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Virginia Peregrine Falcon monitoring and management program: Year 2004 report

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COLLEGE OF WILLIAM AND MARY

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The Virginia Department of Game and Inland Fisheries
(Wildlife Diversity Program)
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Virginia Department of Transportation
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Front Cover: *Breeding female on James River Bridge. Photo by Bryan Watts.*

The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within today's social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

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EXECUTIVE SUMMARY

The Peregrine Falcon (*Falco peregrinus*) was believed to be extinct as a breeding species in Virginia by the mid-1960's. Intensive management efforts since the late 1970's have resulted in a known breeding population that is now approaching 20 pairs. However, all known breeding pairs currently nest on artificial structures and reproductive performance continues to be erratic. The primary objective of this program is to continue monitoring efforts to document population trends and to learn more about factors that may limit breeding success and survivorship. The ultimate goal is to develop management actions that will result in a population that is self-sustaining.

Fifty-four nesting structures were surveyed for falcons during the 2004 breeding season. Surveys resulted in the documentation of 19 occupied territories. Fifteen breeding attempts produced 27 chicks that were documented to survive beyond fledging (reproductive rate 1.5chicks/occupied territory). As in previous years, hatching rate continued to be relatively low. Of 14 clutches that were followed completely, only 39 of 53 (73.6%) eggs hatched. Of these 39 chicks, 27 (69.2%) fledged. It should be noted that much of the chick production resulted from management actions taken during the breeding season. Eleven (40.7%) of the 27 chicks known to fledge were the result of translocations. Many of these birds would most likely have been lost if left in place. Of the 6 chicks that were left on bridge sites, only 1 actually fledged from those structures. Translocation of chicks from bridge sites known to have a history of poor fledging success to mountain hack sites has improved chick survivorship and increased the potential for birds to re-colonize the historic mountain breeding range. This management practice should continue for the foreseeable future.

Although hatching rate has improved in the past 2 years compared to the previous several, the Virginia population continues to experience problems with hatching and chick mortality in the early stages of development. Eleven of 57 eggs produced did not hatch in 2004. Some of the eggs collected were cracked and thin-shelled. Addled eggs collected from the population in 1992 revealed DDE concentrations within ranges that have been shown to have adverse impacts on reproduction in previous studies. Sixteen addled eggs were collected during the 2001 and 2002 breeding seasons and examined by Kat Potter in Rob Hale's lab at the Virginia Institute of Marine Science. Analysis revealed detectable concentrations of many different compounds including DDE. A relationship between DDE concentrations and shell thickness was documented. The study identified an unusual congener pattern of polybrominated diphenyl ethers (PDBEs). This group of compounds is environmentally persistent and used widely as flame retardants. Continued monitoring of contaminant exposure within this population seems warranted. Eleven eggs collected during the 2004 breeding season will be transferred to Rob Hale's lab for potential analysis.

BACKGROUND

Context

The original population of peregrine falcons in the eastern United States was estimated to contain approximately 350 breeding pairs (Hickey 1942). From published records and accounts, there have been 24 historical Peregrine eyries documented in the Appalachians of Virginia (Gabler 1983). Two additional nesting sites were documented on old osprey nests along the Virginia portion of the Delmarva Peninsula (Jones 1946). Throughout the 1950's, and into the 1960's Peregrine Falcon populations throughout parts of Europe and North America experienced a precipitous decline (Hickey 1969). A survey of 133 historic eyries east of the Mississippi River in 1964 failed to find any active sites (Berger et al. 1969). The Peregrine Falcon was believed to be extinct in Virginia as a breeding species by the early 1960's.

As part of a national effort to restore the eastern Peregrine population, the Virginia Department of Game and Inland Fisheries, Cornell University, and the College of William and Mary initiated a hacking program for Virginia in 1978. The program involved the release of captive-reared Peregrines with the hope that these birds would re-colonize the historic breeding range. Between 1978 and 1993, approximately 250 young falcons were released in Virginia. Since the close of this program, captive-reared Peregrines have been released on a limited basis within the state. Such releases have involved more targeted projects. Beginning in 2000, wild-reared falcons have been translocated from coastal breeding sites to mountain release sites. Such movements have taken advantage of young produced from sites where fledging success is known to be poor.

