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Status of the Peregrine Falcon (*Falco peregrinus*) on the Virginia Barrier Islands

Mitchell A. Byrd, Department of Biology
College of William and Mary, Williamsburg, VA 23185

ABSTRACT

Reintroduction of peregrine falcons (*Falco peregrinus*) to the barrier islands and adjacent areas through the technique of hacking began in 1978. Since 1978, 110 falcons have been released at coastal sites with a successful fledging and dispersal rate of 83%. Population models are presented to predict the growth of this founding population of peregrines. Because of subsequent variation in one major parameter used in the model, number of released birds, the model only suggests a range of population size. The present number of known adult pairs of peregrines is ten, near the minimum level predicted in 1983 for 1988. Success of these breeding pairs appears adequate to sustain the population. Evaluation of the viability of this population can only be made in the future.

Key words: Endangered species, *Falco peregrinus*, peregrine falcon, reintroduction, Virgina barrier islands

INTRODUCTION

The peregrine falcon (*Falco peregrinus*) is essentially cosmopolitan in its distribution (Brown and Amadon, 1968). Three races have been described in North America (White, 1968a, 1968b): *F. p. pealei, F. p. tundrius* and *F. p. anatum*. *Falco p. pealei* is a large, dark, sedentary form inhabiting the island chains of the Pacific Northwest. *Falco p. tundrius* is a paler-colored, smaller, highly migratory form with a breeding distribution limited to the Nearctic tundra region. *Falco p. anatum* is a large, forest-inhabiting race that is variable in its migration behavior. Its range spans the continent, intergrading with *tundrius* to the north and limited to north-central Mexico in the south. Peregrines which habitually nested in Virginia were an *anatum* subpopulation referred to as the Appalachian peregrine, and the population was comprised of individuals larger and darker than the other subpopulations of the race (White, 1968b).

The existence of 24 historical peregrine eyries of this population in the Virginia Appalachians was listed by Hickey, (1942) and Alva Nye (pers. comm.). Nesting was documented at two additional sites on the coast (Jones, 1946). The Virginia population was thought to winter on the coast, including the barrier islands. In addition, the coast and barrier islands are on the primary migration route of the highly migratory tundra race (Brown and Amadon, 1968). The barrier islands, thus, historically, provided habitat for two different populations of peregrine falcons.

The population of peregrine falcons in the United States east of the Mississippi River was estimated to reach peak numbers of 350 breeding pairs (Hickey, 1942). The decline and eventual extirpation of the eastern peregrine was attributed to the

biological concentration of organochlorine pesticide residues such as DDT and related compounds (Peakall, 1976). The last nesting peregrine in Virginia was gone by the mid-1960's (Hickey, 1969).

In 1975, the U.S. Fish and Wildlife Service appointed an Eastern Peregrine Falcon Recovery Team to develop a Recovery Plan (Bollengier *et al.*, 1979) which detailed the actions necessary to restore the peregrine in the east and to protect historical sites. The Plan depends on establishing a new population of peregrines by introducing captive-produced falcons into the wild (Barclay and Cade, 1983). In 1970, the Division of Biological Sciences and the Laboratory of Ornithology at Cornell University established a captive breeding program to develop techniques for eventually providing a source of falcons for reintroduction into the vacant eastern breeding range (Cade, 1974). The first young peregrines were produced in 1973 and since 1976 more than 50 young have been raised each year (Cade and Fyfe, 1978). Captive propagation was successful enough by 1975 to begin reintroductions in that year (Cade, 1980). Breeding birds came from several races and geographic areas (Barclay and Cade, 1983). This paper deals with this effort to reintroduce falcons to Virginia as a breeding population rather than with either fall migrants or the small wintering population on the islands.

METHODS

Field Methods - The Cornell facility effort has been the source of all birds introduced to the barrier islands. Peregrines were released into the wild using a technique known as "hacking", a process modified from traditional falconry practice as described by Mitchell (1900, referenced in Barclay and Cade, 1983). Nine hack towers were constructed, of which eight remain: six are located on the barrier islands, one located on an island in southern Chesapeake Bay and one located at Back Bay National Wildlife Refuge (Figure 1). This technique consisted of placing broods of three to six young falcons approximately 28-30 days old in a protective hack box at the release site. Falcons were fed daily on either coturnix quail or chickens and released at approximately 40-45 days of age when they were capable of flight. Food was supplied at the hack box until the young falcons became independent and dispersed from the site. Further details on this technique may be found in (Cade and Temple, 1977) and Sherrod and Cade (1983).

