

## EASTERN POPULATION OF THE DUCK HAWK

BY JOSEPH J. HICKEY

## INTRODUCTION

THE breeding sites of the Duck Hawk (*Falco peregrinus anatum*) are marked by such a well-recognized permanency that the species offers some interesting possibilities for the study of bird populations. When, in 1937, a census of these cliffs was undertaken for the Hawk and Owl Society, it was felt that so many nests, observed by so many different people, lent themselves admirably to a national inquiry. One could learn if the falcons were decreasing in numbers, perhaps determine that population curves were evident, and so on. By a happy coincidence, Dr. R. M. Bond had already started a similar survey on the Pacific coast, and he subsequently agreed to enlarge his investigation to cover the region west of the Rockies. As his results will be published separately, the present paper covers North America exclusive of Alaska, British Columbia, Washington, Oregon, California, Idaho, Nevada, Utah, Arizona, and western Mexico. Both these papers rely primarily upon the extensive method of investigation—a technique which of necessity yields uneven results. They will, however, be richly complemented by J. A. Hagar's study (in preparation) which is based entirely on the intensive method—six years' observations of a daily character on all the eyries in Massachusetts.

It was hoped at first that questionnaires would yield the data needed. These have proven of great value in the British Isles, but the United States—polled by Gallup investigators, by Crosley telephone girls, and by 'Fortune' surveyors—requires more organization and publicity than a business man, like the writer, can provide in his spare time. Questionnaires were tried in the present study but, outside of Canada, old-fashioned letter-writing had to be used to gather data and enlist observation on published nesting sites. No other North American bird is surrounded by so much jealousy and suspicion, and the investigator repeatedly had to exhibit the three qualities which, according to Meredith (1934), the ancient Persians deemed so necessary in a falconer:

The first: that he have patience;

The second: that he be a good sportsman, and have a genuine love for his hawks;

The third: that he be good-tempered, pleasant spoken, and of a cheerful and cheery countenance.

As a basis for the present study, the history of each reported eyrie has been compiled for as many years as possible. These details, together with the locations of all sites reported, will eventually be filed with the National Audubon Society. There at some future date, it is hoped, they may be consulted by competent ornithologists who wish to study and evaluate subsequent population changes in this interesting species.

This report is, therefore, the result of a cooperative survey to which 146 people generously contributed in the past four years. For data and other assistance, the writer is especially indebted to Messrs. R. M. Bond, P. A. Dumont, A. F. Ganier, O. J. Gromme, S. C. Harriot, R. S. Harrison, R. A. Herbert, F. B. Lane, S. E. Perkins, 3rd, R. H. Pough, C. A. Proctor, J. N. Rice, 3rd, W. D. Sargent, W. R. Spofford, R. M. Stabler, P. A. Taverner, H. M. Van Deusen, W. A. Wimsatt, and the Royal Ontario Museum of Zoology. J. A. Hagar and Dr. Bond were a constant source of counsel and advice, although their own studies have not been used to influence any of the conclusions reached in this paper. Hagar's report on the number of occupied, extinct, and doubtful eyries now in Massachusetts has, however, been included. For additional criticism, the writer is also indebted to Professor Aldo Leopold and Dr. Ernst Mayr. The Hawk and Owl Society defrayed the not-inconsiderable costs of the author's postage, and Margaret Brooks typed various drafts of the present paper.

In addition to two years' preliminary field work, Herbert and Spofford conscientiously shared with the author intensive nesting studies which were carried out in 1939 and 1940 over an area of approximately 10,000 square miles (26,000 sq. km.) in Connecticut, New York, New Jersey, and Pennsylvania, hereafter referred to as 'around New York.' It is largely due to their inspiration and help that this supplemental part of the study was completed. In this connection we were also aided by Professor F. J. Trembley, and by members the Peregrine Club of Philadelphia and the Linnaean Society of New York.

#### BREEDING DISTRIBUTION

The known limits of *anatum's* breeding range east of the Rockies were found to conform closely with those given by the A. O. U. 'Check-list' (1931) and by Bent (1937), but very little recent work has been done in the Far North. In the list of breeding localities quoted by the latter, eyries at (or near) Milltown, Bangor, Auburn, and New Haven are doubtful; those at Grand Manan, Tallcott

Mountain, and Lehigh Gap deserted; those at Chickies and Neosho Falls probably deserted. Southerly, the range extends along the coast to the last fjord, in the Appalachians to Georgia, in the Mississippi Valley to Tennessee, and more westerly to the Big Bend country in Texas and possibly to Mexico. An adult, seen on June 27, 1939, by J. O. Stevenson (in litt.) at Santa Catarina, twelve miles west of Monterrey, Mexico, suggests that the present accepted southern limit may be subject to some revision.

In carrying out a census of the eyries of this subspecies, it was found that many sites were referred to by all kinds of aliases. This is largely due to the failure of observers to obtain the exact name of the cliff (some of course have none) and to the fact that their discoverers often refer to such sites by the name of the last community through which they happened to pass. A good deal of confusion has therefore occurred in avifaunal lists. Even in the banding files of the U. S. Fish and Wildlife Service this is creeping into evidence. One eyrie in New England now has no less than five synonyms, every one of them referring to the same cliff. The pair at this particular site is also so frequently molested that the birds spend many hours in each breeding season on an escarpment four or five miles (about 7 km.) distant. This habit has resulted in an additional eyrie being erroneously reported. Most situations did not reach this extreme, but many were cleared up by actual field work, while in other cases allowances were made for possible duplications.

#### NUMBER OF REPORTED NESTING SITES

Of the 408 reported nesting sites east of the Rocky Mountains, 67% are located in the United States (see Table 1). This preponderance may simply reflect the intensity of field work in the central and eastern parts of the continent, rather than the geographic indication of the species' center of abundance. It is hardly necessary to point out that Labrador and Greenland can scarcely claim even 1 per cent of the bird students, falconers, and egg collectors resident in the eastern States.

TABLE 1  
REPORTED EYRIES

	<i>U. S.</i>	<i>Canada</i>	<i>Labrador</i>	<i>Greenland</i>	<i>Total</i>
Previously published . . . . .	167	65	7	5	244
Other sources . . . . .	108	51	3	2	164
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Total . . . . .	275	116	10	7	408

### TYPES OF NESTING SITES

Peregrine nesting sites fall into four types east of the Rocky Mountains:

1. *Rocky cliffs, bluffs and escarpments* are by far the commonest now reported in use. (a) As a rule, these nests are on the escarpment itself, although occasionally the nest may be on the ground on top, and, on small cliffs, may be placed so much to the side of the cliff as to be almost off it. (b) Occasionally eggs are laid on cliffs in the abandoned nests of other large birds, such as the Red-tailed Hawk (*Buteo borealis*). A single egg is said to have been taken many years ago from an old nest of a Bald Eagle (*Haliaeetus leucocephalus*) in a great cottonwood in Iowa (Peck, 1924).

