

HISTORICAL SURVEY OF PEREGRINE FALCON EYRIES
IN NATIONAL PARK SERVICE LANDS
BORDERING LAKE SUPERIOR

By
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ABSTRACT

Peregrine falcon, Falco peregrinus anatum (Bonaparte), history, current status and reintroduction potential in the Apostle Islands National Lakeshore, Isle Royale National Park and Pictured Rocks National Lakeshore were investigated. Two nestings were documented in both Isle Royale National Park and the Pictured Rocks National Lakeshore. The peregrine is currently absent as a breeding species from each area studied.

Three areas in Isle Royale National Park and one in the Pictured Rocks National Lakeshore were described in detail and the information was submitted to the Federal Peregrine Falcon Recovery Team for consideration as possible reintroduction sites. A reintroduction at any of the sites would not be feasible until DDE and PCB levels in the Lake Superior ecosystem drop significantly.

INTRODUCTION

A decline in breeding populations of peregrine falcons (Falco peregrinus Tunstall) in most of Europe and North America occurred during 1950 - 1965 and resulted in concern for the future of the bird. As a result, an International Conference was held at the University of Wisconsin, Madison, Wisconsin, in 1965. At this conference peregrine populations were described as declining on a worldwide basis and most evidence pointed to the persistent chlorinated hydrocarbons as being a major cause (Hickey and Roelle, 1969).

In 1969 a Research Planning Conference on Peregrines and other Birds of Prey was held at Cornell University, Ithaca, New York. Reports on peregrine population changes since the 1965 conference were presented and the effects of pesticides and other industrial pollutants on raptor physiology were discussed (Hodson, 1971a). It was revealed that the decline was continuing and the importance of the industrial pollutant polychlorinated biphenyls (PCB's) may affect the reproductive success equal to DDT and its derivatives (Hodson, 1971b).

By 1973, the reasons for the peregrine decline were well documented, use of persistent pesticides in North America had been curtailed and a concentrated effort was being made to save the peregrine from possible extinction. In February, 1974, an additional conference on Peregrine Falcon Recovery was held at Greenwich, Connecticut, and attention was focused on coordinating and speeding peregrine falcon recovery efforts (Clement, 1974).

LITERATURE REVIEW

The Peregrine Falcon

The peregrine falcon (Falco peregrinus Tunstall) is one of 58 species in the family Falconidae, the falcons and caracaras. The Falconidae are one family of six that comprise the order Falconiformes. This order includes all diurnal birds of prey. All of the Falconiformes are characterized by strong flight, keen vision, feet with sharp, curved talons and an opposable hind toe, and a strong, sharp, hooked bill (Welty, 1975). The Falconidae are further distinguished by a toothed or notched bill (Van Tyne and Berger, 1959) that in peregrines is used instinctively, even by young birds, to seize and quickly sever the spinal cord of prey. This action may have evolved as a mechanism for protecting the eyes from the beaks of birds not killed on first impact (Kaufmann, 1976).

The peregrine depends on superior speed in direct pursuit to catch prey in the open and so is believed to be one of the fastest flying birds (Hickey and Anderson, 1969). Maximum flight speed has not been measured accurately, but is attained in the "stoop" or sudden downward plunge at prey from a great height. Estimates of the "stoop" speed have varied from 165 - 180 miles (248 - 270 kilometers) per hour (Cooke, 1937) to 240 miles (360 kilometers) per hour (Welty, 1975).

Certain adaptations permit the bird to attain high flight speeds and once at those speeds to protect the bird from the enormous air pressures and wind speeds. This is possible because of a streamlined body consisting of a small head, long pointed wings, and hard compact plumage resulting from large contour feathers (Ibid.; Wetmore, 1965). The rapid, powerful wing strokes of the peregrine are supported by a sternum at its anterior end joining the coracoids which unite with the shoulder girdle. The sternum is also elongated posteriorly to support the internal organs in rapid

flight (Wallace, 1963). Finally, there are baffles in the nostrils that protect the lungs and air sacs from extreme air pressures (Welty, 1975).