The first successful nesting of Peregrines Falcons in Virginia after the DDT era occurred in 1982 on Assateague Island. Since that time, the breeding population has continued a slow but steady increase. The size of the known breeding population within the coastal plain has now exceeded 15 pairs. However, both hatching rate and chick survival remain somewhat erratic. An analysis by the U.S. Fish and Wildlife Service in the early 1990's of addled eggs collected in Virginia, showed levels of DDE, Dieldrin, and egg-shell thinning that have been shown previously to have an adverse impact on reproduction. An additional problem that has been suspected but not fully quantified is that the turnover rate of breeding adults appears to be high. At present, the long-term viability of the Virginia population in the absence of continued immigration from surrounding populations remains questionable. Continued monitoring and management of this population is needed to ensure that the population will continue to recover.

Objectives

The objectives of this project were 1) to track the recovery of the breeding population of Peregrine Falcons in Virginia (both in terms of the size and distribution of the breeding population and the number of young produced), 2) to evaluate the success of past and present management techniques used with the breeding population, 3) to improve

productivity of nesting pairs through active management, and 4) to increase our understanding of Peregrine Falcon natural history in the mid-Atlantic region.

METHODS

Geographic Focus

The geographic scope of this project was limited to the coastal plain of Virginia. Given the known number of breeding pairs of Peregrine Falcons in the mountains of surrounding states, it is highly likely that breeding pairs do exist on natural cliff sites within Virginia. However, none are currently known. No attempts to systematically survey these areas have been made since 1992.

Nest Site Surveys

Between 1977 and 2004 approximately 60 structures have been established specifically for breeding Peregrine Falcons within the coastal plain of Virginia (Table 1, Figure 1). Nearly all of the structures that survived to the 2002 breeding season were checked for evidence of resident falcons. An initial survey of breeding structures was conducted between 15 February and 30 March. All surveys of towers and boxes along the Delmarva Peninsula and fringe of the western shore were surveyed from the air using a Cessna 172, high-wing aircraft. Flybys were conducted at low altitude to flush attending adults and to view the inside of nest boxes for activity. The number of adults attending sites and/or activity within the nest box was recorded. Remaining sites on bridges or within urban areas were surveyed on the ground for occupation and activity. Sites that were confirmed to have Peregrine activity were monitored with 2-5 additional ground visits to document breeding activity and to band young. A breeding territory was considered to be “occupied” if a pair of adult Peregrines was resident during the breeding season. Nests were considered to be “active” if eggs or young were detected (Postupalsky 1974). Complete breeding information (i.e. clutch size, hatching rate) could not be obtained for a small portion of active sites due to poor access.

Elizabeth Long extracts chick from hollow beam 150 feet above the James River on the James River Bridge. Photos by Shawn Padgett.

Table 1. Catalog of nesting structures established for Peregrine Falcons in Virginia (1977-2004). Table gives year of establishment and whether or not the site was checked for Peregrine Falcon activity during the 2004 breeding season. Dashed lines indicate that the structure is no longer present.