2. *Cut-banks* were frequently occupied west of the Mississippi River fifty years ago (no recent observations are available along the rivers involved) and are still used in Alberta (W. R. Salt, in litt.) and by *F. p. peregrinus* in northern Europe (Witherby et al., 1939).

3. *Gigantic trees* were nesting sites prior to 1880 in the Mississippi Valley; the birds used holes or nested on the tops of ancient sycamores and cottonwoods where the trunk had broken off.

4. *Man-made structures*.—In the eastern States, one pair (at least temporarily) deserted their ancient cliff and successfully nested on an abandoned stone-bridge pier which was isolated in the adjacent river (F. and J. Craighead, 1939). A second pair remained continuously for more than two years on a skyscraper in New York City, courting and copulating in season but not apparently laying any eggs (Herbert, Kassoy, in litt.). A third pair took up residence on a Canadian skyscraper and, under management, in their third year (1940) brought off two fledglings (J. D. Cleghorn, C. E. Hall, and E. W. Pfeiffer, in litt.). Abroad, the Peregrine occasionally nests on lofty buildings, and for many years resided on the spire of Salisbury Cathedral, England, where the birds were the special wards of the Dean (Butler, Matthews, et al., 1896–98).

### FACTORS AFFECTING BREEDING DISTRIBUTION AND DENSITY

No specific statement can be made at this time on all the factors limiting the breeding distribution of *anatum* east of the Rockies. Any bird that nests from the Rio Grande River to the Arctic Ocean obviously possesses ecological tolerances of a wide degree. Some of these will be more fully discussed by Dr. Bond in his report. The following may be mentioned here:

1. *Physiography*.—Because it now seems almost completely dependent on rocky cliffs and on cut-banks, the Peregrine's present distribution is confined to those regions where these are available. It appears, therefore, to be entirely absent as a breeder in such States as Ohio, Indiana, Illinois, Mississippi, Louisiana, and Oklahoma, and it is proportionately rare in Arkansas, the Dakotas, Manitoba, Saskatchewan, and Texas, which are essentially of the plains type.

2. *Cover*.—In the case of smaller birds, this term refers to hedgerows, bramble patches, brush piles, etc., which offer the species protection from its enemies. In the case of the Peregrine Falcon, it is generally represented by the height of the nesting site. The primary function is the same in each case: isolation and protection from enemies. Peregrines frequently use their high cliffs as lookout perches, but this practice is not always possible at some sites. The species has been known to nest, for instance, in New York in a narrow ravine (Sargent, in litt.) and in a gully; among heather on small islets off the British coast (Witherby et al., 1939); and on the ground in the marshes of northern Europe and Asia (Kirkman, 1913). This factor is further discussed on page 196 of the present paper. Generally speaking, the minimum height acceptable to the birds varies inversely with the degree of wilderness to which the cliff or cut-bank is exposed and directly with the amount of molestation by man in the immediate vicinity of the nesting ledge.

3. *Egg site*.—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. It is primarily the absence of this requisite which sometimes prevents these birds from adopting modern skyscrapers or similar structures as nesting sites. The falcons also prefer the shelter of an overhang (if it is available) or small vegetation. Spofford (in litt.) points out that very small cliffs with fine caves are occasionally used by this species, and that the high density of breeding birds on the inland cliff soon to be mentioned may be due to abundance there of deeply recessed ledges.

4. *Territorial competition*.—The entire foraging area is apparently not defended with this subspecies as it is with the Golden Eagle (Dixon, 1937) and many other birds. Near New York, in 1940, observations by R. A. Herbert and the writer indicate that mated males will defend the immediate vicinity of the nesting site against other males, migrating females, wandering females, and wandering young birds from adjacent eyries. Defense was found to approximate actual attack so closely that the use of a special formalized display for this purpose is uncertain.

Once when a resident male made a tremendous dive at a strange female which had soared toward his cliff (an hour earlier she had fed at another eyrie 1.2 miles—1.9 km.—away), she merely flipped over and presented her claws. The male swerved at the last moment and retired to his nesting ledge, while the female slowly soared eastward away from him (Brooks, Hickey, Wallenstein). This performance took place about 150 yards (140 meters) in front of a cliff on which eggs were being brooded; in two other cases, the pursuit of intruders did not extend beyond a quarter of a mile (400 m.) from the eyrie. Records of males defending territory against females are rarely found in the literature of any species. Herbert (in litt.) reports that a male, which was using a large gas-tank as a summer roost, was once seen to chase away an approaching female shortly before dusk.

Another interesting incident concerns the two pairs which were only one mile (1.6 km.) apart on a north-and-south river. On May 23, 1940, the male of the southern pair was found shot two miles (3.2 km.) north of the northern eyrie (W. H. Carr, in litt.). This bird was paired with a female which had failed to lay eggs.

That females will also defend the vicinity of their eyries against other females is evident from this observation by W. R. Spofford (in litt.): "On May 14, 1939, at the ——— cliff, the tercel (male) came in from the east, followed by a falcon (female) about 100 yards (90 m.) behind. I presumed it was the pair. Actually, when the tercel prepared to alight, the resident brooding falcon (she had two young about two weeks old) came off fast at the interloper, which immediately reversed its direction, and the two birds disappeared after a rapid flight for some miles to the east. Ten minutes later the resident female returned to the ledge. Throughout this period the tercel remained on his perch, occasionally wailing."

There appears to be no regular spacing between eyries east of the Rockies. At one seabird colony in Canada, about a half-mile (800 m.) separates two pairs of Peregrines and about three-quarters of a mile (1.2 km.) separates a third pair (C. P. Grant, in litt.). Inland in New York the distance between two cliffs is estimated at 800 yards (730 m.) in one case; in another, the distance between ledges was paced off to about 1275 yards (1150 m.). The cliffs themselves, however, are generally separated by much greater distances than this. In one region of high Peregrine density, an average of about seven miles (11.3 km.) separates twelve eyries from one another (C. A. Proctor, in litt.). Since cliffs are so scarce, territorial jealousy is, therefore, a factor of considerable importance in restricting the density of nesting Peregrines. This is especially evident where a

long escarpment is the only available nesting site for twenty or more miles (32 km.) around. Many such places exist where only one pair is in residence.

When as much as a mile (1.6 km.) on each side of an occupied nesting ledge is not used by additional Peregrines, it does not necessarily mean that the entire escarpment represents the defended nesting territory of a single pair. One high inland cliff may be mentioned where five pairs of Peregrines reside on seven miles (11.2 km.) of escarpment. This fine series of cliffs may hold close to the maximum Peregrine density, and it is rather interesting to contrast its numerous, still unused ledges with the tiny gully which a sixth pair of these falcons uses some five and one-half miles away (8.9 km.). The high density here is evidently due to the geological character of this formation, which affords a wealth of superb caves and nesting ledges.