The peregrine is the most wide-ranging predatory bird (Cade *et. al.*, 1968). It is nearly cosmopolitan in its distribution and is known to breed throughout most of the Northern Hemisphere, in Chile and the Falkland Islands of South America, in Southern Africa and Madagascar, throughout much of the East Indies, in Australia and on some of the Pacific Islands (Van Tyne and Berger, 1959). Voous (1960) suggests that the distributional limits of the peregrine are governed by temperature and that they are associated with isotherms slightly under 41°F (5°C) and 90°F (32°C) or higher in the warmest month.

Eighteen races have been described from various parts of the world with racial variations occurring in both size and color. The largest races are the temperate and arctic breeding birds. The more northern races are migratory in winter, moving to tropical or sub-tropical climates. The smallest races are the desert inhabitants of the Middle East and North Africa and these birds show the most variation in color (Brown and Amadon, 1968).

As in all birds of prey, the peregrine shows pronounced size dimorphism. In Alaska White and Cade (1971) found female wings average 114 percent longer than male wings and that body weight is about 152 percent heavier in females. It is suggest that this characteristic is associated with food habits and has been selected for as a way of maximizing food utilization during the breeding season. It is reasoned that females prey on medium to large-sized shorebirds and waterfowl, while males take relatively more passerines and small to medium-sized shorebirds.

North American Peregrines

There are three subspecies of peregrine falcon in North America. Each is characterized by variations in size, plumage, breeding range and migratory tendencies. Gradations in size and color occur from east to west and north to south.

American peregrine falcon

The American peregrine falcon (Falco peregrinus anatum Bonaparte) formerly bred across the North American continent and was distributed in a pattern roughly corresponding with the northern hardwood conifer, eastern deciduous, oak savannah, and central and eastern parts of the closed boreal biome types (White, 1968). The subspecies has been recorded as breeding as far north as Thule Settlement in Greenland (Hickey and Anderson, 1969) and as far south as Baja, California and the Tropic of Cancer (Bond, 1946). Breeding populations are presently distributed in reduced numbers from the taiga of Alaska south to Baja, California except along the coast of southern Alaska and British Columbia. They are also found in central Arizona, southwest Texas, Mexico, Colorado, and Quebec, Canada (Snow, 1972). By 1965 the American peregrine had disappeared as a breeding species in the United States east of the Mississippi River (Cade and Fyfe, 1970).

Anatum peregrines from Mexico northward to approximately 50°N latitude appear to be basically non-migratory (White, 1968), although more northern populations show some migratory tendencies if winter food is not adequate (Snow, 1972). Nestlings banded in the northeastern United States have never been recovered south of Georgia and Arkansas (Herbert and Herbert, 1965). American peregrines nesting in continental taiga areas and southern Greenland migrate south over the resident populations to Central America and occasionally South America (White, 1968). Bent (1961) describes the American peregrine as having wintered as far north as southeastern British

Columbia and Boston.

The peregrine is a highly variable species and American peregrines show considerable individual variation in color and marking. Individuals from eastern North America differed from their western counterparts and Nearctic populations by being larger, more heavily marked, and having longer wings and tails. Eastern anatum populations showed locally constant color variations that may have resulted from interbreeding in this generally sedentary population. Color also varies with age. First year adults tend to be darker than older birds within the same geographic population (White, 1968; 1969a).

The American peregrine falcon is listed as rare in the U. S. Department of the Interior's "Red Book" (1966). In a 1968 "Red Book" update F. p. anatum was officially catagorized as endangered throughout its range.

Arctic Peregrine Falcon

The Arctic peregrine falcon F. p. tundrius (White) was first recognized as a subspecies in 1968. Tundrius "breeds in the tundra biome from about 77°N, south to the tree line; east to at least north of the mouth of the Whale River, Ungave Peninsula, Quebec and in Greenland from at least Sukkertopper... to Thule...; west to Cape Prince of Wales, Alaska." (White, 1968).

Banding activities and migration watches have defined the migratory routes of the Arctic peregrine and provided information on the wintering range. One individual banded as a nestling on 29 July 1965 along the Thelon River, Northwest Territory, was recovered in January of 1966 in India Muetra, Province of Chaco, Argentina. This bird had covered 9,000 miles in less than six months (Kuyt, 1967). Birds banded in Greenland are known to migrate down the east coast of North America to winter in Central and South America and in the Caribbean Islands (Burnham et. al., 1974).

