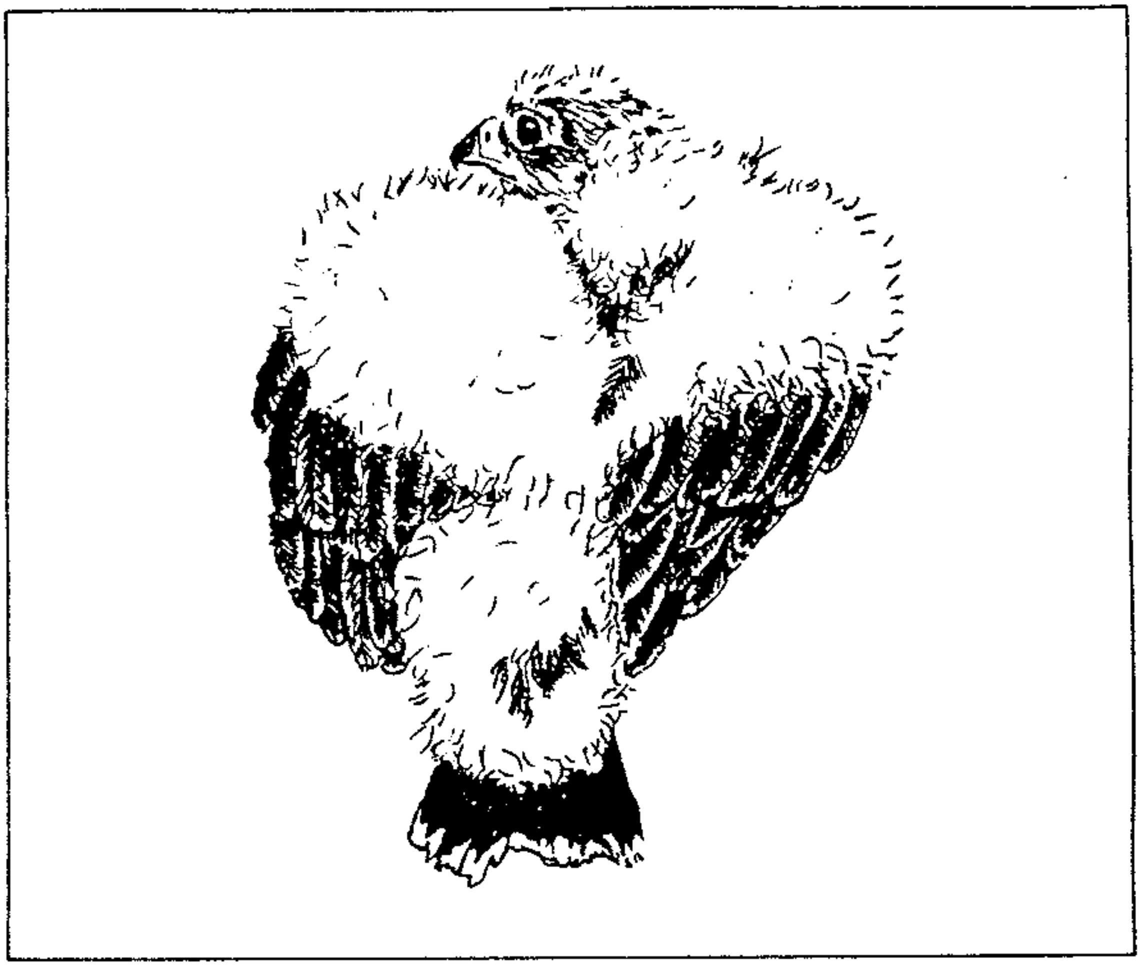
Merlin young at an age of 14 days

1. Still covered with natal down
2. Primary feathers have erupted from sheaths
3. Secondary feathers have erupted from sheaths
4. Tail feathers are erupted, but still in sheaths
5. Egg tooth is absent