Peregrines were first hacked in 1975 (Barclay and Cade, 1983). The hacking technique was designed for use at or near historic eyries with the expectation that when birds reached breeding age, they would return to nest (Bollengier *et al.*, 1979). Predation at historical cliff sites in New Hampshire and New York by great horned owls (*Bubo virginianus*) suggested that the number of peregrines dispersing normally would increase if releases occurred in habitats not usually frequented by that species. In Virginia, therefore, hack sites were established on coastal islands, Chesapeake Bay marsh islands, Back Bay National Wildlife Refuge, and one urban setting (a nine story rooftop in Norfolk, Va.) (Fig. 1). These locations provide open terrain for hunting, a suitable prey base, minimal human disturbance, and safety from predators (Barclay, 1980). These sites are relatively permanent and can be used as nest sites by returning birds.

All released peregrines were individually marked with numbered aluminum U.S. Fish and Wildlife Service bands. Auxiliary plastic bands with alpha-numeric

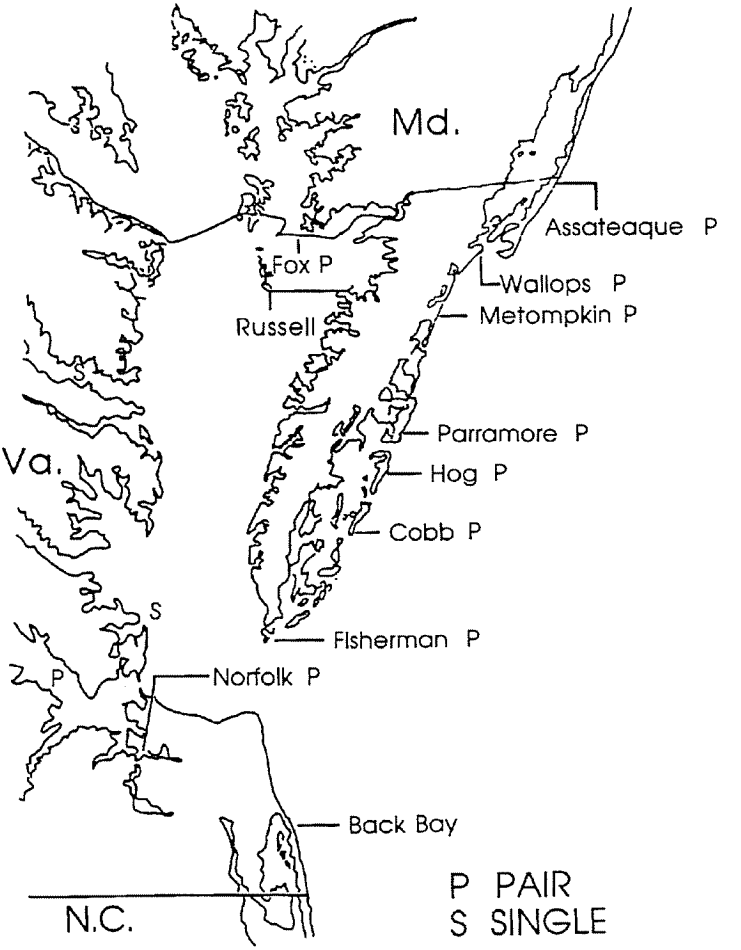

FIGURE 1. Named hach sites indicating pairs of peregrines at these and other sites, 1988. Established pairs of falcons (P) occured on 10 sites and established solitary adults (S) on 3 sites in 1988.

codes were also used, except in 1980 releases. Two birds released in 1979 carried tail mounted radio transmitters. As many banded, breeding adults as possible were trapped by use of harnessed pigeons in 1987 to determine age and origin of these birds.