Arctic peregrines banded on migration in Maryland have been recovered in Greenland. Migrating and sometimes wintering peregrines along the Texas coast have been found to be Arctic birds (Enderson, 1965; Hunt et. al., 1975).

The Arctic peregrine is thus highly migratory with a winter range that overlaps the southern limits of the resident anatum population and extends far into South America (White, 1968). These migrational movements are most pronounced in the United States during September and October (Enderson, 1965), with concentrations of individuals occurring along oceanic coastlines, shorelines of large lakes, and mountain ridges (Hickey and Anderson, 1969). Flight speeds for falcons during migration have been recorded as being 40 - 48 miles (60 - 72 kilometers) per hour (Van Tyne and Berger, 1959).

It is further distinguished by size, plumage and reproductive characteristics. Arctic peregrines are smaller than other North American populations. In addition, White (1968) found that the ratio of wing length to individual primary length (primaries 5-10) showed slightly longer primary feathers in tundrius than are characteristic of anatum. A condition that he suggests may be a reflection of the migratory habits of the Arctic peregrine. Tundra peregrines are the most highly marked of the North American subspecies, showing paler browns or blues in immature and adult plumages (White, 1968). Finally, F. p. tundrius is isolated from more southerly populations by reproductive condition and timing. Arctic peregrines arriving on the breeding grounds have gonads still enlarging but have passed over populations with well advanced eggs. Thus, the timing of courtship, pair bonding, and the entire nesting cycle differs from that of lower latitude populations (Ibid.).

In 1970 the Arctic peregrine was added to the list of endangered native fish and wildlife in the United States (Federal Register, 1970).

Peale's Peregrine Falcon

The third subspecies of North American peregrine falcon is the Peale's peregrine, F. p. pealei (Ridgway). Peale's peregrines breed on the North Kurile and Aleutian Islands south to the Queen Charlotte Islands along the west coast of southern Alaska and British Columbia (Brown and Amadon, 1968). The Peale's peregrine breeds in unusually high densities on certain coastal islands. Beebe (1960) describes an area on Langara Island where "in a linear distance of somewhat over a mile, but less than two square miles of land and sea surface, are concentrated never less than five, usually six and sometimes eight breeding pairs of peregrines." He suggests that an abundant food supply, ample nest sites, a cool moist climate and freedom from persecution by man and mammalian predators are responsible for this high density of breeding pairs.

The Peale's peregrine is essentially non-migratory although individuals often follow migrating shorebirds to winter concentration areas in Puget Sound. Occasionally birds will move as far south as southern California (Beebe, 1960).

Peale's falcons are the largest of the North American peregrines. The weight differences are well defined and average weights are given by Beebe (1960) (Table 1).

Table 1. Average weights of North American peregrine falcons (Beebe, 1960).

SUBSPECIES	FEMALES	MALES
<u>pealei</u>	40 ounces (1134 grams)	24 ounces (680 grams)
<u>anatum</u>	32 ounces (907 grams)	18 ounces (510 grams)
<u>tundrius</u>	28 ounces (794 grams)	15 ounces (425 grams)

The plumage of the Peale's peregrine also varies considerably from that of American and Arctic birds. Markings on the upper breast are much more pronounced than in Arctic and American peregrines. Color contrasts are lessened by a dusting of gray over the underparts of pealei. The malar stripe is broader than that of Arctic birds and equals that of F. p. anatum. In addition, the Peale's falcon produces large amounts of powder down that functions as a necessary waterproofing agent in the extremely wet coastal environment (Beebe, 1960).

Life History

Eyrie Tradition

Repeated occupancy of traditional nest sites is common among raptors (White and Cade, 1971). This nest site tenacity is especially characteristic of peregrines (Hickey, 1942) and results in strong attachments to specific eyries. Herbert and Herbert (1965) found that a pair of peregrines will not leave their traditional eyrie even if a better local territory is vacated.

There are several examples of eyries that have been active for long periods of time. On the Island of Lundy off the coast of Wales, an eyrie is known to have been active since 1243. Of 46 nest ledges known in the British Isles in the 16th and 19th centuries, all but four were occupied during the years 1930-1939 (Harwood, 1973). An eyrie in Finland occupied in 1756 was in use two centuries later (Hickey and Anderson, 1969). Hickey (1942) surveyed peregrines nesting in the eastern United States and found: 20 eyries with histories exceeding 10 years; 14 exceeding 20 years; 7 exceeding 30 years; 11 exceeding 40 years; 14 exceeding 50 years and at least one that could be traced back over a century. It is reasonable to assume that many of these eyries have been in use for centuries and

that the nest site is of extreme ecological importance to the peregrine.