5. *Miscellaneous.*—Although their importance was not demonstrated in the course of this study, three possible factors may be mentioned in passing:

(a) *Competition with other species.*—The relation of the Peregrine Falcon to other predatory birds does not seem to be significant from a population viewpoint, the competition being confined to defense of nesting sites rather than food supply. A Peregrine may attack Ospreys (*Pandion haliaetus carolinensis*), Turkey Vultures (*Cathartes aura septentrionalis*), Bald Eagles, Red-tailed Hawks or Ravens (*Corvus corax*), but with most of these species it often dwells nearby with varying tolerance. It has also been known to breed on the same cut-bank with the Prairie Falcon (*Falco mexicanus*) (Salt, in litt.), and apparently on the same cliff with the Gyrfalcon (*Falco rusticolus*). Instances of the Peregrine killing Ravens, Red-shouldered Hawks (*Buteo lineatus*), and Snowy Owls (*Nyctea nyctea*) are well authenticated in the literature, but appear to be exceptional cases rather than the rule. Although Great Horned Owls (*Bubo virginianus*) were on or very near five of the nineteen eyries studied by Herbert, Spofford and the writer around New York, the exact relationship of these birds to the Peregrine was not satisfactorily determined.

(b) *Climate.*—The Peregrine is possibly affected by climate, for it is replaced in very dry country by the Prairie Falcon and in the Arctic by the Gyrfalcon. Lacking any familiarity with the distribution of the two latter species, the writer did not attempt to make any correlations with humidity, rainfall, types and densities of available prey, etc.

(c) *Food supply*.—At least in the East, this factor is very little in evidence. The Peregrine is probably attracted, however, to the great seabird colonies in the North Atlantic. At one such island, three pairs regularly nest, but their density per mile of available escarpment does not greatly exceed the density of similar escarpments inland. This may be due in part to the species' excellent powers of pursuit and capture, although some writers have overemphasized the latter. (R. A. Herbert and the writer once watched a pair fail seven consecutive times to effect a capture, although a total of over seventy-five racing pigeons passed their eyrie in a three-hour period when the young falcons were clamoring for food.) The species only rarely takes small mammals. Because its food was found to spread over so many species of birds, it is not expected that population curves in any given kind of prey would seriously affect the numbers or distribution of this predator.

#### POPULATION FLUCTUATIONS

##### A. AGE OF PRESENT NESTING SITES

The tenacity with which successive Peregrines cling to the same nesting site is well known. East of the Rockies, twenty eyries have a history exceeding ten years; fourteen exceed twenty; seven exceed thirty; eleven exceed forty; and fourteen exceed fifty years. Most of the remaining cliffs occur in regions where observers are few and observation is infrequent. At least one eyrie can be traced back for over a century, and it is certain that many others are almost ageless in their antiquity. Modern British falconers have, for instance, taken fledglings from an island eyrie which was famous in Elizabethan times (Blaine, verbally).

##### B. DESERTED EYRIES

Is the Peregrine Falcon decreasing? About fifty per cent of the reported eyries were definitely occupied at some time during the past decade. Because the area involved in this survey is so large, it was impossible to enlist field work to check all the remaining locations. Actual allegations of eyries being no longer in use are confined to approximately forty-five sites, all but one of which are in the United States. These may be broken down into three classes (see Table 2) according to (a) the total number of eyries reported, (b) a total of all deserted eyries plus 210 known to be in use, and (c) a total which includes those known to be in use but does not consider twenty which are possibly deserted.



TABLE 2  
DESERTED EYRIES

	Possible	Probable	Definite	Total
Reported deserted . . . . .	20	8	17	45
(a) Compared to 408 disc'd. . . . .	5%	2%	4%	11%
(b) Compared to 255 . . . . .	8%	3%	7%	18%
(c) Compared to 240 . . . . .	—	7%	3%	10%

It will be seen that on the basis of these data, eighteen per cent represent a maximum decrease in the Peregrine population and ten per cent a minimum decrease within recorded times.

1. *Possibly deserted eyries.*—There is ample reason, in the writer's experience, for believing that random checking of a Peregrine nesting site can lead to wrong conclusions about the absence of breeding falcons (especially if the observer fails to climb the cliff). Classified under the 'possible' category are cliffs where systematic observation is lacking as well as those where the correspondent concerned was not personally known to the author. Among the twenty here included are two in Minnesota (W. J. Breckenridge), four in Colorado (R. J. Niedrach), six in Missouri (R. Bennett), and seven in Vermont (G. H. Ross). The failure of falconers in Colorado to re-locate nesting Peregrines is one of the surprises in this survey. One cannot accept the theory that these men are less efficient afield than the old-time collectors and it may be possible that within the past fifty years ecological changes there have favored the Prairie Falcon at the expense of the Peregrine.

2. *Probably deserted eyries.*—Only tree-nesting pairs have been included in this category. Robert Ridgway (1895) found three of these in the spring of 1878 immediately about Mt. Carmel, Illinois; two more records appear to be his from the Wabash river-bottoms in Indiana; while at least two and possibly three pairs were found by Col. Goss (1878) near Neosho Falls, Kansas, at about the same time. These interesting birds may have been remnants of a considerable Peregrine population. Their habits and localization may be compared to those of the Peregrines that still use old bulky nests in trees in some parts of Germany, in contrast to the Peregrines of the British Isles where only cliffs are occupied—although abandoned nests of the same raptores (Falconiformes), crows (Corvidae), and herons (Ardeae) are also available (Witherby et al., 1939). It should be noticed that tree-nesting individuals in the European race (*F. p. peregrinus*) use the abandoned nests of other large birds, while *anatum*, with one possible exception, utilizes only cavities and broken-

off trunks. Only one or two tree-nesting examples are currently known to exist in North America and it took an earthquake to flood their territory in the Mississippi Valley and save the virgin timber from the lumbermen (Ganier, 1932).

3. *Definitely deserted eyries*.—All of the seventeen sites that were recognized in 1940 as definitely abandoned eyries have been deserted for at least three years. Five of these became extinct before 1915, and four more between 1930 and 1937. The history of the remaining eight suggests that they were not always used by Peregrines and that they may be called 'temporary' eyries—a term offered by J. A. Hagar (in litt.). All but one of these became deserted since 1929.

#### C. NEWLY USED EYRIES

Although 143 new nesting sites have been discovered east of the Rockies within the past decade, there is no evidence to indicate that any appreciable number of these had just been taken over by Peregrines. Indeed, a great many had unquestionably been overlooked by ornithologists for years. No lists, however, were left by the egg collectors of the past to show the cliffs which Peregrines were *not* using at that time. One temporary eyrie was definitely taken up in 1933 (J. V. Sparmaker *vide* F. Schmidt, in litt.) and another small cliff was taken over by a new pair in 1940 (N. Wight, in litt.). Four abandoned quarries have also been occupied, but two of these are now deserted. The two pairs on skyscrapers have already been mentioned. There is no question, then, that at least minor fluctuations exist in the population, but up to the present they have been surprisingly hard to detect. In New Hampshire, Vermont, New York, Connecticut, New Jersey, and Pennsylvania, where the Peregrine has been intensively watched, one temporary eyrie exists for about every ten permanently used sites. In the case of six such eyries within a wide circle around New York, no more than two were occupied at any one time in the last fifteen years. It is the writer's conclusion that in the six States just mentioned the number of pairs on territory at the start of each breeding season is remarkably constant from one year to another. A similar situation has been reported in certain passerine species elsewhere over four- or five-year periods; cf. Parula Warbler (*Compothlypis americana*) and Black-throated Green Warbler (*Dendroica virens*) studied by Cadbury and Cruickshank in 'Bird-Lore's Fourth Breeding-Bird Census' (Hickey, 1940).