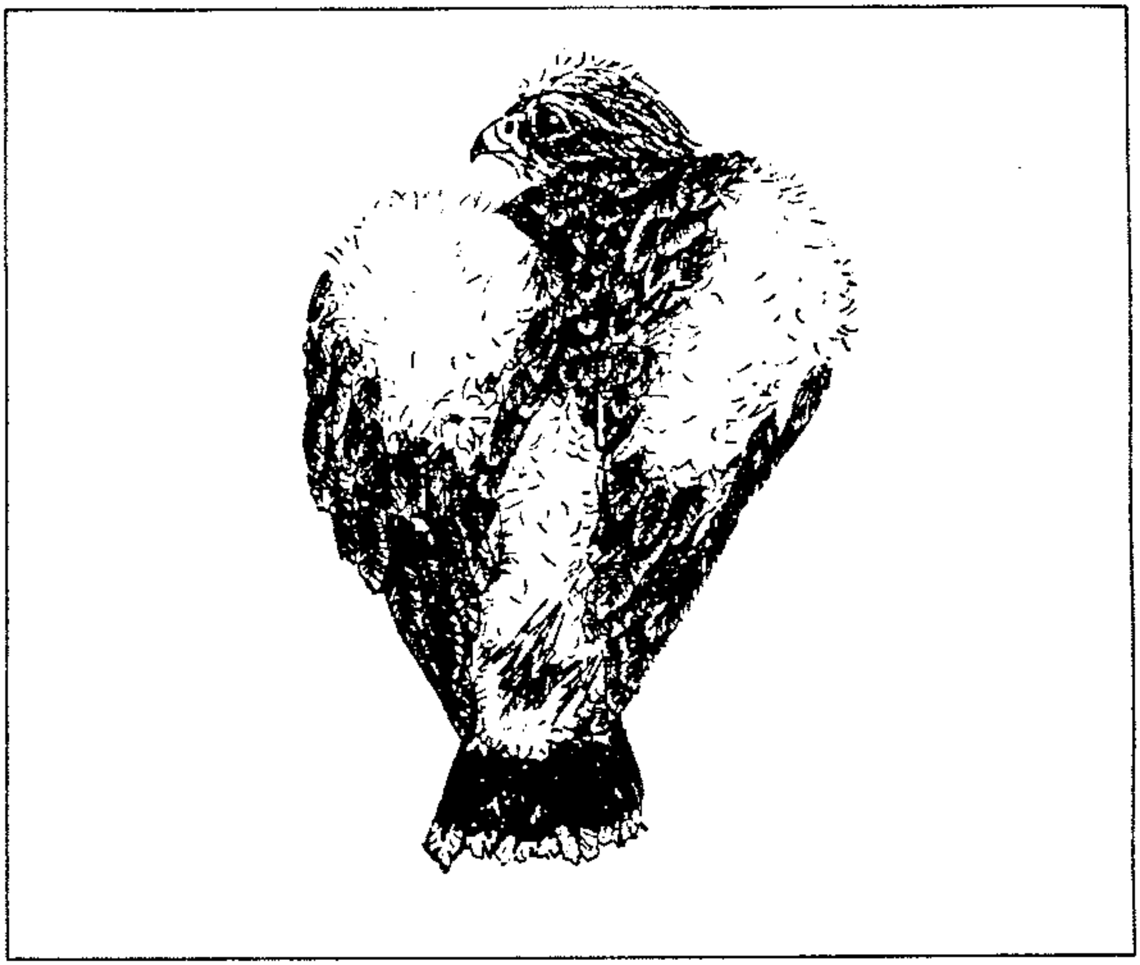
Merlin young at an age of 17 days

1. Auricular area with a hint of feathering
2. Back still covered with natal down
3. Feather sheaths still visible on primaries and secondaries
4. A small patch of feathers is notable on the rump
5. Tail feathers are erupted



Merlin young at an age of 20 days

1. Auricular area feathered to back of the head
2. Hint of feathering on the back
3. Feathers sheaths on primaries and secondaries not visible
4. Tail erupted, so as the terminal band is clearly evident



Merlin young at an age of 23 days

1. Head region mostly feathered, except for crown
2. Back is mostly feathered
3. Scapulars are present around wing margins

APPENDIX II. DATA SHEET

BANDING VISIT DATA SHEET

TERRITORY NAME: ______________________ 10' BLOCK ____________ DATE: ________

NARRATIVE LOCATION: ____

____

______________________________ T___N R___E/W Section ______ ¼ ______

	*Band Number	Age-S	Weight	WC	WCF	T	Crop	Fat	Eye	Parasites	Other
Adult											
Adult											
Young #1											
2											
3											
4											
5											
6											

*INSTRUCTIONS: Use ( ) if return; circle if foreign.

MOLT CARDS

Adult Female

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LR															
RR															
LP															
LS															
RP															
RS															

Adult Male

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LR															
RR															
LP															
LS															
RP															
RS															

NEST DESCRIPTION: ☐ Repaired ☐ New ☐ Renest Other: ____________

Number of nest structures in area: ______ Distance(s) from current nest: ____________

Nest tree species: ______________________ Nest tree DBH: ________

Nest height: ____________ Nest decoration; characterization of nest woods: ________

____

______________________________ Sampled: ☐ YES ☐ NO

Other Data: Prey Items: ______________________________

How nest was found: ______________________________

Mothballed: ☐ YES ☐ NO Trapping time: ________ Photos (specify on whose camera) - Birds: A Y / N; A Y / N; Yng. Y / N; Nest Y / N; Nest tree Y / N; Nest woods Y / N; Other Y / N Specify: ______________________