Constant use or immediate reoccupation of specific nest sites is remarkable even in cases of extreme persecution. At a cliff in England, 87 peregrines were taken in 50 years without causing desertion (Hickey and Anderson, 1969). The peregrine population of Cornwall, England was virtually exterminated by the Air Ministry during World War II to protect messenger pigeons and no young were produced for several years. Yet, recolonization was rapid immediately following the war (Ratcliffe, 1969a). At an eyrie in the eastern United States all sets of eggs were robbed for ten years without causing the adults to desert the site (Hickey, 1942).

Not all nest sites are attractive to peregrines and every population has a number of deserted eyries. Hickey (1942) found that 10 - 18 percent of 408 eyries in Eastern North America were inactive. Eight percent of 61 eyries censused in Britain were reported as deserted in at least one breeding season. Of 627 nesting sites in the British Isles, 57 were deserted in the 1930's (Hickey and Anderson, 1969). Along the Colville River in Alaska there was close to 17 percent variation in breeding densities in consecutive years (Ibid.). Herman et. al. (1970) states that the number of deserted eyries will increase with time even in a stable population owing to the periodic use of temporary nest sites.

Desertion and eventual reoccupation of an eyrie is not unusual. One British eyrie was robbed repeatedly during the 1920's and few if any young were reared. Yet, the site remained occupied continuously and young were fledged each year from 1930 to 1933. In 1934 the eyrie was mysteriously deserted and remained so for many years but was eventually reused (Ratcliffe, 1969b). Two other sites in England, both the only suitable breeding place for miles around, were deserted for 25 years, however, both were reoccupied by breeding pairs in 1954 and 1959 (Ibid.). Herbert (1969) describes an

eyrie in New York that was occupied from 1909 to 1911 and not reused by peregrines until 1947.

The reasons for desertion and eventual reoccupation of any eyrie are conjectural. Genetic continuity may be involved. If both members of a pair fail to return to an eyrie and none of their offspring survive to reoccupy the site, the eyrie may be deserted for one or more years (Snow, 1972). Population pressures and changing environmental conditions may influence the rapidity with which an eyrie is re-used (Hickey and Anderson, 1969). Ratcliffe (1969b) has suggested that there are limits of acceptability within any established population and that the threshold of acceptability varies with individual birds. Marginal sites are thus below the threshold of acceptability for the majority of the population and once deserted will remain so until an individual with a lower threshold of acceptability chances into the area.

Eyrie tradition seems to result from a combination of factors. First is the attractiveness of the nest site. Hickey (1942) considered the cliff to be the dominant feature of the peregrine's niche and that the best cliffs act as magnets attracting the birds "no matter how many 'nests' are broken up or adult birds destroyed." Secondly, recognition of signs of past occupation may create a psychological stimulation necessary to attract peregrines (Ratcliffe, 1969b). These signs are streaks of white excrement on the cliff face below nesting, feeding and resting ledges and perches when an eyrie is occupied. The same areas are marked by bright colored algae and lichens when the site is abandoned. There may also be grass on ledges that have been used while adjacent unused ledges are bare (Harwood, 1973; Ratcliffe, 1969a; Snow, 1972). Snow (1972) feels that such color variations may represent a type of genetic continuity which links generations of peregrines to a particular nest site. White and Cade (1971) suggest

that traditional eyrie use functions to reduce intolerant behavior and promote stability in the population.

The Nest Site

North American peregrine falcons have been reported to nest on cliffs and rock outcroppings of all sizes, on river cutbanks, on the ground, in trees and on man-made structures. The actual nest is usually nothing more than a shallow depression formed in the material on the nest ledge. In addition, abandoned nests of other species are sometimes utilized.