## D. REPLACEMENT OF MISSING BIRDS

The speed with which missing birds are replaced at eyries is a widely attested character of the Peregrine population both here and in Europe. There is a British record (Witherington, 1909) of a female replaced within thirty-six hours of her death, and at one Canadian site the adults were replaced so quickly that two new birds eventually raised a brood that neither had parented (Taverner, in litt.). These and countless less spectacular observations could imply the existence of a mobile non-breeding population of considerable importance to the species. As a rule, missing birds are replaced by at least the start of the next breeding season. Within recent years, the loss of both male and female within a two-year period failed to disrupt the annual nesting at one Maryland eyrie (W. A. Wimsatt, in litt.); a Vermont pair was shot and replaced in about two weeks (C. A. Proctor *vide* Van Deusen verbally); and a New York male probably passed one season before finally pairing with an immature female early in April.

Quick replacements at the start of the breeding season can, of course, be effected by migrating birds. Spectacular replacements later on in the nesting cycle seem to the writer to be due to the presence of nearby Peregrines which have encountered some disaster at their own nesting sites. There are two reasons for this hypothesis: (1) unpaired birds are rarely seen or recognized in the breeding season (in cities like New York and Philadelphia where they winter in numbers, their presence would be conspicuous); (2) nesting birds that lose their eggs, often desert their eyries. Green (1916) reports that a male *F. p. pealei*, which he collected in British Columbia, was replaced within forty hours by one apparently from an eyrie a couple of miles (3.2 km.) away. During the wet, disastrous season of 1940, when four clutches around New York disappeared from open, exposed ledges, one female was actually driven off its eggs by an intruding bird of the same sex. Although this second falcon was thus able to satisfy its brooding drive, the thirty-day-old eggs chilled in the contest. A week later they were still in its possession with their rightful owner still in the vicinity (Spofford et al.). There were two pairs which had unsuccessful seasons in this vicinity and from which this intruding bird could have come, one five and one-half miles (8.8 km.) away, another about eight miles (12.8 km.) away.

## FACTORS AFFECTING SURVIVAL

## A. EGGS AND YOUNG

Pertinent life-history statistics have been compiled from the entire region considered in this paper, and they should make an interesting comparison with the data being separately accumulated by J. A. Hagar in Massachusetts.

1. *Clutch*.—There is no doubt that over most of the Peregrine's range, here as well as abroad, the normal clutch is four, and that clutches with fewer eggs are often due to premature collecting, second sets, and (rarely) interruptions by storms. There are several instances where the falcon is known to have laid a single egg in one scrape and then laid the remainder of her clutch in a different scrape on the same ledge or a different ledge on the same cliff.

TABLE 3  
DATA ON CLUTCHES

<i>Number in Clutch</i>	<i>Number of Sets Reported</i>			<i>Total</i>
	<i>U. S.</i>	<i>So. Canada</i>	<i>Arctic</i>	
2.....	14	5	5	24
3.....	75	4	12	91
4.....	175	11	4	190
5.....	13	2	—	15
6.....	4	—	—	4
7.....	1	—	—	1
Total.....	282	22	21	325
Mean clutch average...	3.72	3.5	3	3.65

Where second sets were known to the collector, they have been omitted from Table 3, which summarizes the clutch data so far available. Like all other Falconiformes the Peregrine is, of course, single-brooded. If the eggs are lost at a rather advanced stage of incubation, or if the young are lost, no further attempts at nesting are known to have been made by the same pair until the following season.

2. *Hatching success*.—The interesting possibility that in the North the Peregrine lays fewer eggs (see Table 3) is substantiated at least in part by the hatching successes summarized in Table 4. Unfortunately the Canadian samples in both cases are small, while the Arctic records are almost negligible. This trend is directly opposite to the late Rev. F. C. R. Jourdain's belief that the largest clutches of eggs are usually found in the North (Boyd, 1936). Since the Swallow Inquiry of the British Trust for Ornithology (op. cit.) clearly demonstrated for at least one passerine that broods in northern

localities possess the largest number of young, Jourdain's generalization probably covers only multi-brooded species.

TABLE 4  
HATCHING SUCCESS

<i>Number young on ledge</i>	<i>Number of reports</i>			<i>Total</i>
	<i>U. S.</i>	<i>So. Canada</i>	<i>Arctic</i>	
1.....	2	1	—	3
2.....	28	13	—	41
3.....	58	6	2	66
4.....	34	5	1	40
5.....	2	—	—	2
Total.....	124	25	3	152
Mean average.....	3	2.5	—	2.8

It will be seen that the difference between 3.65 eggs (the mean average clutch for the total area) and 2.80 fledglings (the mean average hatch for the same region) is 0.85, a drop of 23.3%. In other words, about one egg in every set fails to hatch. This failure is the first indication of a long series of decimating factors which cut down sharply the breeding potential of this species. Several correspondents state that infertility of one egg in every set is "not uncommon." However, an analysis of ninety-five records by egg collectors shows that only 7% of their sets contained one infertile egg, while 4% of such sets were added. (About 31% of these sets were freshly laid, and 58% were incubated in various degrees.) In discussing this situation in the British Isles, H. A. Gilbert (in litt.) writes: "It is very rare to find an infertile egg—and I am convinced that at least 95% . . . are hatched unless cracked by falling stones or upset by human interference." Hagar (in litt.) suggests that future reports of infertile eggs be accompanied by specific reasons why such eggs could not be considered merely added.

3. *Nest losses.*—Beyond the vast amount of egg collecting which once was so popular in the East, very little data are available on egg losses. Incomplete clutches may be abandoned if exceptionally nervous birds are molested. In one extreme case, the falcon deserted when the observer cautiously poked his head over the cut-bank which she shared with a Prairie Falcon and two other hawks (W. R. Salt, in litt.). Sometimes an egg is broken as though it were kicked. Eggs may disappear one at a time, or a whole clutch be gone after a week's interval. During the wet season of 1940, the latter took place on four of the five exposed ledges around New York, whereas

the cave-nesting birds there showed a high nesting success. While one might charge the disappearance of the sets to crows (no fragments were found), it seems equally possible that the birds may have abandoned the eggs first, or that they were washed away by storms. One female, for instance, was actually found a day after a heavy storm, to be brooding her eggs in a light stream of running water. Undue molestation by picnickers and workmen may have been a contributing factor in three out of four of these cases. At one Virginia site, an opossum (*Didelphis virginiana*) is said to have taken all the eggs (E. J. Court vide Wimsatt, in litt.), while at one New England eyrie, some animal, perhaps a raccoon (*Procyon lotor*), once ate all the young (J. N. Rice, 3rd, in litt.). While second clutches are frequently laid when a set is taken by a collector, they are often conspicuously absent after the loss of the first set through some of the disasters mentioned above.