Site Code	Location Description	Structure Type	Year Est.	Checked 2004
VA-PEFA-01	Fisherman's Island Tower	Peregrine Tower	1980	Y
VA-PEFA-02	Cobb Island Tower	Peregrine Tower	1978	Y
VA-PEFA-03	Hog Island Tower	Peregrine Tower	1977	Y
VA-PEFA-04	Paramore Island Tower	Peregrine Tower	1982	-----
VA-PEFA-05	Metomkin Island Tower	Peregrine Tower	1982	Y
VA-PEFA-06	Wallops Island Tower	Peregrine Tower	1981	Y
VA-PEFA-07	Chincoteague Tower	Peregrine Tower	1979	Y
VA-PEFA-08	Great Fox Island Tower	Peregrine Tower	1981	Y
VA-PEFA-09	Watts Island Tower	Peregrine Tower	1997	Y
VA-PEFA-10	Finney's Island Tower	Peregrine Tower	1997	Y
VA-PEFA-11	Tangier Island Water Tower	Nest Box	1999	-----
VA-PEFA-12	Hyslop Marsh Tower2T	Peregrine Tower	1995	Y
VA-PEFA-13	Saxis Marsh N. Tower	Peregrine Tower	1996	Y
VA-PEFA-14	Saxis Marsh S. Tower	Peregrine Tower	1998	Y
VA-PEFA-15	Parker Marsh Tower	Peregrine Tower	1997	Y
VA-PEFA-16	Elkins Marsh Chimney	Nest Box	1995	Y
VA-PEFA-17	Elkins Marsh Shack	Nest Box	1997	Y
VA-PEFA-18	Wachapreague Shack	Peregrine Tower	1994/2000	Y
VA-PEFA-19	James River Ghost Ship	Moth Ball Fleet	1987	Y
VA-PEFA-20	Coleman Bridge Box	Nest Box	1989	Y
VA-PEFA-21	Norfolk Southern RR Bridge	Bridge	1992	N
VA-PEFA-22	James River Bridge	Nest Box	1991	Y
VA-PEFA-23	Berkley Bridge	Nest Box	1996	Y
VA-PEFA-24	Benjamin Harrison Bridge	Nest Box	1996	Y
VA-PEFA-25	Mills Godwin Bridge	Nest Box	1996	Y
VA-PEFA-26	West Norfolk Bridge	Nest Box	1996	Y
VA-PEFA-27	Norris Bridge	Nest Box	1989	Y
VA-PEFA-28	Stoney Man, SNP	Natural Cliff Face	-----	Y
VA-PEFA-29	Old Rag, SNP	Natural Cliff Face	-----	Y
VA-PEFA-30	Back Bay tower	Peregrine Tower	1982	-----
VA-PEFA-31	Plum Tree Island tower	Peregrine Tower	1998	Y
VA-PEFA-32	Plum Tree Island box	Nest Box	1990	Y
VA-PEFA-33	Saxis Marsh W. tower	Peregrine Tower	1998	Y
VA-PEFA-34	Mockhorn Island tower	Peregrine Tower	1997	Y
VA-PEFA-35	Tangier Island tower	Peregrine Tower	2000	-----
VA-PEFA-36	Upsher Bay tower	Peregrine Tower	2000	Y

Table 1. –continued-

Site Code	Location Description	Structure Type	Year Est.	Checked 2004
VA-PEFA-37	Silver Beach Range Tower	Nest Box	1997	Y
VA-PEFA-38	Hawksbill Mountain	Natural Cliff Face	-----	Y
VA-PEFA-39	Concrete Ships	Nest Box	1995	Y
VA-PEFA-40	Chesapeake Substation	Nest Box	1998	Y
VA-PEFA-41	Holiday Inn VA Beach	Nest Box	1997	Y
VA-PEFA-42	Possum Point Substation	Nest Box	1998	Y
VA-PEFA-43	Newport News City Hall	Nest Box	1993	Y
VA-PEFA-44	Elizabeth River Substation	Nest Box	1998	Y
VA-PEFA-45	Cargill Grain Elevator	Nest Box	1993	Y
VA-PEFA-46	Lafayette Bridge	Nest Box	1998	Y
VA-PEFA-47	North Elkins Shack	Nest Box	1994	Y
VA-PEFA-48	Churchland Bridge	Nest Box	1999	Y
VA-PEFA-49	Yorktown Substation	Nest Box	1998	Y
VA-PEFA-50	Jordan Bridge	Nest Box	1995	Y
VA-PEFA-51	Campostella Bridge	Nest Box	1998	Y
VA-PEFA-52	I-64 Bridge	Nest Box	1999	Y
VA-PEFA-53	ALCOA Bridge	Nest Box	1999	Y
VA-PEFA-54	I-295 Bridge	Nest Box	2001	Y
VA-PEFA-55	Dominion Building	Nest Box	2000	Y
VA-PEFA-56	River Front Plaza	Nest Box	2002	Y
VA-PEFA-57	Bank of America Building	Nest Box	1984	Y
VA-PEFA-58	Russell Island	Peregrine Tower	1982	-----
VA-PEFA-59	Bermuda Hundred	Nest Box	1998	Y
VA-PEFA-60	Chesapeake Bay Bridge	Nest Box	2004	Y

Shawn Padgett with peregrine chick in basket of snooper truck. Photo by Bryan Watts.