Cliffs are the preferred nest locations (Hickey and Anderson, 1969). The primary function of the cliff is to provide isolation and protection from enemies (Hickey, 1942). The minimum acceptable height "varies inversely with the degree of wildness to which the cliff or cutbank is exposed and directly with the amount of molestation by man in the immediate vicinity of the nesting ledge" (Ibid.). In large cities, ledges high up on office buildings sometimes meet these requirements and have been used by nesting peregrines (Welty, 1975). In Great Britain, Ratcliffe (1969c) found that occupation of "small and unsuitable rocks" only occurred in the most remote and least disturbed areas. Breeding ledges even in the wildest areas were seldom on cliffs less than 30 feet (9 meters) high (Ibid.). This dependence on cliffs seems to have prevented colonization of regions lacking such formations but with otherwise seemingly suitable habitat (Hickey and Anderson, 1969).

The use of abandoned cliff stick nests of other species has been documented. Gainer (1931) found peregrine eggs in an old red-tailed hawk (Buteo jamaicensis jamaicensis Gmelin) nest in Tennessee. Hickey and Anderson (1969) reported peregrines using an old golden eagle (Aquila chrysaetos canadensis Linnaeus) nest in Colorado in 1889. Cade (1960) described 11 instances of peregrines utilizing old rough-legged hawk (Buteo

lagopus s.-johannis Gmelin) nests in arctic Alaska. Common raven (Corvus corax principalis Ridgway) nests are also used frequently in western North America (Hickey and Anderson, 1969).

Island nesting populations of each North American subspecies of peregrine have been described. The American peregrine breeds on islands off the coast of Baja, California (Hickey and Anderson, 1969). The Peale's falcon is almost exclusively an island nester utilizing seashore cliffs, pinnacles detached from main island masses (Beebe, 1960) and are often found near the top of very steep, nearly vertical, grass covered slopes (Hickey and Anderson, 1969). The Arctic peregrine has been found nesting on islands along the coasts of Ungava and Newfoundland in Northeast Canada (Bent, 1961). Island nests of all three subspecies are generally associated with breeding colonies of seabirds on which they prey and nest sites are usually less protected due to the elimination of mammalian predators and freedom from human disturbance provided by the insular environment.

Instances of tree nesting peregrine falcons have been recorded. Tree nests are prevalent in Europe and have been reported in mid-Russia and Siberia (Hickey and Anderson, 1969). Large tree nests of other species are most commonly used in Europe. In the United States, excluding Alaska, tree nesting peregrines have preferred holes or hollows created in the tops of large old growth trees when limbs or the entire tops of these trees were broken off (Ibid.). Hickey and Anderson (1969) listed ten instances of peregrines nesting in hole or hollow nests in the United States, excluding Alaska.

Peregrines nesting in tree nests of other species have been recorded twice in the contiguous United States (Ibid.). Alaskan records of tree nesting peregrine have always involved the abandoned nest of another species (Hickey and Anderson, 1969; White and Roseneau, 1970).

There are scattered records of ground nesting peregrines. In the Netherlands peregrines nested on a bare coastal sand dune in 1926 and 1930, and a pair nested on an inland dune in 1949. Ground nesting occurs in bogs in the Baltic region and in Finland; in each of these areas, cliff sites or tree nests were sometimes used as alternates. Ground nests have been recorded in China. In Australia peregrines will nest under grass tussocks in plains areas. Peregrines attempted to nest for two years on an open heath in southern England. Tundra ground nests are reported from the U. S. S. R. and Eurasia (Hickey and Anderson, 1969). In North America peregrines are reported to have nested twice on low sandy mounds in the Canadian Arctic (Ibid.) and there is secondhand evidence of an instance of ground nesting near Bear Lake in northern Canada (Fyfe, 1969). One instance of ground nesting in the United States has been recorded. Hatt et. al. (1948) described a pair on South Fox Island in Lake Michigan in 1939 nesting on the ground on the side of a 200 foot (61 meter) sand slope 125 - 135 feet (38.1 - 41.1 meters) above the water.

Isolated ledges on man-made structures can provide suitable peregrine nesting habitat. Hickey and Anderson (1969) record peregrines nesting on: churches in England; a castle at Heidelberg, Germany; ruins and old towers in England, Germany and Spain; skyscrapers and public buildings in Philadelphia, Montreal, Nairobi and New York; a stone pier on an unfinished bridge in Pennsylvania; a watertower in Hungary; a barn in Finland; a barrel in a California marsh; platform on an electric power pole and in a man-made cave with an opening 30 feet (9.1 meters) above the sea in Britain. In addition, Groskin (1952) mentioned a successful peregrine nesting on the steeple of a church in Harrisburg, Pennsylvania.

