1983

Peregrine Falcon Investigations

M. A. Byrd
The Center for Conservation Biology

PERFORMANCE REPORT

STATE:	Virginia	PROJECT NO.:	EW-1-5
PROJECT TYPE:	Research and/or Inventory	STUDY NO.:	III
PROJECT TITLE:	Virginia Endangered Species Investigations	JOB NO.:	III-A-1, III-A-2, III-A-3, III-A-4
STUDY TITLE:	Peregrine Falcon Investigations		
PERIOD COVERED:	July 1, 1982 - June 30, 1983		

JOB III-A-1 OBJECTIVE: To obtain sightings of Peregrine Falcons in Virginia and determine where migrants are located.

JOB III-A-2 OBJECTIVE: To introduce Peregrine Falcons at hack sites on the barrier islands of the Eastern Shore of Virginia. There are historical records of tree nesting peregrines in Eastern Virginia. This program will be an attempt to restore peregrines to this portion of the former range.

JOB III-A-3 OBJECTIVE: To operate a peregrine falcon banding station at Fishermans Island N.W.R. during the fall migration period.

JOB III-A-4 OBJECTIVE: To relocate and visit all known historical peregrine eyries in order to evaluate their continued quality and to determine the presence of birds.

SUMMARY:

Fall and winter surveys of peregrines were conducted. Hacking sites were operated at Great Fox, Cobb, and Russell Islands. Eighteen birds were released of which 15 fledged and dispersed from the sites. Three birds were attacked and killed by an adult tiercel at Great Fox Island. A summary of previous releases is included and a population growth model projected. Surveys and analysis of historical nesting sites is included as a basis for possible future introductions.

FALL MIGRATION:

Three stations to monitor raptor movements during the fall migration were established at Fishermans Island, at Wise Point on the tip of the Eastern Shore Peninsula, and at Kiptopeke Beach. The stations were manned a total of 59 station days during September and October. A total of 12,000 raptors were seen of which 63 were peregrines. The peregrine migration appeared to be one of the strongest in recent years with numerous days of northeasterly winds, conditions conducive to good inshore peregrine movement.

WINTER RECORDS:

Several one-day trips were made during the winter and early spring to the Virginia barrier islands and other coastal areas to locate wintering falcons. It is felt that winter records no longer provide useful information on the presence of wintering tundra birds because of the likely presence of previously hacked birds in the area.

Wintering adults were seen in Norfolk (4), Fishermans Island (2), Metomkin Island (1), Wallops Island (1), Craney Island (2), Assateague Island (2), Russell Island (1), and Great Fox Island (2). Immature peregrines were observed on a number of the barrier islands during the winter months. It is believed that most of these adults are hacked birds although the two individuals at Craney Island were trapped and proved to be tundra birds, one previously banded as a nestling and the other as a passage bird. One of the adults found in Norfolk has wintered there for many years.

HACKING PROGRAM:

Two new hacking towers were constructed during the year. One of these towers was located at Parramore Island and one at Metomkin Island. Existing sites at Back Bay National Wildlife Refuge, Norfolk, Cobb Island, Fishermans Island, Wallops Island, Assateague Island, Great Fox Island, and Russell Island brought the total sites potentially available for hacking or nesting to ten. Location of all completed hack sites is shown in Figure 1.

Several sites, including Norfolk, Fishermans Island, Wallops Island, and Assateague Island could not be used for hacking because of the presence of adults. The hacking tower at Great Fox Island blew down in the winter and was erected again in April. During the intervening period a pair of adult peregrines appeared there but later departed.

The pair of peregrines at Fishermans Island may have lost eggs to fish crows. The pair at Assateague were again productive, hatching four chicks. All four young have successfully fledged at this time.

In 1983, hacking operations were conducted at Cobb Island, Russell Island, and Great Fox Island. Seven young each were placed at Cobb Island and Russell Island. Four young were hacked at the tower on Great Fox Island. All fourteen young successfully fledged from Russell and Cobb Islands. At Great Fox Island, a pair of adults appeared at the hack tower one week after the young made the first flights. The highly aggressive tiercel killed three of the young. The fourth was rescued and placed on the tower at Cobb Island where it successfully fledged.

Peregrine falcon releases have been conducted since 1978. Table 1 summarizes the success with this type of release.