There are two records of fledglings falling off the ledge at an early age, and two reports of fledglings dying on the ledge. Heavy infestations of *Protocalliphora* were noted at three nests in 1940, and it was at one of these that a fledgling died. This bird, a female, was raised in an extremely damp situation and death may have come from a fungous condition of the throat (W. D. Sargent). In three reports of young birds being shot on their nesting ledge, the gunners are given as a game warden, a pigeon fancier (the ledge contained a number of racing-pigeon bands), and an unknown party. At one site in Kentucky, mountaineers claim that, while they have not been able to hit an adult, not a single young bird has left the local eyrie in recent years. As soon as the fledglings walk out on their nest ledge, they are shot off (A. F. Ganier vide Spofford, in litt.). Immediately after they leave their parents, young Peregrines enter a critical period when their powers of pursuit and capture are not fully developed. It is at this stage that they have turned up (according to pictures in the public press) in the basement of a Philadelphia skyscraper and in a barrel on the upper floor of a barn in New Jersey.

*Productivity samples.*—Although as many as ninety cliffs were visited in a single season by the writer and his cooperators from Quebec to Maryland, the fairly complete nesting history was worked out for only one region—around New York. At nineteen occupied sites, an average of about 1.1 birds was fledged over a two-year period (see Table 5). These results were based on what is felt to be one normal season (1939) and one subnormal season (1940) in one region only. In 1940, scattered reports from central Pennsylvania sug-

gested that the birds there had no better success than those around New York. At the same time, Herbert and Spofford found six out of eight eyries in New England with eggs or young—a much better reproductive rate than elsewhere experienced, although their sample is admittedly a small one.

TABLE 5  
SAMPLE REPRODUCTION

	1939	1940
Sites studied . . . . .	23	23
<i>Deserted</i> . . . . .	4	4
Permanent eyries . . . . .	2	2
Temporary eyries . . . . .	2	2
<i>Occupied by one or more birds</i> . . . . .	19	19
No eggs laid . . . . .	5	4
Results inconclusive . . . . .	1	3
Nesting successful . . . . .	10	6
Number of young raised		
Probably hatched . . . . .	30	15-16
Died on ledge . . . . .	1	1
Disappeared . . . . .	1	1
Probably fledged . . . . .	28	12-14
Young raised per occupied site . . . . .	1.5	.7

The details of these two seasons are rather interesting, and the results for a given eyrie may be seen by reading from left to right in the following columns:

1939	1940
2 old eyries were deserted	2 old eyries deserted (one had not been checked in 1939; one from 1939 was not checked in 1940)
2 temporary eyries were deserted	Same 2 still deserted
1 male present, apparently unmated	This male had a one-year-old female; no eggs laid
3 females failed to lay; a fourth female on a skyscraper very likely did not lay either; all were paired	Same 3 females without eggs; skyscraper pair disappeared about time of egg-laying
1 set and female disappeared	Same female or her successor disappeared and the eggs chilled
1 set was collected; 1 young hatched from second set but was shot before it flew	Set was marked on open ledge but disappeared
4 young at one site disappeared mysteriously	Eggs chilled when intruding falcon drove off owner
	3 sets disappeared and the pairs deserted
10 pairs raised young; as 8 had 24 fledglings, the total hatch was probably 30; observations on one additional pair were incomplete	Observations on 2 eyries were incomplete
	6 pairs raised young; of these 4 hatched 10 birds; hence the total hatch was probably between 15 and 16

During 1940, two adult males in the above sample were shot by gunners. One belonged to a non-breeding pair and was found dead late in May about three miles (4.8 km.) from the eyrie. It was replaced by another male within six weeks. The second male was shot early in the season and died about four feet (1.2 m.) from the scrape in which his mate was brooding approximately ten-day-old eggs. This female continued to brood her clutch, fed herself, and, in about two weeks, secured the attendance of a new male. She successfully hatched the eggs and her young flew off without further disorder. This incident occurred in a region of high density (previously mentioned) where several pairs were experiencing unsuccessful seasons.

4. *Sex ratio*.—Reports were received mostly from falconers on 114 fledglings seen on nesting ledges. These were given as 61 males and 53 females (53.5% and 46.5%). These figures cannot be regarded as significant, unfortunately, because not all Peregrines can be sexed on the basis of size alone. The margin of error in these cases, as Herbert (in litt.) estimates, may run from 10% to 20%. Frequent statements in the ancient literature of falconry refer to a widespread belief that there are two females to every male (hence the word *tercel*). Modern falconers are reluctant to take all the young from an eyrie, but in five cases where this was done and the birds were raised to maturity, the sex ratio was given as six males to nine females. F. B. Lane likewise reports (in litt.) this ratio as seven to twelve at seven nests which he visited, and Herbert and Spofford as ten to eighteen on their banding excursions. What effect the frequent loss of one egg in each set has on the sex ratio at birth therefore remains uncertain. Conclusive data on the sex ratio of adults are also lacking. As far as is known, the birds are monogamous.

5. *Age of females*.—The relationship of age to fertility in the female is worthy of consideration. Three reports state that mated one-year-old females failed to lay any eggs. A fourth describes an immature falcon that brooded a clutch of two. While it is probable that these were her own eggs, actual proof is lacking. Considering the two-year sample around New York, only one out of thirty-four females was a first-year bird. At one New Jersey eyrie, during the past decade, Herbert (in litt.) believes that he recognized two females in different years as two-year-old birds. Each significantly laid a clutch of two eggs.

Of even more importance, however, is the presence of females that fail to lay year after year. This situation seems to hold at one eyrie for most of the last ten years, and it is unquestionably true at



two other sites from at least 1938 to 1940 inclusive. These last two eyries were subjected to intensive watching by the writer in 1940 in order to make sure that no eggs were being taken by predators or egg collectors. In each case, courtship by the male lasted at least one month past the normal period. To the tercel's displays, the falcon was generally unresponsive, although she came to the cliff for food and sometimes permitted copulation. As this apparent sterility occurred in three out of about eighteen cases (16.6%), its occurrence takes on considerable significance. It seems likely that this condition may be brought on by old age.