Behavior of adults (specify tape used for trapping): ______________________

____

Sonogram: Recorder ____________________; Tape ______________ ____

APPENDIX III. MEASUREMENTS ON ADULT AND YOUNG MERLINS BANDED FROM 1987 - 1991

Measurements taken on After Second Year Male Merlins from 1987-1990

Location	Date	USFWS Band #	weight (gms)	Wingchord (mm)	Wingchord Flat (mm)	Tail (mm)	Toe (mm)	Breast	Crop	Parasites
WI Julian Bay	7-4-87	1143-99296	149	189	190	111	28	4	0	none
MI Bell Harbor	7-19-88	1253-74501	142.4	195	198	117	28	4	0	none
MI Suzies Cave	7-18-88	1443-38322	156.4	186	190	129	29	4	0	none
VNP Stonewall	7-11-88	1443-38317	142.4	185	187	115	29	4	0	none
VNP Yodle Mainland	7-8-88	1443-38304	140.9	189	191	113	28	4	0	none
VNP 3 Sisters	7-10-88	1443-38313	156.9	192	195	112	28	5	0	none
VNP Mica Island	7-9-88	1443-38308	147.4	185	189	124	27	4	0	none
WI Michigan Island	7-7-88	1443-38303	150.8	193	196	118	27	4	0	none
VNP Cutover	7-18-89	1253-74581	152.8	191	193	118	28	5	0	none
VNP Brule East*	7-6-89	1253-74596	137.9	193	196	114	28	5	0	none
VNP North Gunsight*	7-7-89	1253-74595	150.3	193	195	115	29	5	0	none
VNP Dryweed	6-24-89	1253-74512	138.2	191	193	115	27	3	0	none
VNP Cajun Island*	6-23-89	1253-74511	140.4	191	193	115	28	5	0	none
VNP Juniper West	6-23-89	1253-74510	137.6	194	196	116	27	4	0	none
VNP Williams South	6-21-89	1253-74506	149.8	194	197	115	27	5	0	none
VNP Woodenfrog NE	7-3-89	1253-74524	155.9	187	190	113	29	4	0	none
VNP Tiny Woodenfrog	6-22-89	1253-74509	159.8	190	192	116	28	4	5	none
VNP Yodle Mainland**	6-21-89	1443-38304	140.9	187	190	115	28	4	2	none
VNP Cuculus	6-22-89	1253-74507	151	193	196	112	27	5	0	none
VNP Ash River	6-20-89	1253-74505	148.4	181	185	112	28	5	4	none
VNP Fox Island	7-6-89	1253-74600	145.8	192	193	119	28	4	4	none
VNP School Teacher	6-22-89	1253-74508	144.6	195	197	114	29	2	0	none
VNP 3 Sisters	7-16-89	1253-74582	144.3	186	188	114	27	5	0	none
VNP Kettle Falls*	7-7-89	1253-74594	151.8	192	194	113	28	5	0	none
WI Prentice Park	6-16-89	1253-74502	152.8	194	196	111	27	4	0	none
WI 2nd Landing	6-16-89	1253-75404	152.8	193	196	113	27	4	0	none
WI Ashland South	6-16-89	1253-74503	168	191	193	113	27	4	10	none
MI Suzies Cave	7-12-89	1253-74592	148.9	196	198	119	28	4	0	none
MI McGinties Cove	7-15-89	1253-74590	154.8	191	193	115	28	4	0	none
WI Superior Burbs	7-21-90	1253-97007	150.8	196	197	116	28	4	2	none
WI Trek and Trail	6-29-90	1253-74578	149.8	191	192	112	28	5	0	none
WI 2nd Landing**	6-28-90	1253-74504	153.1	193	195	113	28	5	0	none
VNP Fox Island	7-7-90	1253-74554	145.5	196	197	116	28	5	0	none
VNP Deerhorn	7-5-90	1253-74577	134.8	175	176	105	28	3	3	none
VNP Mica Island	6-23-90	1253-74564	148.5	189	190	112	28	4	0	none
VNP Echo Island	6-23-90	1253-74579	151.9	194	195	119	28	4	0	none
VNP School Teacher**	6-23-90	1253-74508	155.3	195	196	112	28	4	3	none
VNP 3 Sisters	6-16-90	1253-74582	145.3	185	187	110	28	4	0	none
Mean			148.6	190.6	192.8	114.8	27.9	4.2	0.9	

* : Canadian Sites

* * : recapture, age (ATY)

Measurements taken on After Second Year and Second year Female Merlins from 1987-1990

Location	Date	USFWS Band #	Weight (gms)	Wingchord (mm)	Wingchord Flat (mm)	Tail (mm)	Toe (mm)	Breast	Crop	Parasites
WI Julian Bay	7-4-87	614-64101	226.6	219	220	129	36	5	0	Hippoboscidae
MI Suzies Cave	7-18-88	614-64142	211.1	209	211	127	32	3	0	none
MI Edwards Island	7-18-88	614-64143	209.1	209	211	126	31	3	0	none
VNP Stonewall	7-11-88	614-64116	219.9	219	221	123	30	4	0	none
VNP Mica Island	7-9-88	614-64109	219.9	203	205	124	32	4	0	none
VNP School Teacher	7-10-88	614-64112	200.3	211	214	130	32	3	0	none
VNP Wolf Pack	7-9-88	614-64106	202.6	207	209	126	31	3	0	none
VNP Cutover	7-18-89	614-64169	205.8	210	213	126	33	3	0	none
VNP Dryweed	6-24-89	614-64122	226	211	213	125	33	4	0	none
VNP Cajun Island **	6-23-89	614-64120	248.6	208	211	125	31	4	8	none
VNP Juniper West	7-4-89	614-64145	194.3	208	210	126	33	3	0	none
VNP Woodenfrog NE	6-22-89	614-64119	222.4	208	210	124	32	5	0	none
VNP Yodle Mainland	7-3-89	614-64129	213.8	212	215	120	33	3	0	none
VNP Cuculus	7-3-89	614-64133	229	212	217	128	34	3	0	none
VNP Ash River	7-3-89	614-64140	229.3	208	212	126	32	4	0	none
VNP School Teacher	6-22-89	614-64118	249.3	208	210	119	31	3	0	none
VNP 3 Sisters(SY)	7-16-89	614-64168	227.3	209	211	128	33	3	0	none
VNP Kettle Falls**	6-24-89	614-64121	230.8	219	221	131	33	3	0	none
VNP Namakan River**	7-5-89	614-64158	196.3	213	216	127	33	3	0	none
WI 2nd Landing(SY)	6-28-89	614-64128	210.2	213	217	131	33	3	0	none
WI Michigan Island	6-27-89	614-64123	221.3	204	206	124	33	5	0	none
WI Ashland So.(SY)	6-27-89	614-22306	224.5	216	218	126	35	4	0	none
MI Suzies Cave(SY)	7-12-89	614-64159	210.6	202	204	128	33	4	0	none
VNP Fox Island(SY)	7-7-90	614-64178	207	210	212	130	33	4	0	none
VNP School Teacher*	6-23-90	614-64168	220	210	211	119	33	4	0	none
VNP 3 Sisters	6-16-90	614-64172	245.8	210	212	129	33	5	5	Hippoboscidae
VNP Sexton Island	7-15-90	614-64179	211	209	210	120	33	5	0	none
WI 2nd Landing	6-28-90	614-64173	229.8	209	211	125	33	4	0	none
WI Turtle Flambeau	7-13-90	614-64185	238	212	215	125	33	5	0	none
WI Prentice Park(SY)	7-20-90	1204-08002	211	203	207	119	33	5	0	none
Mean			219.7	210.0	212.4	125.5	32.7	3.8	0.4	