Model - A stochastic model for population growth developed by Grier (1979) was used to assist in population estimates and to project results of the reintroduction program. The model simulates the growth of an existing or reintroduced population using known or assumed 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 model 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 annual breeding attempt,
5) mean number of young per successful breeding,
6) first year mortality rate,
7) mortality rate of third year and older animals,
8) limit (if any) on number of breeding pairs per year,
9) number (if any) and sex of first-year animals released per year, and,
10) number (if any) and sex of older animals released per year.

Simulation results include number of animals 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 are presented. The model does not, however, account for emigration and immigration of peregrines.

Other parameters included 60% first-year mortality and 20% subsequent annual 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). Means of 1.5 young per nesting attempt and 2.5 young per successful nesting attempt were used in the model. Several studies (Mebs, 1960 referenced in Barclay, 1980; 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 percent breeding success of all recorded attempts in the *F. p. pealei* population of Queen Charlotte Islands. The number of breeding pairs in coastal Virginia will probably be limited by the number of towers or other suitable nesting substrata 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 could be erected in the immediate future. It does not take into account other possible nesting substrata such as bridges or buildings. The number of pairs present in any simulation is defined by the number of the sex which is limiting in any given year.

RESULTS

Hacking Results - Sixteen releases of captive produced peregrines were made at six island sites (Table 1) from 1978-1985. Two additional releases were made in Norfolk in 1981 and 1982 and one release at Back Bay in 1982 (Table 2). A total of 110 birds was released at these 9 sites between 1978 and 1985.

Hacking success is measured by the percentage of released peregrines that become independent with respect to food and normally disperse from the hack site. For consistency, birds not seen after four weeks post-release are assumed independent unless individual evaluation or other evidence suggests otherwise. The success rate of peregrine releases from 1978-1985 in Virginia was 84 percent. The success and mortality by site and year appear in Tables 1 and 2.

Mortality and other losses incurred during hacking at 9 sites ranged from 0% to 71%. The greatest single loss of five young at Russell Island in 1985 was due to predation by a great horned owl. The losses of 3 young at Assateague Island in

TABLE 1. Fledging success of peregrine falcons released on the barrier and Chesapeake Bay islands, 1978-1985.

Year	Island Location	Number Released	Number Fledged	% of Young Fledged
1978	C obb	5	3	60
1979	Cobb	5	5	100
1980	Cobb	5	5	100
	Fisherman	5	3	60
1981	Assateague	6	3	50
	Great Fox	6	6	100
	Cobb	6	6	100
1982	Russell	6	6	100
	Great Fox	6	6	100
1983	Cobb	7	7	100
	Russell	7	7	100
	Great Fox	4	1	25
1984	Russell	6	6	100
	Cobb	5	5	100
	Parramore	7	7	100
1985	Russell	7	2	29
	TOTALS	93	78	84

1981 and three young at Great Fox Island in 1983 were due to harassment and killing by previously-hacked adult falcons.

The moderate pre-dispersal mortality of all Virginia releases ((17%) is probably due to several factors, namely, the choice of predator-free hack sites and the dedication of hack attendants. In several cases, young peregrines were rescued from predicaments that would have proven fatal if not for human intervention.

Only one peregrine shooting is known to have occurred in eastern Virginia since 1978. An unbanded individual (implying a wild peregrine) was found shot near Norfolk, Virginia. The possibility exists that more peregrines are being shot and not reported since it is an unlawful activity.

Population Estimation and Projection - Determining total population numbers of peregrines resident on the barrier islands or in Virginia, generally, is difficult due to the high mobility of the young birds and our inability to follow widely dispersed individuals throughout the year. Estimating the number of breeding-age adults is easier due to the tendency for these birds to remain territorial at suitable breeding sites, ie., hack towers and bridges. In 1988, 10 established adult pairs and three adult unpaired birds (2 males and one female) were known to exist in Virginia. The locations of adult pairs and singles are shown in Figure 1. Although two of the single birds comprised a hypothetical eleventh pair, the individuals occupied separate territories approximately 40 km apart. Both birds remained sedentary

TABLE 2. Fledging success of all eastern Virginia peregrine falcon releases.