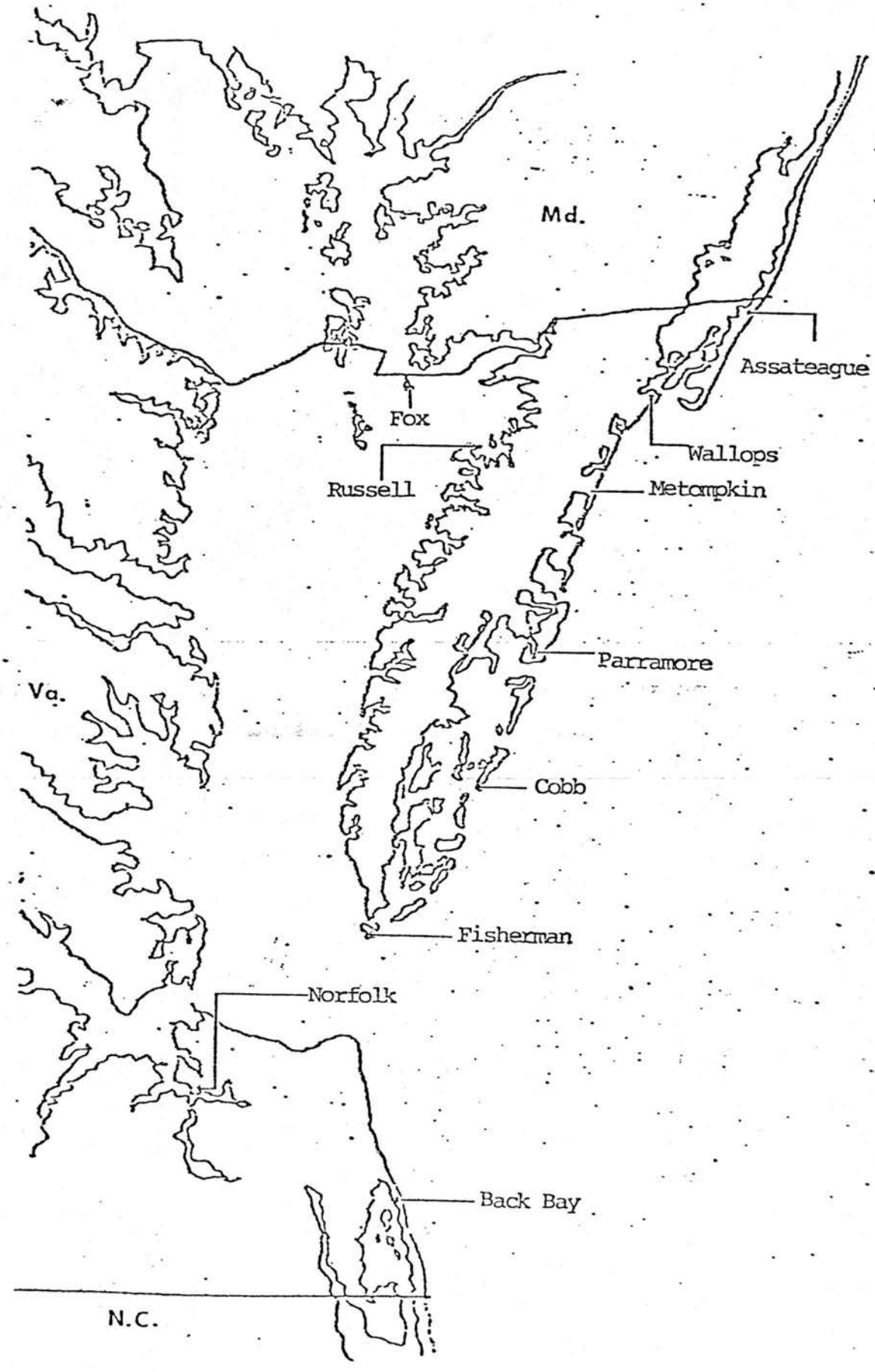

FIGURE 1. Location of Peregrine Falcon Hack Towers.

TABLE 1. Summary of Peregrine Falcon Release Results.

Release Date	Hack Site	No. of Young Released	No. of Young Lost	Cause	No. Dispersed
6/19/78	Cobb	5	2	storm	3
6/27/79	Cobb	5	0	-	5
5/22/80	Cobb	5	0	-	5
6/1/80	Assateague	5	0	-	5
5/31/80	Fishermans	5	1	unknown	3
			1	followed subadult	
7/26/80	Norfolk	6	1	congenital	5
5/23/80	Cobb	6	0	-	6
5/31/81	Assateague	6	3	adult harassment	3
6/3/81	Great Fox	6	0	-	6
5/29/81	Norfolk	4	0	-	4
5/31/82	Back Bay	7	0	-	7
6/7/82	Great Fox	6	0	-	6
6/5/82	Russell	6	0	-	6
5/18/83	Russell	7	0	-	7
6/16/83	Great Fox	4	3	adult harassment	1 1
6/14/83	Cobb	7	0	-	7
Totals		90	11	-	79

As may be seen in Table 1, 16 releases have been made in eastern Virginia between 1978 and 1983. Two sites were used once, three sites were used twice, one site was used three times, and a single site was used five times.

Hacking success may be measured by the percentage of released peregrines that become independent with respect to food and normally disperse from the hack site. This success rate may be biased due to the inherent difficulty in distinguishing mortality from dispersal during the fourth and fifth weeks following release. For consistency, birds not seen after four weeks post-release have been assumed independent unless other evidence suggests the contrary. The success rate of released peregrines for six years has been 88 per cent. Success and mortality by site appear in Table 1.

POPULATION ESTIMATES:

Determining total population numbers of peregrines resident in Virginia is difficult due to the high mobility of the young birds and our inability to follow widely dispersed individuals throughout the year. The number of adults is more easily determined due to the tendency for these birds to remain territorial at suitable breeding sites, i.e., hack towers. At present, three established pairs and two unpaired birds (of the opposite sex) are known to exist. Although these two single birds comprise a hypothetical fourth pair, the individuals occupy separate territories approximately 124 km apart. Both birds remain sedentary throughout the year making it improbable that they will pair with each other. Each bird does represent a potential pair at their respective sites.

A stochastic model for population growth developed by J. W. Grier was used to assit in the population estimate and to project results of the reintroduction program. The model simulates the growth of an existing or reintroduced population using known parameters. The incorporation of random chance within given probabilities for reproduction, sex of individuals, and mortality realistically approximates the unpredictability of small founding populations. The program parameters include:

1) monogamous or polygamous breeding pattern

2) age that breeding begins

3) maximum number of young per female

4) mean number of young per total breeding attempts

5) mean number of young per successful breeding

6) first year mortality rate

7) mortality rate of older birds

8) limit (if any) on number of breeding pairs per year

9) number (if any) of first year birds released per year

10) number (if any) of older birds released per year

Simulation results include number of birds of given age classes present at the beginning and end of any year. The stochastic nature of the program produces variable results due to random chance. For this reason, five simulations are run for every year and the mean and range of possible outcomes is presented.