* = Recapture, Age After Third Year (ATY)

** = Canadian Sites

Measurements Taken on Young of the Year (L) Merlins from 1987-1991

Location	Date	USFWS Band#	Sex	Age(days)	Toe (mm)	Parasites
WI Julian Bay	7-11-87	614-64102	F	9-11	30	Auditory Myaisis
same	¦	614-64103	F	¦	31	Auditory Myaisis
same	¦	1143-99297	M	¦	28	Auditory Myaisis
same	¦	1143-99298	M	¦	28	Auditory Myaisis
WI Michigan Island	7-14-87	Egg Collected	-	-	-	-
VNP Ash River	7-8-88	1443-38305	M	18-20	26	none
same	¦	1443-38306	M	¦	26	none
same	¦	614-64104	F	¦	34	none
same	¦	614-64105	F	¦	32	none
VNP Wolf Pack	7-9-88	614-64107	F	18-20	31	none
same	¦	614-64108	F	¦	32	none
same	¦	1443-38307	M	¦	26	none
VNP Mica	7-9-88	614-64110	F	12-15	31	none
same	¦	1443-38310	M	¦	27	none
same	¦	1443-38312	M	¦	27	none
VNP 3 Sisters	7-10-88	Brancher	U	28+	-	-
same	¦	Brancher	U	28+	-	-
same	¦	Brancher	U	28+	-	-
VNP School Teacher	7-10-88	1443-38315	M	20-22	29	none
same	¦	1443-38316	M	¦	26	none
same	¦	614-64113	F	¦	34	none
same	¦	614-64114	F	¦	35	none
same	¦	614-64115	F	¦	35	none
VNP Stonewall	7-11-88	1443-38318	M	23-25	29	none
same	¦	1443-38319	M	¦	29	none
same	¦	1443-38321	M	¦	27	none
same	¦	614-64117	F	¦	34	none
VNP Alder Creek	7-11-88	1443-38325	M	12-15	27	none
VNP West Eight Mile	7-12-88	Bad Tree	U	23-25	-	-
same	¦	Bad Tree	U	¦	-	-
same	¦	Bad Tree	U	¦	-	-
MI Shiverette	7-17-88	Brancher	U	28+	-	Mallophaga
same	¦	Brancher	U	¦	-	Mallophaga
same	¦	Brancher	U	¦	-	Mallophaga
MI Edwards Island	7-18-88	Brancher	U	28+	-	Mallophaga
MI Suzies Cave	7-18-88	Brancher	U	28+	-	-
MI Belle Harbor	7-19-88	Brancher	U	28+	-	-
same	¦	Brancher	U	28+	-	-
same	¦	Brancher	U	28+	-	-
WI Second Landing	7-21-88	Brancher	U	28+	-	-
same	¦	Brancher	U	28+	-	-
same	¦	Brancher	U	28+	-	-

Location	Date	USFWS Band#	Sex	Age(days)	Toe (mm)	Parasites
VNP Namakan River*	7-5-89	614-64151	F	9-11	33	none
same	¦	614-64152	F	¦	33	none
same	¦	614-64153	F	¦	33	none
same	¦	1253-74528	M	¦	27	none
VNP Kettle Falls*	7-7-89	614-64154	F	20+	33	none
same	¦	614-64155	F	¦	33	none
same	¦	1253-74529	M	¦	27	none
same	¦	2-eggs		¦	-	-
VNP 3 Sisters	7-16-89	614-64144	F	20+	33	none
same	¦	614-64166	F	¦	33	none
same	¦	brancher	U	¦	-	-
same	¦	dead	M	14-16	-	-
VNP Cajun Isle*	7-4-89	614-64148	F	9-11	32	none
same	¦	614-64149	F	¦	31	none
same	¦	614-64150	F	¦	32	none
same	¦	1253-74527	M	¦	27	none
VNP School Teacher	7-16-89	614-64165	F	8-10	30	none
same	¦	1253-74588	M	¦	27	none
same	¦	dead	-	¦	-	-
VNP Wolf Pack	7-7-89	1253-74592	M	dead	27	none
same	¦	dead**	-	¦	-	-
same	¦	dead	-	¦	-	-
Territory Failed	7-16-89	-	-	¦	-	-
VNP Fox Island	7-17-89	614-64167	F	10-12	30	none
same	¦	1253-74587	M	¦	27	none
same	¦	egg collected	-	¦	-	-
VNP Cuculus	7-3-89	614-64134	F	14-16	33	none
same	¦	614-64135	F	¦	32	none
same	¦	614-64136	F	¦	33	none
same	¦	1253-74521	M	¦	26	none
same	¦	egg collected	-	¦	-	-
VNP Juniper West	7-4-89	614-64146	F	10-12	31	Auditory Myaisis
same	¦	614-64147	F	¦	32	Auditory Myaisis
same	¦	1253-74525	M	¦	26	Auditory Myaisis
same	¦	1253-74526	M	¦	27	Auditory Myaisis
VNP Williams South	7-4-89	614-64138	F	dead	33	none
same	¦	614-64139	F	10-12	31	none
same	¦	1443-38323	M	¦	29	none
same	¦	1443-38324	M	¦	29	none
same	¦	dead**	-	¦	-	-
VNP Yodle Mainland	7-3-89	614-64130	F	14-16	33	none
same	¦	614-64131	F	¦	33	none
same	¦	614-64132	F	¦	33	none
same	¦	1253-74520	M	¦	28	none
same	¦	egg collected	-	¦	-	-
VNP Ash River	7-3-89	614-64162	F	16-18	34	none
same	¦	614-64163	F	¦	33	none
same	¦	614-64164	F	¦	34	none

