REPRODUCTIVE SUCCESS OF OSPREY (PANDION HALIAETUS) NESTING IN THE VICINITY OF THE CHALK POINT OIL SPILL

Final Report
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Introduction

On April 7, 2000, approximately 126,000 gallons of a mixture of #2 and #6 fuel oil were released from a break in a pipeline providing fuel to the Chalk Point Generating Station. The pipeline was owned by the Potomac Electric Power Company (PEPCO) and operated by Support Terminal Services Operating Partnership, LP (ST Services). The spill initially leaked into a Spartina spp. dominated brackish wetland located in Swanson Creek, a tidal tributary of the Patuxent River. The marsh covers approximately 45 acres adjacent to the PEPCO Chalk Point facility. Extensive oiling of the wetlands within Swanson Creek took place during the first two days of the spill. On April 8, high winds, rain, and tides resulted in the oil being blown over containment booms and into the Patuxent River and its tributaries. The spill spread approximately 17 linear miles downstream in the Patuxent River and into several downstream tributaries, including Indian Creek, Trent Hall Creek, Washington Creek, and Cremona Creek, oiling approximately 40 miles of shoreline (Figure 1). In addition, water quality surveys indicated concentrations of petroleum products remained elevated above background levels in the Patuxent River for approximately 2-3 weeks following the spill (unpublished data). Shoreline clean-up activities, particularly in the most heavily impacted areas (e.g., Swanson Creek), continued through the summer and fall.

Primary habitats impacted during the spill were wetlands, sandy beaches and associated open water areas. Several avian species that are dependent on aquatic habitats were nesting in the area at the time of the spill, including ospreys (*Pandion haliaetus*), federally threatened bald eagles (*Haliaeetus leucocephalus*), and great blue herons (*Ardea herodias*). The foraging strategies of these species and willingness to enter water and wetlands make them susceptible to oiling. Several oiled ospreys and great blue herons were observed by wildlife survey teams during the response effort. One of the concerns of the Natural Resource Trustees for the Chalk Point Oil was the potential effects of the oil spill on the reproductive success of these avian species. To this end, the objective of the present study was to evaluate the potential effects of the oil spill on the nesting success of ospreys. Other reports describe results of monitoring the nesting success of bald eagles and great blue herons.

Study Organism and Susceptibility to Oiling

The osprey is one of the largest raptor species found within the Patuxent River region and at least 127 nesting pairs were documented along the river and its tributaries in 2000 (Steve Cardano, unpublished data). Ospreys are the only North American hawk species to feed almost exclusively on fish (Robbins and Blom 1996, Henny 1986, Reese, 1992). Demersal fish species inhabiting shallow waters, or deep water species frequenting surface waters, are most often taken by ospreys (Vana-Miller 1987). The foraging strategy of ospreys is to plunge feet first into the water and capture fish with their talons. In addition, Henny (in Palmer 1988) reports that ospreys bathe by plunge diving into the water. These behaviors make ospreys highly susceptible to oiling. During the first week of the Chalk Point spill, an osprey survey team composed of personnel from PEPCO and the Nanjemoy Creek Environmental Education Center observed ten oiled adult ospreys nesting within the spill zone. In addition, nesting materials in three nests associated with oiled adults were also observed to be oiled.

Oil spills can have direct or indirect impacts on nesting birds. Adults that become oiled may transfer the oil from their plumage to their eggs during incubation. Refined oil may be highly toxic to avian embryos depending on the species; stage of embryonic development; and type, weathering, and dose of oil. Small quantities of oil on eggs can lead to embryo mortality, or cause deformities, especially during the early incubation phase (Albers 1991, 1995, Hoopes et al. 1994). Studies have shown that as little as 1-20 uL of some types of oil can have lethal effects on developing embryos (Parnell et al. 1984, Hoffman 1990). Louisiana heron (Hydranassa tricolor) eggs treated with 10 uL of weathered crude oil had a reduced hatchability of 17% (Macko and King 1980).

Habitat changes resulting from the extensive oiling of the tidal wetlands of Swanson Creek and other similar tributaries within the spill zone, may have reduced or contaminated prey species. Several studies have reported reproductive effects on avian species due to dietary exposure to petroleum-derived products (Coon and Dieter 1981, Ainley, et al. 1981). In addition, because ospreys require relatively clear, unobstructed water for successful foraging, any disturbance, natural (e.g., sedimentation and ripples caused by wind) or anthropogenic (e.g., oil sheens), that impacts the water's surface may contribute to reduced prey visibility, and therefore reduced foraging success (Vana-Miller 1987, Poole 1989). During the Chalk Point spill, extensive sheening was observed throughout the middle Patuxent River region.