Figure 2 displays the simulated growth of the Virginia reintroduced peregrine population. This model is based on the number of peregrines released to date and assumes that nine male and nine female peregrines will be released per year to 1990. Future "releases" may include the supplementation of existing broods. Other parameters include 60% hatch year mortality and 20% post-hatch year mortality. These mortality rates are conservative estimates which include pre-dispersal losses and are based on band recovery data from wild populations (Enderson 1969) and returns of released peregrines (Barclay 1980). Reproduction averages 1.5 young per nesting attempt and 2.5 young per successful nesting attempt. Several studies (Mebs 1960; Herren 1969) indicate that this productivity is conservatively realistic. Forty percent of nesting attempts produce no young which is largely a reflection of the low reproductive success of second year birds which are included as breeders in this model. Beebe (1960) found approximately 60% breeding success of all recorded attempts in the F. p. peali population of Queen Charlotte Islands. The number of breeding pairs in coastal Virginia will probably be limited by the number of towers which are present in a given year. The number of pairs which can attempt breeding is limited to 14 for this series of simulations. That is the maximum number of hack-breeding towers that can be erected in the immediate future. The number of pairs present in any simulation is defined by the number of the sex which is limiting in any given year. The model indicates a current population in Virginia of 15-23 peregrines (mean = 18.2) including 3-7 pairs (mean = 4.8).

An identical model was run without limiting the number of breeding pairs to determine maximum population numbers. The mean number of breeding pairs present in 1990 under these circumstances is 18. This indicates that 18 nest sites will be needed by 1990 to allow the mean number of potential pairs to attempt breeding.

Analysis of survivorship tables shows that the mortality rate affects population growth to varying degrees partly depending on the age of the maturity of the species. Populations of birds such as the bald eagle (Haliaeetus leucocephalus) which do not breed until their fourth year are extremely affected by slight changes in mortality rates. Species which breed at very young ages, i.e., Peromyscus spp. are affected more by reproductive rate changes than mortality rate changes. Peregrines generally do not breed successfully until their third year. The attempts of sub-adult

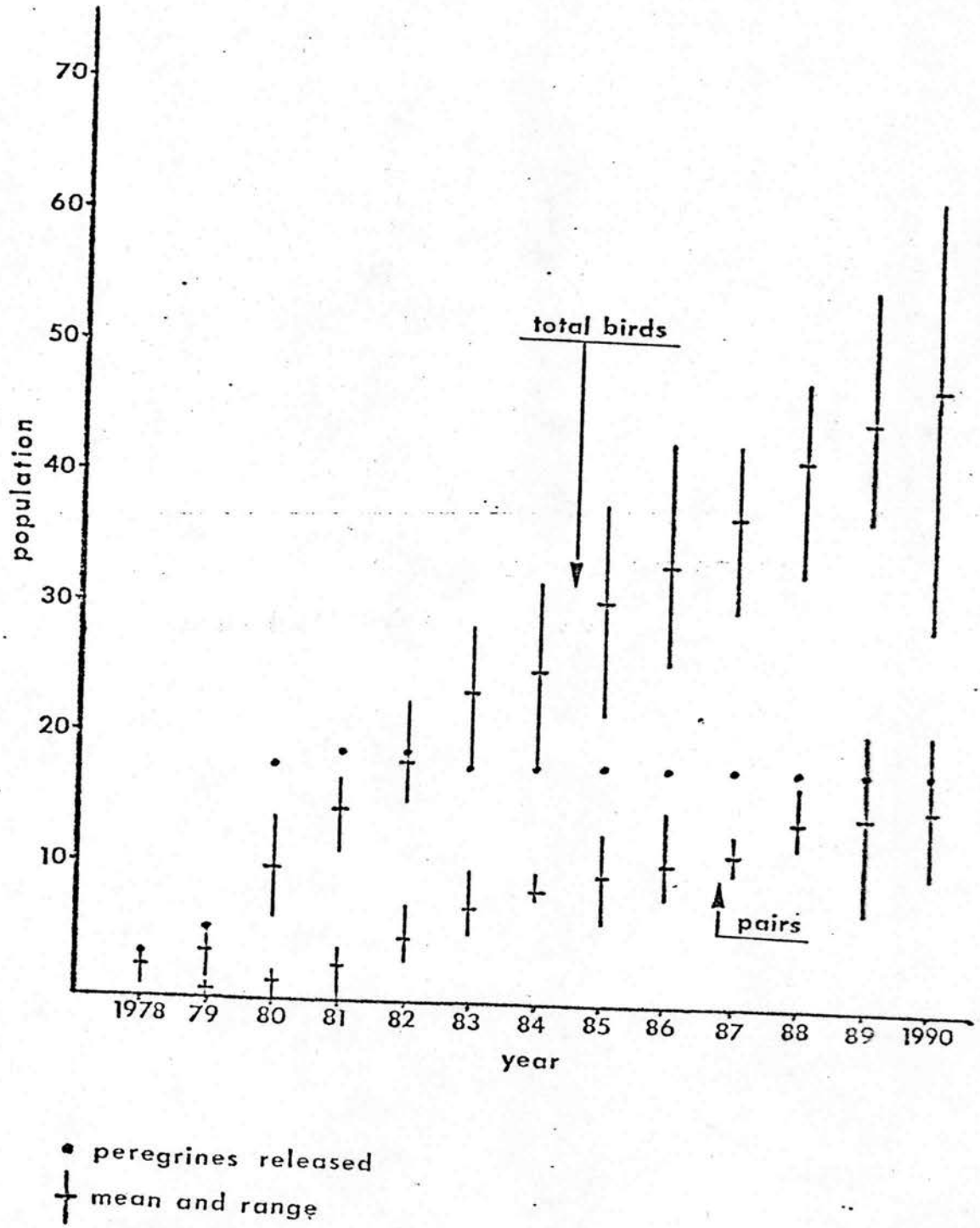

FIGURE 2. Projected Growth of Virginia Peregrine Population Assuming 60% Hatch-Year and 20% after Hatch-Year Mortality.