Location	Date	USFWS Band#	Sex	Age(days)	Toe (mm)	Parasites
VNP Woodenfrog	7-3-89	614-64137	F	10-12	33	none
same	¦	1253-74522	M	¦	27	none
same	¦	1253-74523	M	¦	27	none
VNP North Gunsight*	7-7-89	1253-74530	M	10-12	27	none
same	¦	1253-74531	M	¦	27	none
VNP Dryweed	7-6-89	614-64156	F	16-18	33	none
same	¦	614-64157	F	¦	33	none
same	¦	1253-74597**	M	U	25	none
same	¦	1253-74598	M	16-18	28	none
same	¦	1253-74599	M	¦	28	none
VNP Cutover	7-17-89	614-64170	F	18-20	33	none
same	¦	614-64171	F	¦	33	none
same	¦	1253-74580	M	¦	28	none
VNP Brule*	7-17-89	1253-74586	M	14-16	28	none
same	¦	614-64166	F	¦	33	none
WI Prentice Park	6-27-89	614-64126	F	8-10	30	none
same	¦	614-64127	F	¦	29	none
same	¦	1253-74517	M	¦	27	none
same	¦	1253-74518	M	¦	27	none
same	¦	1253-74519	M	¦	27	none
WI Second Landing	6-27-89	614-64124	F	10-12	32	none
same	¦	614-64125	F	¦	32	none
same	¦	1253-74514	M	¦	27	none
same	¦	1253-74515	M	¦	24	none
same	¦	1253-74516	M	¦	28	none
WI Ashland South	6-27-89	614-22307+	F	10-12	-	none
same	¦	614-22308+	F	¦	-	none
same	¦	614-22309+	F	¦	-	none
same	¦	803-53448+	M	¦	-	none
same	¦	Fetus Collec.			-	-
WI Michigan Island	7-10-89	dead	U	16-18	-	-
same	¦	dead	U	¦	-	-
same	¦	dead	U	¦	-	-
MI Suzies Cave	7-12-89	614-64160	F	16-18	33	none
same	¦	614-64161	F	¦	33	none
same	¦	1253-74591	M	¦	28	none
MI Belle Harbor	7-16-89	dead	U	16-18	-	-
WI Julian Bay	6-12-90	egg collected	-	-	-	-
WI Second Landing	6-28-90	614-64183	F	10-12	32	none
same	¦	1253-74565	M	¦	28	none
WI Trek and Trail	6-29-90	1253-74566	M	16-18	28	none
same	¦	1253-74567	M	¦	28	none
same	¦	1253-74562	M	¦	28	none
same	¦	1253-74563	M	¦	28	none
WI Turtle Flambeau	7-13-90	614-64181	F	18-20	33	none
same	¦	614-64184	F	¦	33	none