Peregrine falcon nestings in New York City and Montreal, Canada are the best documented instances of nesting on man-made structures. In New York

City peregrines once wintered regularly on 20 skyscrapers, three bridges, a gas tank and a high school. Most of these birds were unattached, wintering females but occasionally a wintering pair was reported (Herbert and Herbert, 1965). From 1943 to 1953 there was one year-round resident pair that regularly roosted on the Grand Central Building in winter. This pair successfully hatched four clutches between 1943 and 1947. In 1943, three young were hatched on the 16th floor of the St. Regis Hotel; in 1945, three young were hatched on the 23rd floor roof of an abandoned building 1 - 1.5 miles (1.61 - 2.42 kilometers) from the St. Regis Hotel; and in 1946 and 1947, six young (three each year) were hatched on the 16th floor ledge of the St. Regis Hotel (Ibid.).

The principle eyrie of the "Sun Life" peregrines of Montreal was located on the 20th floor of the Sun Life Assurance Company of Canada's head office building in Montreal, Canada. Peregrines were first seen around the building in the late spring of 1936, they were sighted again in early April, 1937, but no sign of nesting was found until 21 March 1938, when five eggs were discovered scattered on a ledge of the building's 20th floor. Nesting failed but the birds remained until 25 October. In 1939 eggs were discovered on the 17th floor but incubation was impossible at this site also. By early spring 1940, two shallow boxes filled with a mixture of sand and gravel were placed on the 20th floor ledge and after some initial confusion on the part of the peregrines, two eggs were hatched on 21 June. The "Sun Life" peregrines returned faithfully to Montreal each year through 1952 and during that time produced 50 eggs out of which 26 hatched and 22 young successfully fledged (Hall, 1955).

Reproductive failure of peregrines nesting on man-made structures has been attributed to: lack of proper nesting substrate for eggs; noisy

intolerance of intrusion when young are present, thus giving away the nest site; and absence of terrain where the first flight of young birds could be made safely (Hickey and Anderson, 1969).

At any given eyrie peregrines have favorite nesting ledges, feeding ledges or perches and night ledges or perches. Herbert and Herbert (1965) found that each pair studied along the Hudson River in New York had at least one or more night perches marked with whitewash. These were used for night or rain shelter and were usually a small shallow ledge with an overhang. They were sometimes so narrow that the bird had to face sideways.

Feeding ledges at the New York eyries were distinct from nest ledges and night perches. The adults never fed themselves on a nest ledge that was in use but instead had "one or more main feeding ledges. When young were present, two or three additional ledges might be set up near the nest ledge." (Herbert and Herbert, 1965). Feeding ledges varied from year to year though some were used consistently. In one instance a fallen dead cedar within 100 yards (91.44 meters) of two favorite nest ledges was used for more than 30 years (Ibid.).

The importance of the nesting ledge to peregrine breeding success was pointed out by Cade (1975): "Our observations on captive falcons indicate that the nest site (nesting ledge) is the focus of a great deal of activity early in the breeding season and that it may be an important stimulus for reproductive maturation." Ratcliffe (1969a) and Herbert and Herbert, (1965) have shown that there is also a certain amount of continuity in nesting ledge use. The same nesting ledges at eyries in Britain were chosen even after an absence of falcons from the eyrie of 40-50 years (Ratcliffe, 1969a). Herbert and Herbert (1965) found it difficult to categorize the requirements for a nest ledge because some unused ledges appeared to be superior to the chosen site on their New York study area. They were able to make some

general observations though. A preference for locating the nest on a high cliff ledge with a "commanding and extensive view" was recorded. Some additional general physical requirements of ledges along the Hudson River were sufficient soil or gravel in which to make a scrape and provide drainage and a little grass and/or a stunted tree to shelter the young. Cliffs with large trees were avoided (Herbert and Herbert, 1965).

Nest ledge size is variable. Herbert and Herbert (1965) found some as large as four feet and some so small "that it would seem the young must fall off." Ratcliffe (1962) found the favorite inland nesting ledge in Britain to be a flat grassy shelf, 18 inches (46 centimeters) or more wide, of varying length and with a sheer wall of rock above and below. Hickey and Anderson (1969) pointed out the importance of nest ledge (or cave) size in providing enough room for the young to exercise properly so that they might "depart from the eyrie in a healthy condition."