Years	Location	Number Released	Number Fledged	% of Young Fledged
1978-1985	Barrier Islands	93	78	84
1980	Downtown Norfolk	6	5	83
1981	Downtown Norfolk	4	4	100
1982	Back Bay N.W.R.	7	7	100
	TOTALS	110	91	83

throughout the year making it improbable that they paired with each other. Each bird currently represents a potential pair at its respective site.

The stochastic model was used to project estimates of population site and to evaluate results of the reintroduction program (Fig. 2).

This model was based on the number of peregrines released through 1982 and assumed that nine first year male and nine first year female peregrines would be released per year to 1990. With a limitation on the number of breeding pairs in coastal Virginia (14), the model indicates a current population in Virginia of 33-48 peregrines (mean = 41.8) including 12-17 pairs (mean = 14.0). Yearly projected population numbers from 1978 to 1990 are presented in Table 3.

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 those circumstances was 18. This indicates that 18 nest sites would be needed by 1990 to allow the mean number of potential pairs to attempt breeding.

Figure 3 shows the simulated growth of a Virginia peregrine population which is subject to 50% hatch first-year mortality and 15% subsequent 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 percent and post-hatch year mortality by 25% in the growth simulations (Figs. 2 and 3) produces a significantly higher number of pairs and total birds present in the year 1990. The projected 1990 population estimate in the simulation is also significantly affected (Table 4). As noted earlier, studies of mortality by band recovery methods indicate that some peregrine populations may experience mortality rates as low as 55 percent (Shor, 1970) for first-year birds.

Peregrine Movements - Information was compiled from band recoveries on movements of 12 Virginia released peregrines and four peregrines released out of state and recovered in Virginia through 1982 (Table 5). Most of these records are due to trapping efforts of raptor banders. The movement of Virginia-released

TABLE 3. Population growth simulation A data. Sixty percent hatch-year and twenty percent after-hatch-year mortality was assumed. Pairs are defined by number of limiting sex.

Year	Birds released	Total birds present Simulations: 1	2	3	4	5	Mean	Range	Pairs present Simulations: 1	2	3	4	5	Mean	Range
1978	3	1	1	3	1	2	1.6	1-3	0	0	0	0	0	0.0	0-0
1979	5	2	5	5	1	4	3.4	1-5	0	0	1	0	1	0.8	0-1
1980	18	6	12	14	9	8	9.8	6-14	0	2	2	0	2	1.2	0-2
1981	19	15	17	16	11	14	14.6	11-17	0	4	4	2	3	2.6	0-4
1982	19	17	15	20	16	23	18.2	15-23	3	5	7	4	5	4.8	3-7
1983	18	29	21	22	18	29	23.8	18-29	5	5	8	7	10	7.0	5-10
1984	18	32	23	27	18	26	25.2	18-32	9	8	8	8	10	8.6	8-10
1985	18	38	27	31	22	36	30.8	22-38	13	6	11	7	10	9.4	6-13
1986	18	43	26	32	30	32	32.6	26.43	15	8	9	10	11	10.6	8-15
1987	18	40	30	43	38	35	37.2	30-43	13	10	11	12	12	11.6	10-13
1988	18	42	33	48	43	43	41.8	33-48	14	12	17	12	15	14.0	12-17
1989	18	36	36	55	45	52	44.8	36-55	14	7	21	15	17	14.8	7-21
1990	18	39	28	62	52	55	47.2	28-62	14	10	21	16	20	16.2	10-21

peregrines appears to be consistent with the wandering typical of juvenile birds. The longest movement to New York entailed 520 km over 11 months, in contrast to several birds that were captured a few months after release in the vicinity of their hack tower. Of the nine recoveries of Virginia peregrines, five were southerly, two were northerly, and two easterly. Any inland movements remain undetected with the possible exception of unidentified males on a building in Richmond from 1983-1986 and on a bridge on the Rappahannock River from 1986-1988.