Location	Date	USFWS Band#	Sex	Age(days)	Toe (mm)	Parasites
WI Superior Burbs	7-21-90	1253-97008	M	18-20	28	none
same	¦	1253-97009	M	¦	28	none
same	¦	1204-08003	F	¦	33	none
same	¦	1204-08004	F	¦	32	none
WI Prentice Park	7-20-90	Brancher	U	28+	-	-
same	¦	Brancher	U	¦	-	-
same	¦	Brancher	U	¦	-	-
same	¦	Brancher	U	¦	-	-
WI Red Cliff	7-19-90	Brancher	U	28+	-	-
same	¦	Brancher	U	¦	-	-
same	¦	Brancher	U	¦	-	-
same	¦	Brancher	U	¦	-	-
same	¦	Brancher	U	¦	-	-
WI Sioux River	7-22-90	Brancher	U	28+	-	-
same	¦	Brancher	U	¦	-	-
same	¦	Brancher	U	¦	-	-
same	¦	Brancher	U	¦	-	-
same	¦	Brancher	U	¦	-	-
same	¦	Brancher	U	¦	-	-
VNP Echo Island	7-14-90	614-64174	F	16-18	33	none
same	¦	614-64175	F	¦	33	none
same	¦	614-64176	F	¦	32	none
same	¦	1253-74575	M	¦	28	none
same	¦	1253-74576	M	¦	28	none
VNP 3 Sisters	7-6-90	deserted	-	-	-	-
VNP Blind Pig	7-6-90	1253-97004	M	25+	28	none
same	¦	Brancher	?	¦	-	-
VNP Fox Island	7-7-90	1253-74568	M	11-12	28	none
same	¦	1253-74569	M	¦	28	none
same	¦	1253-74570	M	¦	28	none
VNP Sexton Island	7-15-90	Brancher	-	28+	-	-
same	¦	Brancher	-	28+	-	-
same	¦	Brancher	-	28+	-	-
same	¦	Brancher	-	28+	-	-
VNP Mica Island	7-8-90	1204-08001	F	10-12	32	none
same	¦	614-64182	F	¦	32	none
same	¦	1253-97002	M	¦	28	none
VNP School Teacher	7-16-90	Brancher	-	28+	-	-
same (bad tree)	¦	Brancher	-	28+	-	-
same	¦	Brancher	-	28+	-	-
VNP Deerhorn	7-5-90	1253-74572	M	10-12	28	none
same	¦	1253-74574	M	¦	28	none
same	¦	614-641200	F	¦	31	none
VNP Dryweed	7-17-90	1253-97003	M	20-23	28	none
same	¦	1253-97005	M	¦	28	none
same	¦	1253-97006	M	¦	28	none

Location	Date	USFWS Band#	Sex	Age(days)	Toe (mm)	Parasites
WI Prentice Park	7-5-91	1253-97010	M	23+	29	none
same	¦	1253-97011	M	23+	28	none
same	¦	1204-08005	F	23+	34	none
same	¦	1204-08006	F	23+	34	none
WI Wisconsin Point	7-6-91	1253-97012	M	15	28	none
same	¦	1204-08007	F	15	33	none
same	¦	1204-08008	F	15	33	none
same	¦	1204-08099	F	15	33	none
WI Second Landing	7-14-91	1204-08012	F	12	33	none
same	¦	1253-97014	M	12	28	none
MN Woodland	7-6-91	1253-97013	M	23	28	none
same	¦	1204-08010	F	23	33	none
same	¦	Brancher	U	23	-	-
MN Eng	7-13-91	1204-08009	F	15-16	32	none
same	¦	1204-10301	F	15-16	33	none
same	¦	1204-10302	F	15-16	32	none
MN Sarahs	7-13-91	1253-97045	M	15	28	none
same	¦	1253-97044	M	15	28	none

APPENDIX IV. LIST OF MERLIN TERRITORIES FROM 1987 - 1991

LIST OF MERLIN BREEDING LOCATIONS FROM 1987-1991

Date	State/Province	Map Code #	Study Area	Location	Status	# of young
1991	Mn	Mn-59	Duluth	Glenwood/ Sarahs	Successful	2
1991	Mn	Mn-58	Duluth	Lester Park	Successful	?
1991	Mn	Mn-57	Duluth	Maynard Eng	Successful	3
1991	Mn	Mn-56	Duluth	Woodland and Gleenwood	Successful	3
1991	Mn	Mn-55	Duluth	Superior Street	Successful	?
1991	Mn	Mn-54	Duluth	35th ave.	Successful	?
1991	Mn	Mn-53	Duluth	Park Point	Successful	1
1991	Wi	Wi-25	Superior	Wis. Point	Successful	4
1991	Wi	Wi-24	Superior	Baxter Street	Active	
1991	Wi	Wi-23	Chequamagon	Washburn/Memorial Park	Active	
1991	Wi	Wi-21b	Chequamagon	Washburn S-curve	Sign of Activity	
1991	Wi	Wi-11c	Chequamagon	Prentice Park	Successful	4
1991	Wi	Wi-6d	Chequamagon	Second Landing #4	Successful	2
1991	Wi	Wi-22	Flambeau Flowage	Site #2	Successful	3
1991	Wi	Wi-14c	Flambeau Flowage	Site #1 Artificial	Sign of Activity	
1991	Wi	Wi-10b	Apostles	Outer Island Lagoon	Active	
1990	Mn	Mn-52	Duluth	West Duluth	Successful	?
1990	Mn	Mn-51	Duluth	Duluth Heights	Successful	2
1990	Wi	Wi-21	Chequamagon	S-Curve	Sign of Activity	
1990	Wi	Wi-20	Superior	Suskewahana	Successful	4
1990	Wi	Wi-19	Apostles	Julian Bay #2	Active	
1990	Wi	Wi-6c	Chequamagon	Second Landing #3	Successful	2
1990	Wi	Wi-18	Chequamagon	Bayfield, Greg Swevels	Successful	4
1990	Wi	Wi-11b	Chequamagon	Prentice Park	Successful	4
1990	Wi	Wi-17	Chequamagon	Buffulo Bay Red Cliff	Successful	5
1990	Wi	Wi-16	Chequamagon	Sioux River	Successful	5
1990	Wi	Wi-14b	Flambeau Flowage	Site #1 Artificial	Successful	2
1990	Mn	Mn-24b	Voyageurs	KAB Echo Island	Successful	5
1990	Mn	Mn-3c	Voyageurs	KAB 3 Sisters	Active	
1990	Mn	Mn-4c	Voyageurs	KAB School Teacher	Successful	3
1990	Mn	Mn-25b	Voyageurs	KAB Deer Point	Successful	3
1990	Mn	Mn-6c	Voyageurs	KAB Ashriver	Occupied Nest	
1990	Mn	Mn-8c	Voyageurs	KAB Yoder Mainland	Sign of Activity	
1990	Mn	Mn-29b	Voyageurs	KAB Cuculus	Sign of Activity	
1990	Mn	Mn-23b	Voyageurs	KAB Yew Bush	Occupied Nest	
1990	Mn	Mn-26b	Voyageurs	KAB Tiny Woodenfrog	Occupied Nest	
1990	Mn	Mn-5c	Voyageurs	KAB West Kab	Occupied Nest	
1990	Mn	Mn-50	Voyageurs	KAB Blunt	Occupied Nest	
1990	Mn	Mn-10c	Voyageurs	NAM Wolf Pack	Sign of Activity	
1990	Mn	Mn-49	Voyageurs	NAM Twin Alligator	Sign of Activity	
1990	Mn	Mn-41b	Voyageurs	NAM Juniper East	Occupied Nest	
1990	Mn	Mn-48	Voyageurs	NAM Blind Pig	Successful	2
1990	Mn	Mn-11c	Voyageurs	NAM Mica	Successful	3
1990	Mn	Mn-47	Voyageurs	NAM Sexton	Successful	4
1990	Mn	Mn-42b	Voyageurs	NAM Juniper West	Occupied Nest	