birds are usually included in reproductive figures. The relatively high percentage of unsuccessful breeding attempts reported (40%) is probably reflective of these sub-adult attempts. Survivorship tables do indicate that relatively small changes in mortality rates have profound effects on peregrine population growth (Young 1969).

Figure 3 shows the simulated growth of a Virginia peregrine population which is subject to 50% hatch year mortality and 15% post-hatch year mortality. Other parameters in this model are identical to the growth simulation displayed in Figure 2. The reduction of hatch year mortality by 17% and post-hatch year mortality by 25% in the growth simulations produces a significantly higher number of pairs and total birds present in the year 1990. The current population estimate in the simulation is also significantly affected. Table 2 contains the figures and statistical results. As noted earlier, studies of mortality by band recovery methods indicate that some peregrine populations may experience mortality rates as low as 55% (Shor 1970) for hatch year birds.

The growth program allows one to determine whether populations, defined by certain parameters, can be self-supportive. When no artificial release of birds occurs, natural reproduction has to be sufficient to compensate mortality or the population declines. Repeated simulations indicate that a peregrine population experiencing 60% hatch year and 20% post-hatch year mortality rates cannot be self-supportive at documented reproductive rates. This implies that stable wild populations which display these reproductive rates are subject to lower mortality rates than is calculated by band recovery studies.

TABLE 2. Differences of Simulated Populations Using T-test Comparison of Means. Degrees of Freedom Equal 8 For All Tests.

Simulation A - 60% hatch year mortality; 20% post-hatch year mortality.

Simulation B - 50% hatch year mortality; 15% post-hatch year mortality.

	Simulation A (n=5)	Simulation B (n=5)	t
1982			
pairs present	4.8 ± 1.44	7.6 ± 4.30	2.95
total birds present	18.2 ± 3.27	31.0 ± 5.15	4.69
1990			
pairs present	16.2 ± 4.49	40 ± 4.30	8.56
total birds present	47.2 ± 13.59	108 ± 5.12	9.46