During the breeding season of 1987, in collaboration with the Peregrine Fund, breeding adults were trapped at sites in Maryland, Virginia, and New Jersey to determine their origins. Twelve adults were captured which were breeding in Virginia or were of Virginia origin (Table 6). Five birds nesting in Virginia were of Virginia origin and three had immigrated from either Maryland or New Jersey. Four birds nesting in New Jersey had originated in Virginia. These limited data indicate a wide movement of birds, suggesting that the reestablished peregrine

TABLE 4. Comparison of simulated populations in 1982 and 1990 with 60/20 (Sim A) and 50/15 (Sim B) mortality rates.

	Simulation A (n=5)	Simulation B (n=5)	t(8)	P
1982				
Pairs present	4.8 ± 1.44	7.6 ± 4.30	2.95	0.05
Total birds present	18.2 ± 3.27	31.0 ± 5.15	4.69	0.01
1990				
Pairs present	16.2 ± 4.49	40 ± 4.30	8.56	0.001
Total birds present	47.2 ± 13.59	108 ± 5.12	9.46	0.001

population should be considered as a mid-Atlantic, and not as a Virginia, population.

Breeding Success and Population Viability - The first successful breeding attempt of peregrine falcons in Virginia for more than 20 years occurred at the Assateague Island hack tower in 1982. Both of these birds were banded and were considered to be hacked birds, although they were not trapped for identification. The number of known adult pairs each year since 1982 has grown with a total of 10 pairs in 1988 (Table 7).

DISCUSSION

Mortality - As observed in most avian groups, mortality of first-year peregrines is the highest of any age class. Estimates of first-year mortality rate of wild peregrines vary from 55% (Shor, 1970) to 80% (Mebs, 1960 referenced in Barclay, 1980). Barclay (1980) determined a 72 percent success rate of releases in the eastern U.S. from 1975 to 1979. First-year mortality of 70% is accepted for North American peregrine populations (Enderson, 1969). First-year mortality can be divided into pre- and post-dispersal periods. The post-dispersal period is commonly thought to be a more difficult time as it requires the young birds to hunt successfully. Post-dispersal young are also prone to encounter more hazards due to their increased range. Pre-dispersal birds, however, are subject to many dangers. The fledging, or first flight, is an important phase in avian development and tends to be hazardous. Injuries that occur due to lack of judgment or skill may doom a young peregrine. Data are lacking on the pre-dispersal mortality for wild peregrines, but estimates do exist for a congener with similar population dynamics. Prairie falcons (*Falco mexicanus*) in Idaho experience pre-dispersal mortality rates varying from 12-26% (Kochert, 1976; Peterson, 1976 referenced in Barclay, 1980). These figures are minimal estimates as every individual was not accounted for due to the lack of radio telemetry.

Biologists have much less control over post-dispersal mortality of released peregrines. Hunting is a behavior which can only be perfected through experience.