Finally, human disturbances may also affect the reproductive success of ospreys. Nests exposed to human disturbances during the early phase of the nesting season have a higher likelihood of failure than non-disturbed nests (Vana-Miller 1987, Henny 1986). In addition, Swenson (1979) found that nests located in areas with minimal human disturbance have an increased likelihood of failure if disturbed suddenly during the later part of the nesting season. Increased boating and shoreline cleanup crew activities associated with the Chalk Point spill are examples of human disturbances that could have adversely affected osprey nesting success and productivity.

Historical Population Surveys

Data collection for determining osprey nesting success on the Patuxent River has been ongoing

since William Montgomery and Calvert Posey started surveying the population in 1973. The survey was initiated as a result of published reports from around the Chesapeake Bay and Mid-Atlantic region stating that ospreys were reproducing below normal levels, a result of exposure to DDT (Hoffman et al. 1995). In 1976, the Patuxent survey was taken over by the lead author of this report. Through the 1970s, osprey nests were examined at one to two week intervals. Each active nest was recorded using Postupalsky's (1977) definition of an active nest, that is, the presence of eggs. Eggs were assumed to be in a nest if the female was low in the nest in the incubation position. From 1981 to1999 the nests were surveyed only once, at the end of June, when the chicks were approximately one to two weeks away from fledging.

In the late 1970s and 1980s, it was apparent that ospreys were enjoying a considerable recovery from the effects of DDT. The Patuxent osprey population grew from 22 active nests in 1973 to over 100 nests in 1994. The focus of the survey had evolved from examining the effects of pesticides on the population to brood size reduction due to shortage of forage species. Food habits range considerably throughout this area. Menhaden (*Brevoortia tyrannus*) are the dominant food source in the more saline regions of the river while gizzard shad (*Alosa sapidissima*), catfish (*Ictalurus spp*.) American eel (*Anguilla rostrata*), and others make up the diet in the fresher zones of the river. In order to examine the effects, if any, of food supply on the nesting ospreys, the Patuxent River population was divided into three regions: an upper, middle and lower section. These sections are based on salinity regimes, and therefore, fish populations. The upper section is considered tidal fresh (>0.5 ppt), and extends from Cocktown Creek/ Kings Landing to Western Branch (Figure 2a). The middle section is oligohaline (0.5 to 5.0 ppt) to low mesohaline (5.0 to 10ppt) and extends from Deep Landing to Broomes Island (Figure 2b), an area encompassing the majority of the spill zone (Figure1). The lower section is high mesohaline (10 to 15 ppt) and extends from Broomes Island, south to Drum Point (Figure 2c). These historical population surveys provided an excellent baseline for comparing the results of the present study.

Methods

The methodology for this assessment was developed cooperatively by the Wildlife Injury Workgroup for the Chalk Point Oil Spill Natural Resource Damage Assessment consisting of personnel from PEPCO, U.S. Fish and Wildlife Service (USFWS), the Maryland Department of Natural Resources, the U.S. Geological Survey's Patuxent Wildlife Research Center and the Nanjemoy Creek Environmental Education Center (NCEEC) and is described in the Wildlife Injury Assessment Workplan for the Chalk Point Oil Spill (October 2000). The National Oceanic and Atmospheric Administration and the Maryland Department of the Environment also provided input to the assessment plan. In general, the approach was to monitor nests in the spill zone on a regular basis until fledging. To be consistent with the earlier surveys, the population was divided into the upper, middle and lower regions of the Patuxent River as described above. For comparative purposes, we assumed that ospreys nesting in the upper region of the river were not affected by the oil spill. This assumption is based on the distance of the spill site from the upper section and the expected foraging range of ospreys. The demarcation of the upper section is approximately 6 kilometers (4 miles) upstream of Swanson Creek. According to Clark (1995)

osprey foraging distances range from 2-5 kilometers (1.2 - 3.1 miles), but they will travel farther when food sources are scarce. Considering the abundance of fish within the Patuxent River system, the foraging range of Patuxent River ospreys is probably at the low to moderate end of that range. Based on this assumption, ospreys nesting in the upstream region were probably not foraging in areas impacted by the spill.

Nest Surveys

Osprey nests in the middle section were examined weekly or biweekly, beginning on April 11, 2000 by personnel from PEPCO, NCEEC, and the Maryland National Capitol Parks and Planning Commission (MNCPPC). Regular monitoring of nests in the upper section was initiated in mid-May and nests in the lower section of the river were visited only once. During each visit, the number of eggs and/or young per nest were noted and recorded. Counts were accomplished by visual examination from a boat or using a mirror attached to a pole using methods similar to those used by Reese (1977) and Woodford et al. (1998). Monitoring was conducted through the end of June when the young began to fledge from the nest. In addition to the reproductive parameters that were recorded during each site visit, nests, adults and nestlings were also inspected for oiling. Active, but inaccessible nests, that is those nests that could not be reached for close inspection and banding, were recorded as "IA". Nest surveys were conducted on days when weather conditions, most notably winds, were favorable. The locations of all nests were recorded on navigational charts.