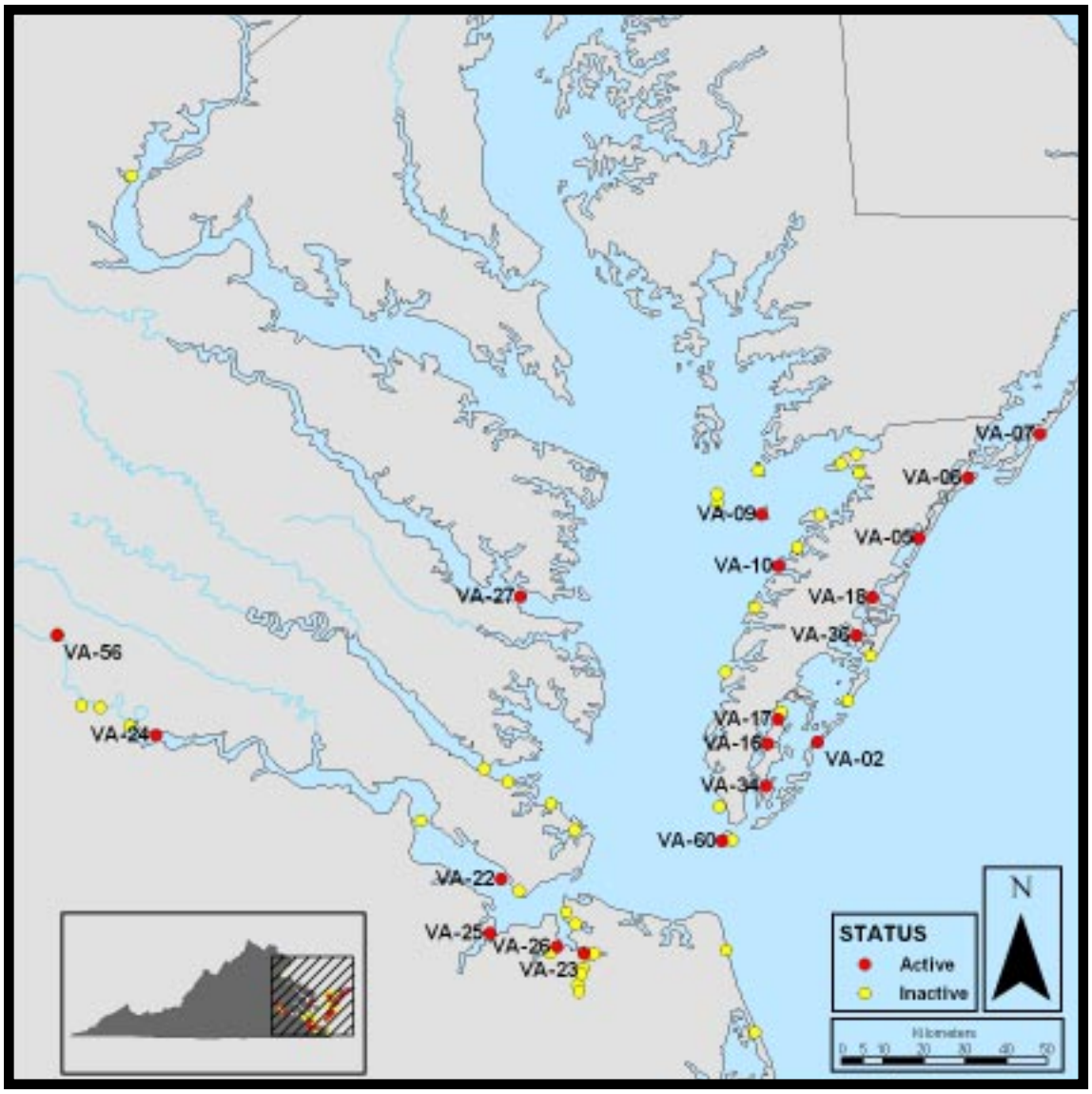

Figure 1. Map of coastal Virginia indicating the location of nesting structures established for Peregrine Falcons. Red circles indicate the location of structures occupied by resident pairs during the 2004 breeding season.