Date	State/Province	Map Code #	Study Area	Location	Status	# of young
1989	Wi	Wi-15	Apostles	Rocky-Semo	Sign of Activity	
1989	Wi	Wi-14	Flambeau Flowage	Site #1	Occupied Nest	
1989	Wi	Wi-13	Chequamagon	East Ashland-Semo	Successful	4
1989	Wi	Wi-12	Chequamagon	N. of S - Curve	Occupied Nest	
1989	Wi	Wi-11	Chequamagon	Prentice Park Deer Yard	Successful	5
1989	Wi	Wi-6b	Chequamagon	Second Landing, Brettings	Successful	5
1989	Wi	Wi-3b	Chequamagon	Pierce Road So. of Ashland	Successful	4
1989	Wi	Wi-10	Apostles	Outer Island Lagoon	Sign of Activity	
1989	Wi	Wi-5c	Apostles	Michigan Island Light	Active	
1989	Mi	Mi-11b	Isle Royale	Suzies Cave	Successful	3
1989	Mi	Mi-10b	Isle Royale	Belle Harbor	Active	
1989	Mi	Mi-9b	Isle Royale	Edwards Island	Occupied Nest	
1989	Mi	Mi-17	Isle Royale	McGinties Cove	Occupied Nest	
1989	Mi	Mi-16	Isle Royale	Blake Point	Active Nest	
1989	Mi	Mi-15	Isle Royale	Peterson Cabin	Sign of Activity	
1989	Mi	Mi-14	Isle Royale	Rainbow Cave	Sign of Activity	
1989	Mi	Mi-13	Isle Royale	Long Point	Sign of Activity	
1989	Mi	Mi-8b	Isle Royale	Shiverette	Occupied Nest	
1989	Mi	Mi-12	Isle Royale	Grace Creek	Sign of Activity	
1989	ONT	Mn-45	Voyageurs	NAM CA,So. of Nam River	Successful	4
1989	ONT	Mn-44	Voyageurs	NAM CA Cajun	Successful	4
1989	Mn	Mn-10b	Voyageurs	NAM Wolf Pack	Successful	1
1989	Mn	Mn-43	Voyageurs	NAM Williams South	Successful	4
1989	Mn	Mn-42	Voyageurs	NAM Juniper West	Successful	4
1989	Mn	Mn-41	Voyageurs	NAM Juniper East	Occupied Nest	
1989	ONT	Mn-40	Voyageurs	NAM East of Blackstone	Active Nest	
1989	Mn	Mn-39	Voyageurs	NAM Ziski	Occupied Nest	
1989	ONT	Mn-38	Voyageurs	NAM River	Sign of Activity	
1989	Mn	Mn-11b	Voyageurs	NAM Mica	Occupied Nest	
1989	ONT	Mn-37	Voyageurs	RAIN CA North of Gunsight	Successful	2
1989	ONT	Mn-36	Voyageurs	RAIN CA Brule	Successful	2
1989	ONT	MN-14b	Voyageurs	RAIN CA Kettle Falls	Successful	3
1989	Mn	Mn-20b	Voyageurs	RAIN Fox	Successful	2
1989	Mn	Mn-18b	Voyageurs	RAIN Dryweed	Successful	5
1989	Mn	Mn-15b	Voyageurs	RAIN Blueberry	Sign of Activity	
1989	Mn	Mn-35	Voyageurs	RAIN 3 Sisters BM #34	Occupied Nest	
1989	Mn	Mn-34	Voyageurs	RAIN West of White Rock	Occupied Nest	
1989	Mn	Mn-33	Voyageurs	RAIN East of White Rock	Occupied Nest	
1989	Mn	Mn-32	Voyageurs	RAIN Deer Point	Occupied Nest	
1989	Mn	Mn-31	Voyageurs	RAIN West of Deer Point	Sign of Activity	
1989	Mn	Mn-30	Voyageurs	RAIN East of Breezy	Occupied Nest	
1989	Mn	Mn-3b	Voyageurs	KAB 3 Sisters	Successful	2
1989	Mn	Mn-4b	Voyageurs	KAB School Teacher	Successful	2
1989	Mn	Mn-29	Voyageurs	KAB Cuculus	Successful	4
1989	Mn	Mn-8b	Voyageurs	KAB Yoder Mainland	Successful	4
1989	Mn	Mn-6b	Voyageurs	KAB Ashriver	Successful	4
1989	Mn	Mn-28	Voyageurs	KAB Woodenfrog NE	Successful	3
1989	Mn	Mn-27	Voyaguers	KAB Cutover	Successful	3