Up to the present very little data have been published on this subject. McLean (1930) has concluded that very old and sexually spent California Quail (*Lophortyx c. californica*) form non-breeding coveys on high ridges apart from the younger birds. Harlow (1922) has stated his conviction that some Ravens (*Corvus corax principalis*) failed to lay year after year, like the falcons just described. He cites one pair which rebuilt the same nest from 1912 to 1918 but failed to lay, and describes other non-breeding pairs which "exhibited every solicitude at the presence of intruders." The male Peregrines scraped courtship hollows on the ledges early in the season, but the females were often away from the cliff for hours at a time and, beyond coming to the cliff for food cached by the male, exhibited little concern when molested. It may or may not be significant that evidence of approaching sterility is practically unreported by eastern egg collectors. In 1939, however, one set was taken in which three of the four eggs were infertile and rotten (Brockway, 1939). This particular female hatched only one egg from her second set. Her 1940 eggs disappeared (W. D. Sargent, verbally).

#### B. ADULTS

1. *Mortality*.—Man is the adult Peregrine's worst enemy. Birds are shot at all seasons, in States that protect them as well as in those that do not, on private lands and on public reservations. This shooting has somewhat decreased in recent years, especially since the abolition of shorebird gunning, but it is still carried on by hunters, by boys, and by game protectors. The number killed by farmers is apparently small (about two out of every hundred pairs ever taking poultry), the number killed by game wardens rather marked, although, in the East at least, game is a very rare item in the Peregrine's diet. While parasites might be regarded as enemies of potentially great importance, only two reports reached the author regarding migrating birds which, it was said, became incapacitated by disease.

2. *Life expectancy*.—The life expectancy of these birds has not yet been established by banding, since most recoveries of marked fledglings occur in the birds' first fall migration. Breeding adults are not infrequently distinguished for three to five years at some particular eyrie by special characteristics, such as their behavior or the color of their eggs. In New Jersey, one resident male was recognized by R. A. Herbert (in litt.) at the same cliff for ten or eleven years.

#### CONSERVATION AND MANAGEMENT

Before discussing problems of conserving this species in the area east of the Rockies, it is necessary to review some general characteristics of the population, to dispel certain exaggerated conceptions about egg collecting and falconry, and to emphasize the importance of the nesting site in the Peregrine's annual cycle.

##### A. SOME GENERAL POPULATION CHARACTERISTICS

Peregrines, as we have already seen, tolerate wide extremes in climate, but as a rule are extremely limited in their present choice of nesting sites. The great mobility of the adult birds and the relative ease with which they secure food have apparently modified territorial competition to the point where only the immediate vicinity of the nesting site is defended. The present-known maximum number of breeding birds per unit of space is best expressed in linear terms—one pair per approximately 1.4 miles (2.25 km.) of ledge-studded escarpment. The birds can tolerate considerable changes in their environment. This is certainly true in respect to their foraging area, but is only partly true in regard to their nesting sites. Some pairs now hunt almost exclusively over cities; many have suffered the construction of highways and railroads immediately below their nest ledges; and one pair (and its successors) tolerated for over a century the activities of a village of two hundred people at the base of their eyrie. As a general proposition, Peregrines appear to be little molested by the progress of what passes for civilization below their cliffs, but frequent or prolonged visits by human beings to the top of an escarpment or cut-bank may bring about interruptions in the breeding cycle, and in some cases actual desertion of the eyrie.

It is rather difficult to make any statement regarding the smallest-size cliff that a pair of Peregrines will use year after year. Perhaps seventy-five feet (23 meters) constitutes the height of the smallest cliff now known to be occupied. This would suggest that many small cliffs located in towns and villages, possessing adequate egg sites in the form of caves or ledges, may have been used by these birds be-

fore the arrival of the early settlers. A good example of such cliffs would be those in the city of New Haven, Connecticut. The smallest escarpments now in use are in wild country or overlooking long talus slopes. In a few cases, birds are really nesting on large outcrops which protrude above the tops of trees and possess perfect nesting ledges or caves. Minimum requirements, it would thus appear, are more qualitative than quantitative. Ideal requirements will be discussed in the section which follows.

It seems impossible, on the basis of present data, to ascertain even approximately the number of Peregrines which any given environment can carry. The general absence of this species in winter north of a line running from Colorado to Massachusetts may indicate, however, that the winter population of prey to the north approaches or is below the minimum limit for this predator's survival. It would be interesting to work out the density of available prey in those States and Provinces where the Prairie and Peregrine Falcons live side by side as well as in those regions where the former replaces the latter.

#### B. EGG COLLECTORS

Peregrine egg-collecting east of the Rockies is gradually dying from old age. In this region, only six or ten such persons are still active. Compare this to fifty years ago when at one popular eyrie, according to Frick (1883), over thirty people climbed one cliff on the same day for a single clutch of eggs. If eggs are taken, the birds usually but not invariably lay a second clutch in the United States but rarely in the Canadian provinces. That these sets contain fewer eggs can be seen in Table 6.

TABLE 6  
KNOWN SECOND SETS

<i>No. in clutch</i>	<i>No. sets reported</i>
2	2
3	16
4	2
5	1
6	1

The average second clutch being three, there is some evidence that the hatch is usually two, so that collecting in the past cut down the breeding potential of these birds by at least 33% from normal. Permanent desertion of a cliff has coincided with a collector's visit in only one known case. It may or may not be significant that Vermont, which has undergone some of the most intensive egging

in the East (over fifty sets taken between 1920 and 1934), now is said to have so many deserted eyries. Until actual facts on the homing of fledglings are available, the exact effect of this egg collecting must remain hypothetical. Although it is still occasionally practiced in States that protect the species as well as on public reservations, the total amount east of the Rockies is now relatively negligible. Failures to locate Peregrine eggs in the past were generally charged off to some earlier visit by a collector. While this assumption was probably correct in many cases, it has completely obscured the losses of eggs through natural causes and the apparent sterility of aged females.

#### C. FALCONERS

Falconers, on the other hand, are a group that is slowly but steadily growing. It is time that conservationists realize the true significance of this movement. As one who is interested only in falcons and not in falconry *per se*, the writer would like to record briefly these seven observations on the movement in America up to the present time:

(1) Falconers constitute, by a wide margin, the most rabid admirers of hawks in our country today. It is not a fad of the wealthy, but a hobby of the middle classes involving considerable devotion and work. The vast majority of its members are sincerely interested in hawk conservation; a few exceptional individuals cannot be trusted.

(2) The term 'falconer' at present is generally applied without distinction to those who are essentially pet-keepers, as well as to those who train their birds to fly and hunt in cooperation with man. Most of them are probably genuine conservationists, but only a few are real falconers.

(3) In most of the East, the wooded terrain is only suited to hunting with accipitrine species like the Cooper's Hawk (*Accipiter cooperi*), but this fact is seldom appreciated by novices who take up the sport in this region.

(4) Peregrines, because of this situation and their great glamor in the Old World literature, are over-rated, and a number of experienced falconers upon recognizing this have turned to hunting with the Goshawk (*Astur atricapillus*) or the Cooper's Hawk.

(5) Falconers are extremely valuable propagandists for hawks, especially among sportsmen and farmers, but their services are not organized nor uniformly directed.

(6) The number of birds used in falconry every year is still relatively small and under experienced hands the number that escape

to the wild is relatively large. Beginners, however, frequently lose their birds by disease or accident. Although veteran falconers unanimously believe that their escapes quickly become self-sustaining wild birds, no bird banding has been done to support this opinion.