The number of alternate nest ledges used during occupation of an eyrie has varied from one to eight and depends upon the number of ledges available (Hickey and Anderson, 1969). Most Hudson River eyries had two or three known alternate nest ledges with one eyrie in an abandoned quarry having only one nest ledge (Herbert and Herbert, 1965).

Alternate nest sites (ledges) may be on different cliffs with the maximum recorded distance between alternate cliffs used in different years being over four miles. Renesting usually involves a shift in nest sites (Hickey and Anderson, 1969).

The nest scrape is a hollow formed out of ledge substrate material (e.g. soil, decomposed rock, gravel, vegetation and prey remains) in which the female peregrine lays her eggs. Divergent positions on the importance of the scrape have been reported. Hickey (1942) stated that, "The peregrine appears to possess an absolute requirement in that the eggs must be laid in

a hollow which is scraped out of dirt, gravel, or similar material."

Cade (1960) studied Alaskan peregrine populations and found that no scrape may be needed "if a containing structure for the eggs is present or can be found." White and Cade (1971) also working in Alaska, found that a scrape was not required for nesting success. Herbert and Herbert (1965) suggested that both views are correct and "well illustrated in the history of city-nesting falcons that have successfully nested and reared young in New York City without a scrape, but whose chances of success were greatly increased by a scrape or nest box with suitable scrape material such as gravel, earth, or debris." They went on to describe the twofold function of a scrape as being "to prevent the eggs from rolling off of the ledge and to provide drainage for the young" and later suggest that although the scrape is not an absolute essential for nesting success it is important and "eagerly sought by the falcons." (Herbert and Herbert, 1965).

Rivers are important in that they create cliffs or cutbanks for nesting. Aquatic habitats provide prey species, an opening over which to hunt and are essential for bathing and feather maintenance. The distribution of peregrines during the breeding season is reported to be water related. Interior populations are shown to follow dendritic patterns of dispersion, and coastal and insular populations follow a perimetric pattern (Snow, 1972). In the Great Basin where water is scarce, Bond (1946) reported that almost all peregrine nests were "within one-half mile of at least enough water for bathing." Gravel bars along the Alaskan rivers that slope gently into the water "facilitate bathing, and Peregrines.. bathe frequently." (White and Cade, 1971). Gravel bars and islands also provide waterfowl habitat and in so doing, provide a valuable prey source (Snow, 1972).

Altitude is reported as being important in limiting peregrine distribution. In Britain, greatest nesting occurred between 1250 and 1500 feet (380 - 460 meters). Maximum elevation reported was 3000 feet (914 meters). Minimum altitudes were governed by accessibility and human interference (Ratcliffe, 1962). White and Cade (1971) found altitude to limit peregrine distribution in Alaska. No peregrines were found nesting above the 2200 foot (670.6 meter) elevation. The authors suggested that the time for raising young could be below a necessary minimum or that lack of food might be a limiting factor. In western North America, Bond (1946) also found altitude a limiting factor.

The distribution of the peregrine is worldwide and encompasses regions with climates as diverse as middle eastern desert and arctic tundra. Climate would thus be of minimum importance in peregrine nesting ecology. Local climate as determined by the aspect of the nest can be of extreme importance in some regions. Nelson (1969a) reported that peregrines in the northwest do not show respect for the sun in choosing a nest site and are thus often doomed to nest failure. Temperatures near 90°F (32°C) caused by direct sunlight can kill a young bird of prey out of the down and just into feathers in less than one-half hour (Ibid.).

From data collected on peregrine nest locations, attempts have been made at developing systems of eyrie or habitat classification. After surveying the peregrines of eastern North America, Hickey (1942) suggested three classes of peregrine nesting cliffs:

"First-class Peregrine cliffs are extremely high, often rather long, usually overlooking water, and generally dominating the surrounding countryside. These so attract this species in the breeding season that Peregrines will apparently occupy them no matter how many 'nests' are broken up or adult birds destroyed.

"Second-class Peregrine cliffs differ from the above merely in their dimensions. Here the birds can withstand considerable molestation.