Banding

An attempt was made to band all chicks surviving to banding age (21-32 d). Chicks were banded with a USGS Bird Banding Laboratory aluminum tarsal band on the right leg and a bi-colored, green and black, alpha-numeric auxiliary band on the left leg. USGS bands used in Virginia during the 2004 breeding season were anodized green. 2003 breeding season were anodized green. Band size 6 and 7 were used for male and female chicks respectively. Auxiliary bands were applied with two pop rivets.

Chicks in nest box on the Benjamin Harrison Bridge. Photo by Bryan Watts.

Translocations

Over the past several years, some breeding sites on bridges have been known to experience low fledging rates. Observations indicate that losses occur during initial flight attempts or when chicks are near fledging age. Numerous chicks have been lost in the water during early flights when they are unable to fly back up to nest structures. Other chicks have flown down to the roadbed and been killed by automobiles. In order to improve survivorship for high-risk sites, a program was initiated to translocate bridge chicks to mountain release sites. Chicks are typically removed from nest sites, transported to mountain sites, and released using standard hacking techniques (Sherrod et al. 1981).

RESULTS

Site Surveys

Fifty-four nesting structures were surveyed for Peregrine Falcon activity during the breeding season (Table 1). Only one structure that is still standing was not surveyed and it is within the territory of a pair nesting on a nearby structure. Of the sites with known occupation, 19 supported resident pairs. These included 9 peregrine towers, 7 bridges, 2 shack remnants on the seaside of the Delmarva, and 1 high-rise building (Table 2).

Table 2. Summary of productivity results for Peregrine Falcon pairs in Virginia during the 2004 breeding season.

Site Code	Location Description	Occ Terr	Active Nest	Eggs	Chicks Hatched	Band Age	Fledg
PEFA-02	Cobb Island Tower	Y	Y	4	2	2	2
PEFA-05	Metomkin Island Tower	Y	Y	4	4	4	0
PEFA-06	Wallops Island Tower	Y	Y	4	1	0	0
PEFA-07	Chincoteague Tower	Y	Y	3	2	0	0
PEFA-09	Watts Island Tower	Y	N	-----	-----	-----	-----
PEFA-10	Finney's Island Tower	Y	Y	4	4	4	4
PEFA-16	Elkins Marsh Chimney	Y	N	-----	-----	-----	-----
PEFA-17	Elkins Marsh Shack	Y	Y	4	2	1	1
PEFA-18	Wachapreague Shack	Y	N	-----	-----	-----	-----
PEFA-22	James River Bridge	Y	Y	3	1	1	0
PEFA-23	Berkley Bridge	Y	Y	4	2	2	2
PEFA-24	Ben Harrison Bridge	Y	Y	4	4	4	2
PEFA-25	Mills Godwin Bridge	Y	Y	4	2	2	2
PEFA-26	West Norfolk Bridge	Y	N	-----	-----	-----	-----
PEFA-27	Norris Bridge	Y	Y	4	4	4	4
PEFA-34	Mockhorn Island tower	Y	Y	4	4	4	4
PEFA-36	Upsher Bay tower	Y	Y	3	3	3	3
PEFA-56	River Front Plaza	Y	Y	4	4	4	3
PEFA-60	Chesapeake Bay Bridge	Y	Y	4	2	2	?
Total		-----	-----	57	41	37	27-29