$t_{.05}(8) = 2.306$
$t_{.01}(8) = 3.355$
$t_{.001}(8) = 5.041$

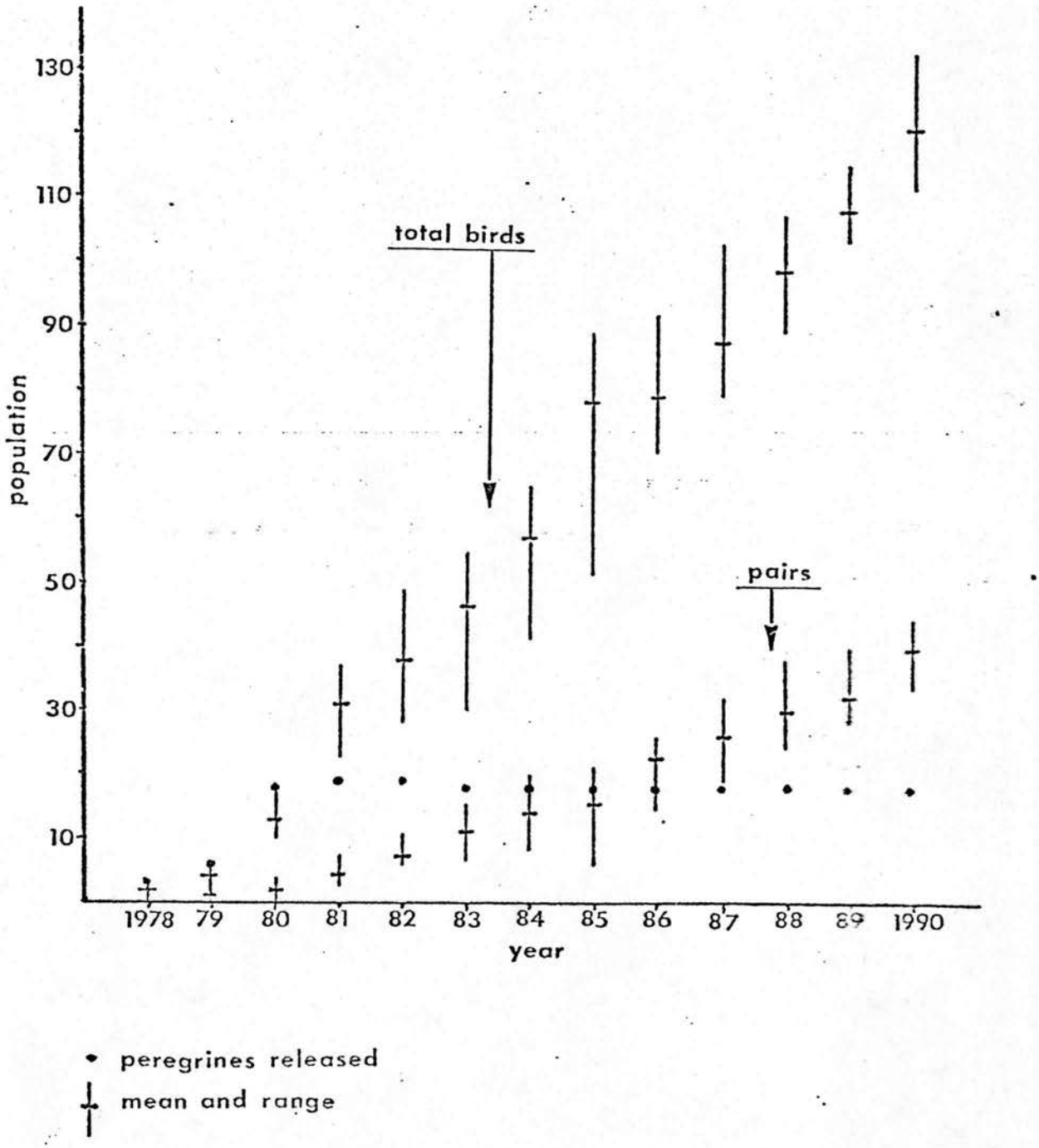

FIGURE 3. Projected Growth of Virginia Peregrine Population Assuming 50% Hatch-Year and 15% after Hatch-Year Mortality.

BANDING PROGRAM:

Three trapping stations located at Fishermans Island, Wise Point, and Back Bay were operated during September and October.

Seven peregrines were captured at Wise Point, two at Fishermans Island, and 32 at Back Bay. One hacked bird from South Marsh Island in Chespeake Bay was captured at Wise Point. One of the young which was produced at the hack tower at Assateague Island was captured several times at False Cape State Park adjacent to Back Bay.

EVALUATION OF HISTORICAL EYRIES:

The existence of twenty-four historical Peregrine eyries has been verified. Nesting has been inferred for two additional sites (Jones 1933). Table 3 is a summary of the site names, references, and known active years. Thirteen of the sites were inspected. No peregrines nor any evidence of recent breeding were seen at any of the sites. For six sites, since only the general location was determined, data were not collected as the actual eyrie could not be located without question. Location information within Virginia was not available at five eyries. The general location and survey status of the eyries is displayed in Figure 4.

The majority of the eyries are distributed along the mountains from northern to southwest portions of the state. Two sites are described as being coastal. The distribution of known eyries is not uniform within the mountains. A measurement of density, mean inter-eyrie distance, is 43.2 Km (n=13). Seven nests in the Shenandoah Park region average 18.9 Km apart. The apparent clumping of eyries in the National Park area probably reflects human observation patterns. Falconers, egg collectors, and birdwatchers were most active in searching for eyries. The Blue Ridge and Shenandoah areas are relatively close to human populations centers and have been utilized for nature watching and recreation much more than the mountains of southwest Virginia.