(7) Boys or young men, untutored and inexperienced, may constitute a problem in the future, but this is perhaps an improvement over former times when youngsters of a similar age were ruthless users of the gun or rabid collectors of eggs. Up to the present time, the one eyrie which Peregrines have deserted due to abnormal molestation by young falconers happens to have been a 'temporary' nesting site.

#### THE NEST SITE AS AN ECOLOGICAL MAGNET

A fundamental concept in any consideration of this species' conservation revolves around the fact that cliffs are the dominant features of the Peregrine's ecological niche over most of its present breeding range, and that these cliffs attract the falcons in widely different degrees. It is rather well known that trees, buildings, or shrubbery possess this same basic faculty for other species, though often more subtly. General statements about the toleration of man's activities by Peregrines depend largely on the types of cliffs which various pairs occupy.

1. *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*. There are numerous examples of this principle. At one eyrie, a nearby pigeon fancier is said to have repeatedly tried to kill off the resident birds without success (Nye, verbally). All the fledglings at this same site were taken by young falconers and natural predators from 1936 to 1940, but adult birds are still present (Wimsatt, in litt.). This cliff not only has a railroad at its base but a large sign has also been painted across its surface. At another site, both first and second sets were taken for ten successive years, yet the birds failed to desert (Bagg and Eliot, 1937). Rowan (1921) has cited the perfect illustration of this ecological magnet in his description of a patch of old heather which was used for nineteen successive years as a nesting site by Merlins (*Falco aeslon*). Although there were a score of other patches on the moor that these Merlins could have used, the birds always chose this particular one in spite of the fact that *every year the nesting pair was shot and not a single egg hatched*. At least in the cen-

tral and northern parts of the Appalachian system, first-class cliffs can be recognized by their size alone, and solely on the basis of similarly large cliffs in the United States, Capes Trinity and Eternity, where the Saguenay enters the St. Lawrence, can be given as examples.

2. *Second-class Peregrine cliffs* differ from the above merely in their dimensions. Here, the birds can withstand considerable molestation. Death of one adult does not necessarily cause the abandonment of the eyrie, but death of both adults may leave the cliff without birds for an indefinite time. Picnickers on top of the cliff will often create complications. These persons are generally absent early in the nesting cycle, so that their presence later on in the season affects the behavior of the female about the time that the eggs are hatching. At one eyrie of this class, the brooding bird has been frightened off so many times that only one egg has hatched in nine years. At this site, after the female deserts in May, the male takes to roosting on a gas tank about seven miles away, yet at the start of each breeding season a pair is again in residence (Herbert, in litt.). Such behavior varies according to individual birds and according to the location of the eggs—whether they are near the top, on an open ledge, in a cave, etc.

3. *Third-class Peregrine cliffs* are small, not very high, although they may be far up a long slope, and they may or may not overlook water. They may be regarded as the marginal niches in Peregrine ecology. Because the birds at such sites are the most responsive to molestation and persecution, these cliffs are the present crux of the conservation problem to preserve Peregrine eyries in civilized areas. The death of one adult may result in permanent desertion of the cliff by its mate. Picnickers on top of the cliff may cause desertion for the rest of the breeding season or for an indefinite period. Since these cliffs are not very high, the amount of cover they provide against the depredations of man is measured to a great degree by the wildness of the general region. As already stated, in the nesting site of the Peregrine Falcon, height and wildness are the two components of cover.

It should be mentioned that this classification of ecological niches does not consider them in the sense that some attract more pairs of Peregrines *at one time* than others. Variations in individual behavior and a superabundant food supply both probably narrow the size of the nesting territory defended, and one would expect the latter to be a factor in maintaining some cliffs as first-class eyries. This is probably true of those sites which are adjacent to or a part of the great seabird colonies. Although the density of the surrounding

bird population may vary from 200 to 800 birds per hundred acres inland, there is no indication that this variation has any appreciable influence in determining the classification of neighboring eyries. One would also expect that any classification along these lines is influenced by altitude and by temperature at the periphery of the species' range where large cliffs cannot be classified as of the first class. Field work up to the present indicates that optimum breeding range extends in the East at least from Maryland to the Laurentian shield. In a superficial analysis of over fifty Appalachian eyries by Herbert, Sargent, Spofford and the writer, all three classes were represented equally. This representation will, of course, vary from region to region.

Bennett (1938) has pointed out that a more balanced sex ratio exists in the southern part (Iowa) of the Blue-winged Teal's (*Querquedula discors*) range than in the northern part (Saskatchewan). He suggests that the unmated males may move on to the northern breeding grounds. There is no available evidence that a similar situation exists with the Peregrine Falcon. As a general but by no means invariable rule, gaps in the population are filled according to each eyrie's value as an ecological magnet, and not according to latitude. It would follow from this principle that pairing in the Peregrine Falcon is not based on sexual selection but rather on the selection of a nesting territory. This deduction should not be accepted without much more intensive study. What we do know is that disaster to one adult at a third-class cliff will often cause the remaining adult to desert. When a bird is shot at a first-class cliff, the survivor generally succeeds in obtaining a new mate by the start of the next breeding season. Females will often desert second-class cliffs where males show a tendency to remain.

#### ACTUAL SIZE OF THE TOTAL POPULATION

Another important conservation concept concerns the actual number of Peregrines breeding regularly east of the Rockies. That the discovery of new pairs has not yet been affected by the law of diminishing returns may be seen from Table 7.

TABLE 7  
DATES EYRIES WERE DISCOVERED

	<i>U. S. The North</i>			<i>U. S. The North</i>	
1840-49	3	1	1890-99	27	16
1850-59	2	-	1900-09	18	25
1860-69	4	8	1910-19	21	10
1870-79	15	3	1920-29	42	10
1880-89	24	6	1930-40	107	36

The total population is, in the writer's opinion, far in excess of previous estimates. West of the Appalachians, where the bird breeds so much on river bluffs and cut-banks, a lack of systematic observation makes a tentative estimate impossible at this time. Sixty eyries have been reported there in the past and many times this number must exist. The density in this area greatly increases as one turns north into Alberta. For the Appalachian region, where over two hundred pairs have been reported, a tentative estimate can be made with more confidence. Although three of the States here contain 100 known eyries, the rate at which new locations are still being reported even in these areas is very impressive. The field work is still random in character and carried out only on week-ends for a limited time each year. A tentative estimate would place the breeding Peregrines in the eastern States at perhaps 350 pairs, but the amount of unexplored country in both West Virginia and Maine renders this figure more of a guess than a statement supported by satisfactory facts. East of the Rockies, the real center of abundance may lie farther north. Available data only indicate that the density in the Appalachians does not diminish in the Laurentians. The possibilities in Greenland are only hinted at; although only seven eyries have been so far recorded on its rugged coasts, twenty-five fledglings were recently sent to Finland from a single port (Meredith, verbally).