Breeding Results

Coastal Virginia supported 19 known breeding pairs of Peregrine Falcons during the 2003 breeding season (Figure 1). Four of these pairs were not documented to produce eggs such that there were only 15 active territories (Table 2). Pairs not making breeding attempts included the Wachapreague and west Norfolk pairs that seemed to form late in the season, the Watts Island pair that was lost early in the season, and the Elkins Chimney pair that has not produced eggs in many years. Remaining pairs produced 57 eggs, 41 of which hatched. Thirty-seven of these chicks survived to banding age and at least 27 were documented to fledge successfully. Fledging success was 1.5 chicks/occ terr and 1.9 chicks/act terr. It should be noted that much of the chick production resulted from management actions taken during the breeding season. Eleven (40.7%) of the 27 chicks known to fledge were the result of translocations. Many of these birds would most likely have been lost if left in place. Of the 6 chicks that were left on bridge sites, only 1 actually fledged from those structures. Two chicks were recovered under bridges and translocated to Shenandoah to be hacked and the remaining 3 chicks died during or just after fledging.

Compared to recent years, hatching rate within the Virginia population was higher but survival to fledging was lower. Of 14 clutches that were followed completely from laying to fledging, only 39 of 53 (73.6%) eggs hatched. Of these 39 chicks, 35 (89.7%) survived to banding age and 27 (69.2%) fledged successfully. Four chicks were lost during the pre-fledging period. Both chicks that hatched on the Chincoteague tower disappeared prior to banding age. There was no indication of cause. During a visit in June, a female was present at the tower site but the male was not observed. In early May, a 2-day old chick was found dead in the Wallops Island tower along with 2 addled eggs. The female was still brooding the chick. Also in early May, 2 chicks less than 1 week old were examined in the Elkins Marsh shack that exhibited neurological symptoms. These chicks were with 2 thin-shelled eggs and were not being cared for adequately by adults. The youngest chick died during the next 2 days and the older chick was fostered to the Chesapeake Bay Bridge and recovered.

Eight chicks were lost during or just after fledging. The entire 4-chick brood on the Metomkin Island tower was lost around the time of fledging. These birds appear to have been eaten by raccoons. Although the tower does have predator guards on the corner posts, raccoons may have gotten around the guards or the birds may have been blown off the tower and been taken on the ground. Both of the birds left on the Benjamin Harrison Bridge were lost around the time of fledging. One of the two birds disappeared near the time of fledging and the other was hit by a truck as flew near the roadbed and was lost in the river. The single bird left on the James River Bridge was observed flying around the bridge by VDOT operators but was lost within the first 2-3 wks post-fledging. One of the two bird remaining on the River Front Plaza building was killed at release when it flew into a nearby skyscraper.

Banding

All of the falcon chicks (N = 37) that survived to banding age were fitted with both FWS and alpha-numeric bands. This included 12 females and 25 males (Table 3).

Translocations

Eleven young falcons were moved to hack sites during the course of the 2004 breeding season (Table 4). This included 4 females and 7 males. Nine of these chicks originated on bridges that have a history of poor fledging success. The remaining 2 chicks were from an office building in Richmond. Eight of the translocated birds were hacked and released at Hawksbill in Shenandoah National Park and were tended by park staff. The remaining 3 birds were hacked at the Clover power substation near Danville and were tended by Dominion employees.

Table 3. List of band codes for peregrine falcon chicks banded in Virginia during 2004 breeding season.