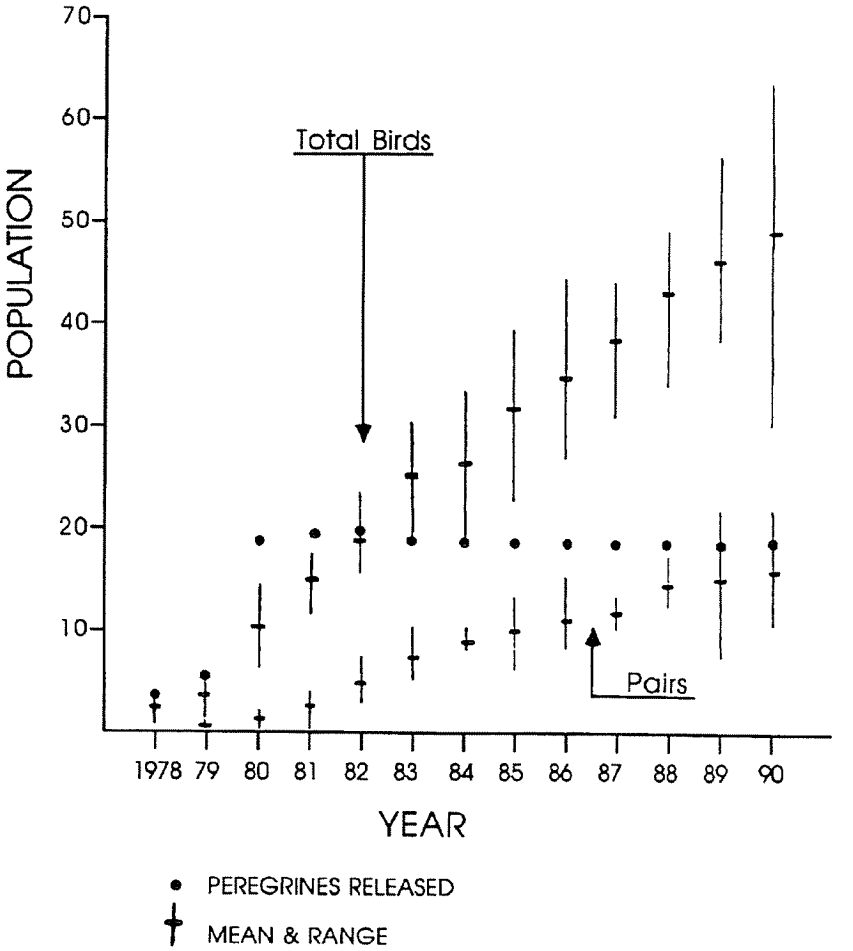

FIGURE 2. Projected growth of Virginia peregrine population assuming 60% hatch-year and 20% after-hatch-year mortality.

For this reason, food is made available to the released peregrines at the sites for up to six weeks post-release. Food reduction is also employed to further stimulate hunting without risking starvation. Hunting proficiency of hacked birds is possibly enhanced by the amount of practice each bird experiences. The high density of potential prey, especially migrating shorebirds, on the barrier islands of Virginia increases prey encounters.

Human persecution continues to be an important cause of post-dispersal mortality. Half of the band recoveries in earlier studies by (Enderson, 1969; Shor, 1970) were attributed to shooting. Peregrines released by hacking are unavoidably subject to human contact although techniques are used to minimize the chances of developing human-food relationships. Nevertheless, hacked peregrines sometimes seem less wary of humans than their wild counterparts. Coupled with the large amount of gunning which occurs in the Chesapeake Bay area, losses of peregrines to unscrupulous hunters is a distinct possibility.