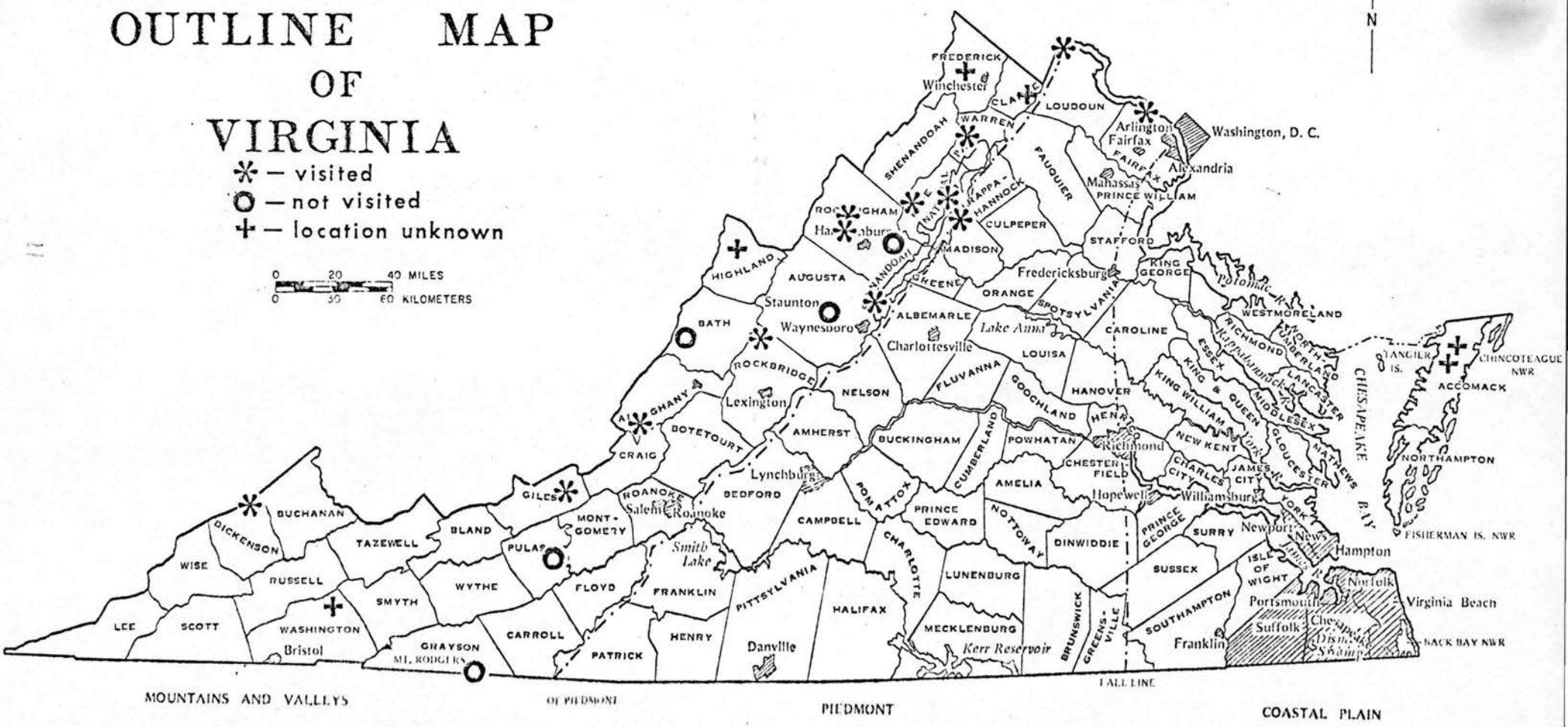

FIGURE 4. Location and Survey Status of Historic Eyries.

TABLE 3. Historical Activity and Reference Sources of Virginia Peregrine Eyries.

Site Name	Reference	Years Known Active
Harpers Ferry	Alva Nye (pers. comm.)	1930-1943
Great Falls	J. J. Hickey (notes); Alva Nye (pers. comm.)	1907-1939
Fort Valley	Alva Nye and Steve Grady (pers. comm.)	1955-1961
Old Rag	Alva Nye to Hickey	pre-1936
Staunton	W. A. Wimsatt to Hickey	1938-1939
Rip Rap	Alva Nye (pers. comm.)	1959-1960
Jump Mountain	J. J. Murray (1933), Alva Nye to Hickey	1933
Hot Springs	W. A. Wimsatt to Hickey	1940
Nichols Knob	W. F. Kent to Hickey	1934
Barneys Wall	J. J. Hickey notes	1941*
Radford	J. J. Murray (1952)	pre- 1933
Towers	D. Burger (pers. comm.)	1963 or 1964*
Stony Man	A. E. Granier (in litt.) to J. J. Hickey	1925
Independence	W. R. Spoffard to Hickey	1933
Dixon Ridge	F. M. Jones notes	1934-1936
Riven Rock	F. M. Jones notes	pre- 1934
Massanutten	Alva Nye (pers. comm.)	pre- 1938
Highland Co.	F. M. Jones to Hickey	1936
New Market	Sidney Sigwald (pers. comm.)	pre- 1950
Coastal #1	F. M. Jones (1946)	1926-1946
Coastal #2	F. M. Jones to Hickey	1926-1946
N. Virginia #1	F. M. Jones to Hickey	1930-1936
N. Virginia #2	F. M. Jones to Hickey	pre- 1939
Clinch Mountain	F. M. Jones (1933)	pre- 1933

* long term used implied

A "typical" peregrine eyrie can be fabricated using the mean values of characteristics thought to be relevant. This hypothetical eyrie is a vertical sedimentary rock outcrop with 1.7 faces. It is 2.8 m in height, 249.5 m in horizontal extent, 402.1 m from a flowing stream, faces southwest or northeast, and is 627.5 m above sea level. The data are summarized in Table 4. A summary page for each visited eyrie has also been compiled.

TABLE 4. Summary of Variable Values for Virginia Peregrine Eyries.

Variable	N	Mean and S.E.	Minimum	Maximum
altitude (m)	15	627.5 ± 85.5.0	18	1152
height of outcrop (m)	13	25.8 ± 5.6	8	73
extent of outcrop (m)	13	249.5 ± 135.9	8	1818
number of cliff faces	13	1.7 ± .24	1	3
distance to water (m)	15	402.1 ± 117.9	1	1360

TABLE 5. Bivariate Scattergram Correlations.

Variables	R	Significance Level
height vs. altitude	- .28658	.17124
extent	- .05647	.42731
number of faces	- .48583	.04617
distance to water	.15487	.30671
altitude vs. extent	- .48490	.04653
number of faces	- .07688	.40144
distance to water	.59775	.00930
extent vs. number of faces	.29955	.16004
distance to water	- .24639	.20855
number of faces vs. distance to water	- .27624	.18047

It is difficult to demonstrate meaningful or consistent interdependent relationships among the physical characteristics of the nest sites. Comparison of known nest sites with other "unused" cliff sites in Virginia was not attempted because it is unsafe to assume that any one cliff in Virginia was never utilized by peregrines. It is possible that peregrines used many more sites than is currently known. Table 5 illustrates bivariate scattergram correlation analysis of eyrie physical characteristics. Several significant relationships exist. Outcrop height is negatively correlated with the number of faces of the outcrop at the .05 level. The altitude of the site is negatively correlated (.05 level) with the horizontal extent of the outcrop and the altitude is positively correlated (.009 level) with the distance to a body of water.

The compass direction the eyries face was determined; data are displayed in Figure 5. Goodness of fit test verifies that the eyries are not uniformly distributed with respect to compass direction (.05 level). Visual inspection of the data reveals a strong tendency towards a bimodal distribution which is best seen by disregarding the 345 degree facing site. The eyries basically face southwest or northeast. Further statistical analysis, including a test for randomness, becomes meaningless because unimodal distribution is an assumption of circular distribution statistics.

The sites can be ranked according to height of cliff and proximity to suitable hunting areas. Harper's Ferry, Great Falls, Towers, and New Market display above median ranking in these respects. It is interesting to note that three of these four sites also display a longer than average history of known use (Table 3).