The existence of a large population in Canada and the Arctic has not, however, been supported by the migration data of ornithologists in Canada or the United States. At Cape May, New Jersey, where observations each fall have been made daily by Audubon wardens for a number of years, less than one hundred birds constitute the total known flight for each September and October (R. P. Allen, in litt.). This puzzling situation may be solved by the field work of other observers now in progress at seemingly richer observation stations along the Atlantic coast.

#### RECOMMENDATIONS

So many writers have eulogized the Peregrine Falcon as the most spectacular example of winged predation that no justification for its conservation is necessary in the present paper. The population is thinly distributed over an immense area and is very gradually decreasing in the more settled civilized regions. The necessity of preserving individual breeding pairs as permanent parts of each local avifauna is therefore a real one. Without the special protection which has been given them, half of the eyries in Massachusetts would, in the writer's opinion, today be deserted. This indeed has already



taken place in Connecticut, where two long-used cliffs are now abandoned and a third, though occupied, has failed to produce young birds for the last five or six years. Certain recommendations are therefore in order.

1. The name 'Duck Hawk' upon extensive study proves to be logical only very locally, and is actually a misnomer over most of the species' range east of the Rocky Mountains. From a conservation viewpoint, the very connotation of this name stimulates a vast amount of wholly unnecessary prejudice. The writer would earnestly recommend to American ornithologists that they follow their sensible Canadian colleagues in calling this bird the 'American Peregrine Falcon,' or simply the 'Peregrine Falcon.'

2. Inclusion of this falcon among the protected species of each State is another important preliminary step in protecting both the birds and their eyries. Only nineteen States now do so, although the effect of the birds on game or other avian populations is obviously a negligible one. The Peregrine is not protected in Canada, although its admirers there are numerous.

3. The preservation of individual eyries is a local matter which involves a local approach. No amount of work for the protection of these birds along their migration routes or on their widely scattered wintering grounds will be effective unless this breeding stock is conserved. State legislation helps but it is only a start.

(a) Talks to the owners of occupied cliffs have value in the long run. When interviewed, most owners are impressed with accounts of the Peregrine's relative rarity, with its reputation as our fastest-flying bird, and with its historical background. One's main purpose in such discussion should be to keep picnickers away from the cliff at least until the eggs are hatched (May 15 in Maryland, June 1 in New Jersey, and June 15 in Quebec). It is also important to eliminate gunning in the vicinity of the eyrie. Special sanctuary signs can be obtained without charge from the Hawk and Owl Society by applying to the writer.

(b) Game wardens, who generally carry guns at all seasons, are also important subjects for education. One of these is said to have brought on the desertion of New England's oldest-known site—a second-class cliff in Connecticut—by shooting both adult birds and their young (Spofford, in litt.). Some States, like Maryland, still regard the Peregrine as vermin, and there wardens destroy this species at every opportunity. It is suggested that persons, who learn at first-hand of game protectors molesting these birds, communicate

their observations to R. H. Pough, National Audubon Society, 1006 Fifth Avenue, New York City.

(c) Perhaps the most effective way for conservation groups to preserve Peregrines as permanent parts of their local avifauna lies in the appointment of volunteer custodians who will watch neighboring eyries, report yearly on the status of the birds, and communicate at once to the Hawk and Owl Society (in care of the writer) any illegal or prejudicial interference which is taking place.

(d) At eyries where special problems of predation arise, such as the birds taking valuable poultry or racing pigeons, this pressure can at least partially be reduced by placing the fledglings in another 'nest.' In 1940, Herbert and Spofford moved two such nestlings to a State where they were protected. Although about ten days younger than the two fledglings already on the new ledge, the transported birds thrived in their new environment.

4 As an education measure of considerable potentiality, the writer would also suggest that in States where the Peregrine is protected the keeping of such birds in captivity be permitted under license for lecture purposes, that falconers be required to carry out this obligation, and that in return recognized hunting privileges be granted to this new class of sportsmen. It is suggested that no novice falconer who has previously failed to raise successfully one of the more common raptores be legally permitted to test his book knowledge of falconry by practicing with the Peregrine Falcon.

5 Bird boxes are now a proven method of encouraging Peregrines to occupy new sites. Man-made structures, which the birds occupy in winter, or on which they may be seen during the breeding season, often lack only a situation in which the falcon can scrape out a nesting hollow. Skyscrapers, church spires, high bridges, and large gas tanks fall into this category. At some of these, an 18 × 18-inch tray containing two inches of dirt and gravel may induce the birds to remain and breed. The extent to which cliffs can be artificially improved by the creation of small caves, the addition of gravel, or the provision against undue rainfall is a matter for thoughtful consideration and future experimentation.

6 The study of future fluctuations of the Peregrine should be encouraged for its conservation as well as its biological value. This report, it is hoped, is a start in that direction. Four things connected with this should be kept in mind by the many persons now interested in this species:

(a) All cliffs that have been thoroughly studied should be accurately mapped, regardless of the presence of Peregrines. Observations from

the base of an escarpment are not conclusive evidence that the birds are absent.

(b) Any publication of the location of an occupied eyrie is a source of potential danger to the subsequent nesting success of the resident birds concerned.

(c) The extensive banding of Peregrines offers the soundest basis for the proper solution of a number of problems. This is one of the few species where the banding of fledgling birds still has definite value.

(d) The annual trapping and banding of adult birds in the general vicinity of their nesting sites is vitally needed as a check on age, fertility, and replacement. This need not be done on nesting ledges and should be conducted near third-class sites only with extreme caution. Data on productivity are still needed for many regions, especially those at the peripheries of *anatum's* range. In selecting a number of eyries to study, observers are urged to cover only a small number of cliffs and to begin their surveys early in the season.

#### SUMMARY

In this cooperative survey, about 400 nesting sites of the Peregrine Falcon are shown to have been reported east of the Rocky Mountains up to the close of 1940, although several times this number are believed to exist. The birds have declined in numbers by at least 11% in the more settled regions, but a large tree-nesting population apparently disappeared in the Mississippi Valley before it was properly recorded. Breeding distribution and density are found to be affected by (1) the number of cliffs and cut-banks that still afford isolation and proper egg sites, and (2) by territorial competition. Available data indicate a flat type population curve, at least in recent years. Clutches seem to decrease from about four in the United States as one goes north, and the hatching success is shown to be about 75%. The breeding potential may be markedly affected by sterility in females, to some extent in first-year birds, and apparently to a considerable extent in very old individuals. Seasonal nesting losses for nineteen eyries around New York showed a wide variation, and a two-year average of about 1.1 birds fledged per occupied site. The gun is given as the adults' worst enemy, the activities of egg collectors are found to be small in this region, and the operations of falconers not discouraging at this time, although their younger adherents require supervision. Breeding sites are shown to possess different values as ecological magnets—a term used to illustrate how some sites will long outlast others, even though the total population de-

creases. Recommendations for the preservation, management, and future study of these birds are added.

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