FWS Band	A-N Band	Location	Date
Females			
987-51281	8/B	James River Bridge	5-18-04
987-51283	8/D	Benjamin Harrison Bridge	5-21-04
987-51284	8/E	Benjamin Harrison Bridge	5-21-04
987-51285	8/G	River Front Plaza	5-21-04
987-51286	8/H	Norris Bridge	6-04-04
987-51287	8/K	Mockhorn Tower	6-08-04
987-51288	8/M	Mockhorn Tower	6-08-04
987-51289	8/N	Berkley Bridge	6-13-04
987-51290	8/P	Metomkin Tower	6-15-04
987-51291	8/R	Finney's Island Tower	6-15-04
987-51292	8/S	Finney's Island Tower	6-15-04
987-51293	8/T	Cobb Island Tower	6-23-04
Males			
2206-43477	*2/*R	Benjamin Harrison Bridge	5-21-04
2206-43478	*2/*S	Benjamin Harrison Bridge	5-21-04
2206-43479	*2/*U	Mills Godwin Bridge	5-21-04
2206-43480	*2/*V	Mills Godwin Bridge	5-21-04
2206-43481	*2/*W	River Front Plaza	5-21-04
2206-43482	*2/*X	River Front Plaza	5-21-04
2206-43483	*2/*Y	River Front Plaza	5-21-04
2206-43484	*5/*A	Chesapeake Bay Bridge	6-01-04
2206-43485	*5/*B	Chesapeake Bay Bridge	6-01-04
2206-43486	*5/*C	Norris Bridge	6-04-04
2206-43487	*5/*D	Norris Bridge	6-04-04
2206-43488	*5/*E	Norris Bridge	6-04-04
2206-43489	*5/*H	Mockhorn Tower	6-08-04
2206-43490	*5/*K	Berkley Bridge	6-12-04
2206-43491	*5/*M	Upsher Bay Tower	6-15-04
2206-43492	*5/*P	Upsher Bay Tower	6-15-04
2206-43493	*5/*R	Upsher Bay Tower	6-15-04
2206-43494	*5/*S	Metomkin Tower	6-15-04
2206-43495	*5/*U	Metomkin Tower	6-15-04
2206-43496	*5/*V	Metomkin Tower	6-15-04
2206-43497	*5/*W	Finney's Island Tower	6-15-04
2206-43498	*5/*X	Cobb Island Tower	6-23-04

Table 4. Summary of translocation activities for Peregrine Falcons in Virginia during the 2004 breeding season.

FWS Band#	Hatch Site	Date Moved	Translocation Site
987-51284	Benjamin Harrison	5-21-04	Shenandoah National Park
2206-43478	Benjamin Harrison	5-21-04	Shenandoah National Park
987-51285	River Front Plaza	5-21-04	Shenandoah National Park
2206-43483	River Front Plaza	5-21-04	Shenandoah National Park
2206-43479	Mills Godwin Bridge	5-21-04	Shenandoah National Park
2206-43480	Mills Godwin Bridge	5-21-04	Shenandoah National Park
987-51286	Norris Bridge	6-12-04	Shenandoah National Park
987-51289	Berkley Bridge	6-21-04	Shenandoah National Park
2206-43486	Norris Bridge	6-04-04	Clover Substation
2206-43487	Norris Bridge	6-04-04	Clover Substation
2206-43488	Norris Bridge	6-04-04	Clover Substation

DISCUSSION

The breeding population of Peregrine Falcons in coastal Virginia increased to 19 pairs during the 2004 breeding season. The population included 18 pairs in 2003 and 17 pairs for the previous 5 years. Fledging rate was lower than in 2003 but still above the 1.25 young/pair suggested to be required to sustain a stable population.

In recent years, pairs nesting on bridges represent approximately 30% of the breeding population. Historically, fledging success from some of these bridges have been relatively poor. Chicks apparently have a difficult time negotiating the wind currents around these structures and frequently do not make it back to the aeries during early flight attempts. These birds often end up in the water or on the road bed below. Translocation of chicks from these locations to mountain hack sites has increased fledging success and potentially could result in some re-colonization of their historic mountain range. In 2004 approximately 40% of productivity resulted from the translocation of birds from these high-risk sites to hack sites. Only 1 of 6 birds that were left on bridges fledged successfully. Whenever opportunities allow, the translocation program should continue to take advantage of chick production that would otherwise be lost. Observations during the hacking operation at Hawksbill suggest that a breeding pair may be forming there in the short term suggesting that future translocations should begin to focus on other potential locations.