Cluster analysis is a program which plots items in "n" dimensional space according to characteristic values and measures the distance between the plotted items. The items can then be paired and grouped in order of similarity (Figure 6). The sites were grouped according to variables thought to be relevant in determining the usefulness of the site for hacking. The variables were altitude, vertical height of cliff, horizontal extent of cliff, distance to water, habitat surrounding site, distance to potential disturbance, and distance to nearest road. The variables were weighted equally. It is assumed that only the first several groupings are meaningful although significant levels cannot be determined. Three main groupings are formed by the seventh amalgamation. Great Falls, Harper's Ferry, and Towers are the terminal groupings. The lowest order groupings involve Riven Rock, Rip Rap, Stony Man, Nichols Knob, Old Rag, and Dixon Ridge, New Market, respectively.

The habitat surrounding most of the sites appears suitable to support horned owls (Bubo virginianus). Horned owls are widespread in range and breed in a variety of habitats (Bent, 1961). Fort Valley was the only site at which a horned owl was observed. Foul weather probably adversely affected vocal responses of owls to the taped calls which were played at the sites. It is possible that the higher altitude sites, Old Rag and Stony Man, are free of horned owl territories.

Hickey (1942) noted nine valid sites in Virginia. This study increased the number of known valid sites by fifteen. Assuming a fairly

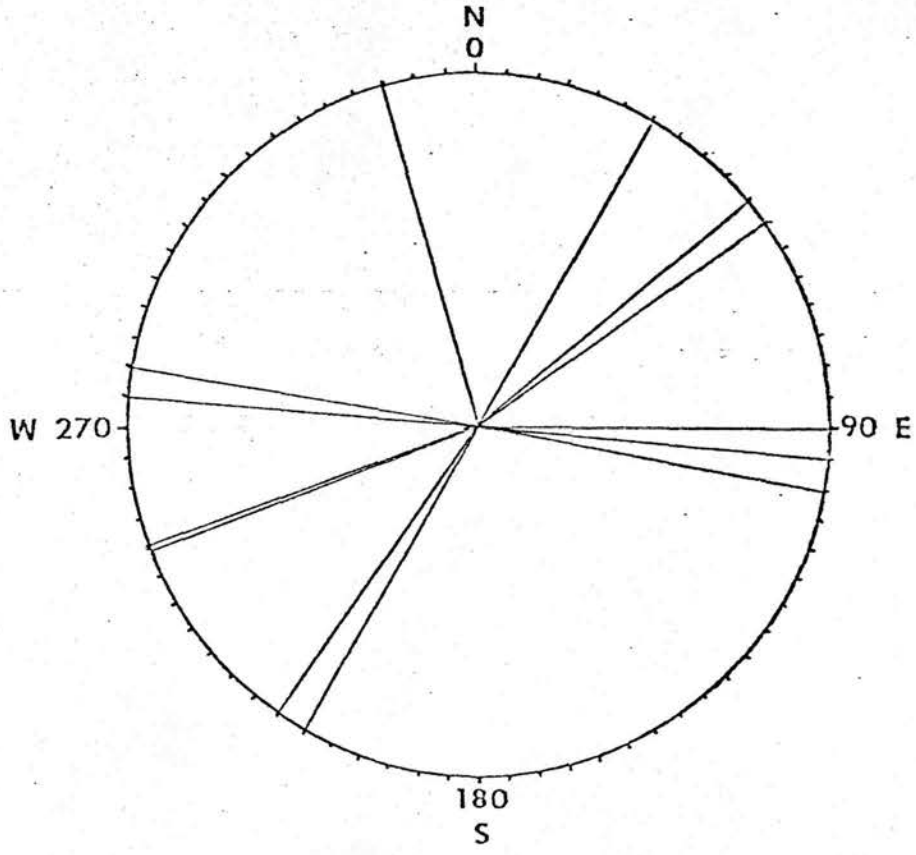

Figure 5. Compass Aspects of Historic Eyries.