Date	State/Province	Map Code #	Study Area	Location	Status	# of young
1989	Mn	Mn-26	Voyageurs	KAB Tiny Woodenfrog	Active Nest	
1989	Mn	Mn-25	Voyageurs	KAB Deer Point	Occupied Nest	
1989	Mn	Mn-5b	Voyageurs	KAB West Kab	Sign of Activity	
1989	Mn	Mn-24	Voyageurs	KAB Echo	Sign of Activity	
1989	Mn	Mn-23	Voyageurs	KAB Yew Bush	Occupied Nest	
1989	Mn	Mn-1b	Voyageurs	KAB Larkin	Sign of Activity	
1989	ONT	Mn-22	Voyageurs	Vermillion Narrow	Sign of Activity	
1988	Wi	Wi-5b	Apostles	Michigan Island Light	Active Nest	
1988	Wi	Wi-9	Apostles	North Twin	Sign of Activity	
1988	Wi	Wi-8	Apostles	York	Occupied Nest	
1988	Wi	Wi-7	Sawyer County	Chippewa Flowage	Occupied Nest	
1988	Wi	Wi-6	Chequamagon	Second Landing	Successful	3
1988	Wi	Wi-1b	Chequamagon	Lost Creek	Sign of Activity	
1988	Mi	Mi-11	Isle Royale	Suzie's Cave	Successful	1
1988	Mi	Mi-10	Isle Royale	Belle Harbor	Successful	3
1988	Mi	Mi-9	Isle Royale	Edwards Island	Successful	1
1988	Mi	Mi-8	Isle Royale	Shiverette Island	Successful	2
1988	Mi	Mi-7	Isle Royale	Mott Barge Cove	Occupied nest	
1988	Mi	Mi-6	Isle Royale	Caribou Island	Occupied nest	
1988	Mi	Mi-5	Isle Royale	Daisy Farm	Sign of Activity	
1988	Mi	Mi-4	Isle Royale	Passage Island Trio	Occupied Nest	
1988	Mi	Mi-3	Isle Royale	Duncan Bay	Sign of Activity	
1988	Mi	Mi-2	Isle Royale	Tobin Harbor	Sign of Activity	
1988	Mi	Mi-1	Isle Royale	Inner Hill	Sign of Activity	
1988	Mn	Mn-21	Voyageurs	RAIN West eight Mile	Successful	3
1988	Mn	Mn-20	Voyageurs	RAIN Fox Island	Occupied Nest	
1988	Mn	Mn-19	Voyageurs	RAIN Alder Creek	Successful	1
1988	Mn	Mn-18	Voyageurs	RAIN Dryweed	Sign of Activity	
1988	Mn	Mn-17	Voyageurs	RAIN Stonewall	Successful	5
1988	Mn	Mn-16	Voyageurs	RAIN 3 sisters	Occupied Nest	
1988	Mn	Mn-15	Voyageurs	RAIN Blueberry	Sign of Activity	
1988	Mn	Mn-14	Voyageurs	RAIN Kettle Falls	Occupied Nest	
1988	Mn	Mn-13	Voyageurs	RAIN Minnitaki	Occupied Nest	
1988	Mn	Mn-12	Voyageurs	RAIN Duckfoot	Occupied Nest	
1988	Mn	Mn-11	Voyageurs	NAM Mica	Successful	3
1988	Mn	Mn-10	Voyageurs	NAM Wolf Pack	Successful	3
1988	Mn	Mn-9	Voyageurs	KAB Jug	Sign of Activity	
1988	Mn	Mn-8	Voyageurs	KAB Yoder Mainland	Active Nest	
1988	Mn	Mn-7	Voyageurs	KAB Yoder	Occupied Nest	
1988	Mn	Mn-6	Voyageurs	KAB Ashriver	Successful	4
1988	Mn	Mn-5	Voyageurs	KAB West Kab	Sign of Activity	
1988	Mn	Mn-4	Voyageurs	KAB School Teacher	Successful	5
1988	Mn	Mn-3	Voyageurs	KAB 3 sisters	Successful	3
1988	Mn	Mn-2	Voyageurs	KAB Sugarbush	Sign of Activity	
1988	Mn	Mn-1	Voyageurs	KAB Larkin	Active Nest	

Date	State/Province	Map Code #	Study Area	Location	Status	# of young
1987	Wi	Wi-5	Apostles	Michigan Island	Active Nest	
1987	Wi	Wi-4	Apostles	Stockton Julian	Successful	4
1987	Wi	Wi-3	Chequamagon	Pirece Road	Successful	?
1987	Wi	Wi-2	Bayfield County	Mason, Doolittle	Occupied Nest	
1987	Wi	Wi-1	Chequamagon	Lost Creek	Sign of Activity	