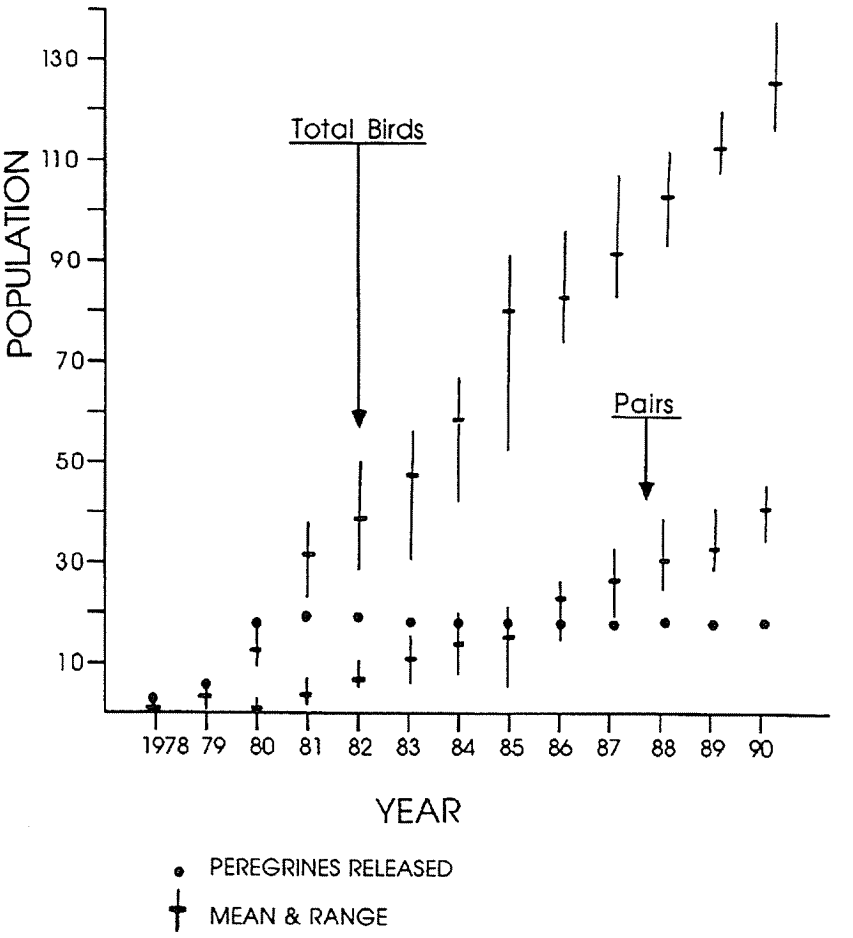

FIGURE 3. Projected growth of Virginia peregrine population assuming 50% hatch year and 15% after-hatch-year mortality.

After reviewing band recovery data, Barclay (1980) concluded that peregrines hacked in the eastern U.S. are not subject to heavier shooting pressure than wild peregrines. Evidence does exist that the amount of raptor shooting in Europe has decreased since 1949 (Newton, 1979) possibly due to a more conservation minded public and protective legislation.

Population Status - Analysis of survivorship tables shows that mortality rate affect population growth to varying degrees, partly dependent upon the age at maturity of the species. Populations of animals such as the bald eagle (*Haliaeetus leucocephalus*) which do not breed until their fourth year are extremely affected by slight changes in mortality rates. Peregrines generally do not breed successfully until their third year. The breeding attempts of subadult birds are usually included in reproductive figures. The relatively high frequency of unsuccessful breeding attempts reported (40%) is probably reflective of a high percentage of attempts by

TABLE 5. Recovery of individual peregrine falcons hacked in Virginia.

	Band number	Sex	Hack site/year	Recovery
	576-89280	M	Cobb/78	Trapped Fisherman 9/78
	576-89270	M	Cobb/78	Returned Cobb (seen) 5/79-7/79
	987-01322	F	Cobb/79	Trapped Sandy Hook, NJ 4/15/80
				Found dead Quogue, NY 4/24/80
	816-40327	M	Cobb/80	Returned Cobb (seen) 5/81-6/81
				Trapped Fisherman 10/5/81
	816-40322	M	Assateague/80	Trapped Assateague 9/24/80
	987-01343	F	Assateague/80	Trapped Assateague 9/24/80
				Trapped False Cape 10/1/80
				Trapped Assateague 10/8&10/13/80
	987-49509F	F	Great Fox/81	Trapped Assateague 9/18/81
	987-49507	F	Great Fox/81	Trapped Corolla, NC 9/30&1/19/81
	987-49533	F	Great Fox/82	Seen at Horntown, VA 7/18/82
*	987-01361	F	South Marsh, MD/80	Resident on Assateague 5/81-10/81
				Trapped Assateague 10/81
*	987-49559	F	South Marsh, MD/82	Trapped Wise Point, VA 9/25/82
**	987-49598	F	Assateague/82	Trapped Back Bay, VA 9/16/82
	987-49551	F	Great Fox/82	Trapped Cape May, NJ 9/18/82
*	987-49564	F	South Marsh, MD/82	Trapped Assateague 10/3/82
*	987-49577	F	Silver Lake, NY/82	Trapped Assateague 10/11/82

*Hacked outside Virginia; recovered in Virginia.
**Young of "natural" nesting in Virginia.

subadults. Survivorship tables do indicate that relatively small changes in mortality rates have profound effects on peregrine population growth (Young, 1969).

The above model allows one to determine whether populations, defined by certain parameters can be self-supportive. When no artificial release of animals occurs, natural reproduction must be sufficient to compensate for mortality or the population declines. Repeated simulations indicate that a peregrine population experiencing 60% hatch-year and 20% subsequent year mortality rates cannot be self-supportive at documented reproductive rates. This implies that stable wild populations which display these reproductive rates probably are subject to lower mortality rates than those calculated by band recovery studies. More study is needed accurately to determine breeding parameters of re-established peregrine falcon populations.

One of the parameters utilized in these models, the release of 18 peregrines per year until 1990, has not been realized. All releases on the barrier islands were terminated after 1985. Despite this, the currently known number of 10 adult pairs appears close to the lower limit of adult pairs as projected by the simulation A of the model (Table 3).