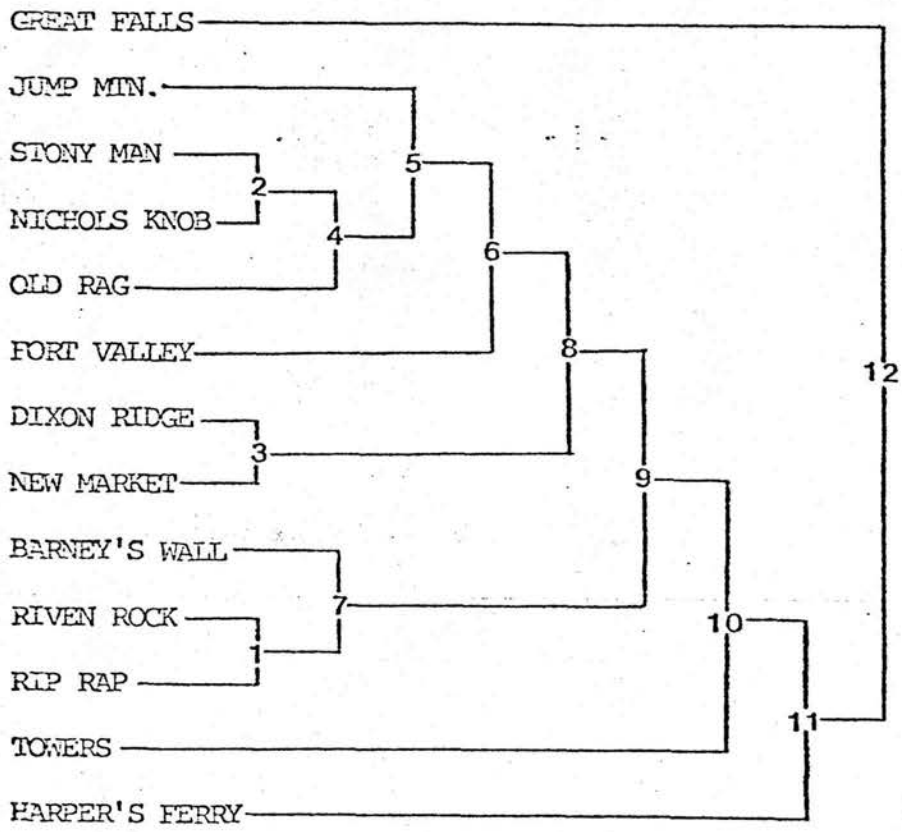

FIGURE 6. Cluster Analysis Showing Similarity in Physical Characteristics of Historical Eyries.

uniform distribution in suitable habitat, relatively few nest sites have been identified in the vast areas of mountainous terrain in southwest Virginia. This suggests that a number of eyries were never found. By rough extrapolation, it may be estimated that the number of breeding pairs present in Virginia before the decline to be between 30 and 45. The knowledge of peregrine eyries and their associated histories was much more complete in the northeastern U.S., i.e., New York, Massachusetts, and Pennsylvania. When considering the limited knowledge of peregrine numbers in the southern Appalachians, Hickey's 1942 estimate of the entire eastern population appears decidely conservative.

Inter-eyrie distance

The density of formerly nesting peregrines in Virginia appears to be low when compared with other areas. The highest density of known breeding peregrines was found by Beebe (1960) on the coast of the Queen Charlotte Island, British Columbia. Nest sites of twenty pairs averaged 1.6 km apart. In a two-year survey on the Colville River Alaska, Cade (1960) found inter-nest distances of 8 and 11 pairs averaged 11.2 - 15.4 km, respectively. Inland nesting sites of peregrines in Britain have varied from 4.8 - 10.3 km apart (Ratcliffe 1962). The greatest concentration of known eyries in Virginia, i.e., the Shenandoah National Park Region, displays a lower apparent density than reports from other areas and the apparent overall density in Virginia is markedly low. Although it is our opinion that many eyries were never found before the population crash, one must consider other factors. It is possible that the eastern U. S. has never comprised optimal habitat and, therefore, the peregrine population never reached high density. Pre-colonial eastern U. S. consisted mainly of homogeneous climax forest. The peregrine is generally associated with vast open areas, i.e., tundra, highland, seacoast, which are suited to the peregrine's style of hunting. Although the eastern woodlands produce abundant potential prey, a large proportion of that prey base could be regarded as inaccessible due to the dense forest cover. Studies of peregrine breeding density, habitat and associated prey abundance have not been attempted.

Evaluation for future use

The release of captive-produced peregrines near historical sites may lead to the reoccupation of those eyries (Eastern Recovery Plan). The hacked peregrines, upon return to their "natal areas" may be attracted to the former eyrie as a suitable nesting site. To be suitable as a hack site, a former eyrie must be free of human disturbance, yet accessible enough that logistic demands do not financially restrict maintenance operations.

The cluster analysis may be useful in making decisions concerning the use of historic eyries for hacking. Occasionally, the success of releasing peregrines depends on the characteristics of the site. The clustering groups together sites which are similar in relevant physical characteristics. If one former eyrie proves to be an outstanding hack site, probably another site similar to it would also prove to be a successful hack site. This analysis does not take into account certain factors such as attendant competence and financial considerations. The sites were rated as suitable or unsuitable for future releases (Table 6).

They also may be rated according to the proximity of potential disturbance. Two sites are regarded as unsatisfactory due to small (class 3) cliff face size. An important factor in eyrie use appears to be the proximity of civilized areas and the associated disturbance (Hickey 1942). Many of the former peregrine eyries in Virginia have become popular recreation areas for picnickers, rock climbers, hikers, etc. Several of the sites may be suitable if the human use patterns can be modified or restricted. Peregrines begin courtship and territorial defense at this latitude in March. Human use of the eyrie sites is usually at a minimum at that time of year with increasing use in later months. Because many sites with heavy human usage are located on National Park property, it may be possible to protect the eyrie by restricting human use. Ultimately, peregrine occupancy will demonstrate which sites are suitable for breeding. Annual surveys of accessible sites during March would probably reveal territorial birds. Upon the reoccupation of a site steps could then be taken to protect the eyrie from human disturbance.

TABLE 6. Suitability of Virginia eyries for release of captive produced peregrines.

Site	Suitable	Unsuitable	Major Concern
Harper's Ferry	X		human disturbance
Great Falls		X	human disturbance
Fort Valley	X		
Old Rag		X	human disturbance
Rip Rap		X	"class 3" site
Jump Mountain	X		
Nichols Knob	X		
Barney's Wall		X	human disturbance
Towers	X		
Stony Man	X		
Dixon Ridge		X	proximity to habitation
Riven Rock		X	"class 3" site
New Market		X	proximity to major road

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TARGET DATE FOR COMPLETION: June 30, 1983

STATUS OF PROGRESS: On Schedule

SIGNIFICANT DEVIATIONS IN PROGRESS: None

RECOMMENDATIONS:

COST THIS SEGMENT: Federal _____: State _____: Total _____

PREPARED BY: Mitchell A. Byrd

APPROVED BY: Jack W. Raybourne
Chief, Division of Game

DATE: August 1, 1983

R. H. Cross, Jr.
Executive Director