Although hatching rate has improved in the past 2 years compared to the previous several, the Virginia population continues to experience problems with hatching and chick mortality in the early stages of development. Eleven of 57 eggs produced did not hatch in 2004. Some of the eggs collected were cracked and thin-shelled. The single chick hatched on the Wallops Island tower died in the first 2 days post-hatching and the 2 eggs collected appeared to be thin-shelled. The 2 chicks that hatched on the Elkins shack exhibited signs of neurological problems. The youngest of these chicks died in the first week post-hatching. A direct connection between these and other events within the population and environmental contaminants has not been established though contaminants have been detected within addled eggs.

Addled eggs collected from the population in 1992 (Morse 1993) revealed DDE concentrations within ranges that have been shown to have adverse impacts on reproduction in previous studies (Wiemeyer et al. 1986). Egg-shell thinning ranged up to 26.9%, a level above the reported 14% to 17% range that has been documented to result in egg failure (Peakall and Kiff 1988). Sixteen addled eggs were collected during the 2001 and 2002 breeding seasons and examined by Kat Potter in Rob Hale's lab at the Virginia Institute of Marine Science (Potter 2004). Analysis revealed detectable concentrations of many different compounds including DDE. A relationship between DDE concentrations and shell thickness was documented. The study identified an unusual congener pattern of polybrominated diphenyl ethers (PDBEs). This group of compounds is environmentally persistent and used widely as flame retardants. Continued monitoring of contaminant exposure within this population seems warranted. Eleven eggs collected during the 2004 breeding season will be transferred to Rob Hale's lab for potential analysis.

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LITERATURE CITED

Berger, D. D., C. R. Sindelar, Jr., and K. E. Gamble. 1969. The status of breeding peregrines in the eastern United States, in J. J. Hickey ed., *Peregrine Falcon Populations: Their Biology and Decline*. University of Wisconsin Press. Madison, Wisconsin. Pp. 165-173.

Gabler, J. K. 1983. The peregrine falcon in Virginia: Survey of historic eyries and reintroduction effort. Unpublished masters thesis, College of William and Mary, Williamsburg, VA 81 pp.

Hickey, J. J. 1942. Eastern population of the Duck Hawk. Auk 59:176-204.

Hickey, J. J., Ed. 1969. *Peregrine Falcon Populations: Their Biology and Decline*. University of Wisconsin Press. Madison, Wisconsin.

Jones, F. M. 1946. Duck Hawks of eastern Virginia. Auk 63:592.

Morse, N. J. 1993. Contaminants in Peregrine Falcon (*Falco peregrinus*) eggs from Virginia, Maryland, and West Virginia. U.S. Fish and Wildlife Service report. irginia Field Office, White Marsh, VA.

Peakall, D. B., an dL. F. Kiff. 1988. DDE contamination in Peregrines and American Kestrels and its effect on reproduction. In T. J. Cade, J. H. Enderson, C. G. Thelander, C. M. White, Eds. Peregrine falcon populations: their management and recovery. The Peregrine Fund Inc., Boise ID.

Postupalsky, S. 1974. Raptor reproductive success: some problems with methods, criteria and terminology. Raptor Research Report 2:21-31.

Potter, K. 2004. Polybrominated dephenyl ether flame retardants in peregrine falcon eggs from coastal Virginia and Maryland. Undergraduate Honors Thesis. College of William and Mary, Williamsburg, VA 87 pp.

Sherrod, S. K., W. R. Heinrich, W. A. Burnham, J. H. Barclay, and T. J. Cade. 1981. Hacking: A method for releasing peregrine falcons and other birds of prey. The Peregrine Fund, Inc. 62 pp.

Watts, B. D., S. M. Padgett, M. A. Byrd, B. J. Paxton, and Jeffrey L. Cooper. 2002. FALCONTRAK: Year 2001 report. Center for Conservation Biology Technical Report Series. CCBTR-02-06. College of William and Mary, Williamsburg, VA. 46pp.

Wiemeyer, S. N., R. D. Porter, G. L. Hensler, and J. R. Maestrelli. 1986. DDE, DDT and dieldrin: residues in American Kestrels and relations to reproduction. U.S. Department of Interior, Fish and Wildlife Service Technical Report 6. Washington, D. C..