Movements - Virginia is within the wintering range of a migrant population of peregrines. Peregrines sighted from September through June, therefore, are pos-

TABLE 6. Location of breeding peregrine falcons in Virginia, or of Virginia origin, 1987.

Breeding Location	Sex	Hack site/year	Naturally hatched/year
Great Fox Island, VA	F	Cobb/81	
Cobb Island, VA	F	Cobb/83	
Parramore Island, VA	M		Chincoteague N.W.R./83
Metomkin Island,VA	F	Smith Island. Md./84	
Chincoteague, N. W. R., VA	M	Cobb/78	
Chincoteague, N. W. R., VA	F		Sea Isle, N.J./83
Hog Island, Va.	M	Parramore/84	
Fisherman Island, VA	M	Smith Island, Md./84	
Sedge Island, NJ	F	Russell/83	
Manahawkin, NJ	F	Parramore/84	
Brigantine, N. W. R., NJ	F		Chincoteague N,W.R./82
Tuckahoe, NJ	F	Russell/84	

sibly birds that are migrating or wintering and not released birds. Since the commencement of Virginia peregrine hacking in 1978, summer sightings have dramatically increased, attesting to the efficiency of hacking. Only banded peregrines can be identified as individuals and then only under excellent viewing conditions or when trapped. For this reason, most sightings are of unidentified peregrines. Peregrines seen between June 1 and August 15 or exhibiting breeding behavior may be safely assumed to be released birds or their progeny. Due to the Virginia recovery of several birds released in other states, resident birds in Virginia cannot be assumed to be Virginia releases. For population considerations, emigration and immigration were assumed to be equal.

Although young peregrines wander widely, the ultimate test of hacking success is the return to and establishment of, successfully breeding adults at the site of origin or at suitable sites in other areas.

Population Viability - The production of young by nesting peregrines in Virginia is consistent with or higher than the parameters utilized in the population model and higher than the eastern population in general (Gilroy, 1987). The model is a useful predictor of population growth. The known number of adult pairs appears to be near that predicted by the model, although there likely are unknown pairs which would increase the total.

Since releases are no longer planned for the coast, a fundamental question exists as to the viability of this population. At three barrier island sites in Virginia, there has been clear evidence of mate loss followed by rapid replacement of that individual. This also has occurred at other sites in the east (Marty Gilroy, pers. comm.), suggesting that there are surplus individuals available to enter the breeding population. In Virginia, reproduction appears adequate to provide replacements but as seen in Table 6, there is considerable movement involved.

TABLE 7. Breeding success of peregrine falcons in Virginia % Pairs

Year	Known Pairs	Pairs Attempting Nesting	Pairs Successful % Attempting Nesting	Which Attempted Nesting	Successful Which Att. Nesting	Young Produced	Young Fledged Per Nesting Attempt	Young Fledged Per Successful Nesting Attempt
1982	1	1	100	1	100	4.0	4.00	4.00
1983	2	1	50	1	50	4.0	4.00	4.00
1984	4	2	50	2	100	4.0	2.00	2.00
1985	7	2	29	2	100	7.0	3.50	3.50
1986	7	4	57	3	75	7.0	1.75	2.33
1987	9	5	56	4	80	14.0(1)	2.80	3.50
1988	10	5	50	4	80	16.0(2)	2.40	3.00
TOTALS	40	50	50	17	85	54	2.70	3.17

(1) Two young in captivity but included in calculations
(2) Four young died of disease, not included in calculations

An adequate evaluation of this population probably can be made only after several years in which no further artificial introduction of young has been made in the Mid-Atlantic region.

Management Considerations - It is essential that disturbance during the breeding season be minimized. Since most of the breeding pairs are located on the barrier islands, the future of those islands is critical. There are increasing pressures for human use of the islands. The extent to which this can be controlled is important to the continued success of peregrines in that habitat.

The most important limiting factor for breeding adults would appear to be adequate nesting sites. The original hack towers continue to be the most important sites on the coast. It is essential that they be repaired and well maintained in the future. New sites on unusual structures such as buildings and bridges must be identified and adequate management, such as nest box installation, implemented.

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