Addled eggs were collected during the survey and archived in the event that petroleum hydrocarbon analysis was deemed necessary. Eggs were determined to be addled based on two criteria. First, the eggs had failed to hatch and the other nestlings in the same nest were two weeks of age or older. Second, when the failed egg was shaken gently, the contents felt liquefied. The egg was collected, wrapped in aluminum foil and sealed in a glass jar. The date and location of each egg was recorded on the aluminum foil. The jar was placed in a cooler and then placed in a freezer when the survey team returned to the PEPCO laboratory. All addled egg samples are presently in the custody of the USFWS Chesapeake Bay Field Office.

Trapping Oiled Adults

Ospreys that were determined to be moderately oiled were trapped, cleaned and returned to the nest. Ospreys were deemed moderately oiled when their entire underside, from legs to neck, were darkened by contact with oil. Typically, the feathers of adult males and females are white on the undersides. The females usually have a brown mottling or "necklace" across the chest that varies in intensity with individuals. The males may have some to no brown mottling across the chest. Since there is variation in the appearance of the brown necklace, careful observations were made to determine the extent, if any, of oil discoloration in these birds, especially females. Sexing ospreys also involves noting size (when comparable) and coloration on the dorsal side. The dorsal or backside of males is blackish and darker than a female’s.

Osprey were trapped using a modified "noose carpet". The trap was made of ½ inch square hardware cloth fashioned into a very shallow cone shape about 0.75 m in diameter. The cone shape provides strength and prevents contact with the eggs. Two fishing corks were attached to one edge to keep the trap from sinking if it became detached from the osprey. Approximately 200 nooses made from monofilament fishing line were attached to the cone. After flushing the adult off the nest, the trap was placed in an inverted position over the eggs. When the adult returned to the nest, its feet became entangled in the monofilament nooses. When the bird attempts to fly from the nest, the weight of the noose carpet carries it into the water and prevents it from escaping. The trapped osprey was then retrieved from the water by the survey team.

After being captured, the osprey (Figure 3) were transferred to waiting wildlife rehabilitation personnel for cleanup and release. If a female was captured, the male would return to the nest to assume incubating duties. In the case that both ospreys needed to be caught, the male was caught in the same manner as the female. The eggs from nests in which both adults were captured were either placed in foster nests or given to wildlife rehabilitation personnel and placed in incubators. Collected eggs were replaced on the nest just prior to the release of the adults. In an effort to minimize stress to oiled adult ospreys, all trapping occurred when the wind was calm and clear skies and mild temperatures prevented the chilling of exposed eggs. Where possible, oiled sticks and vegetation found in nests were removed.

Data Analyses

The data were summarized as follows: the number of active nests (total, accessible, with known outcomes); total eggs laid; percentage hatching; total young fledged; mean number of young fledged per active nest; total number of successful nests (those that fledged at least one nestling); and the mean number of young per successful nest.

Nest success, defined in this study as at least one nestling successfully fledging per nest, of ospreys in the middle section of the river (spill impacted area) was compared to that in the upper section (unimpacted) in 2000 using the Mayfield method (Mayfield 1961, Mayfield 1975, Bart and Robson 1982). This analysis estimates a daily survival rate for nests in each section and controls the bias which may exist due to nests which failed before the collection of data began. Nests in the lower section of the river were not visited more than once and therefore daily survival rate could not be estimated for this section of the river. Program Mayfield, written by J.E. Hines (http://www.mbr. pwrc.usgs.gov:80/software.html) was used to perform the analysis specified in Bart and Robson (1982) to calculate the daily nest survival rates. Program Contrast (Hines and Sauer 1989) was used to compare the daily nest survival rates between the two river sections. Daily survival rates were estimated for both the egg and nestling stages.

Loglinear models (Stokes et al. 1997) were used to compare the number of active nests and number of young per active nest (productivity) among years and among the three sections of the river. In essence, this analysis is similar to an analysis of variance, but is more appropriate for evaluating “count” data (Jeff Hatfield, personal communication). This analysis was performed for the complete set of data (1973-2000, excluding 1993 and 1998 because the lower river was

not surveyed then) and also just for 1999-2000. A value of 0.01 was substituted for cell combinations in which a zero count of nests was obtained. Nests with 3 or 4 chicks were combined into one category of 3 or more chicks, because of the small number of nests with 4 chicks.

Results

During the nest survey, a total 127 active nests were identified, 103 of which had a known outcome, that is the fate of the nestlings through fledging was known (Table 1). In a few instances, nestlings had not yet fledged at the time monitoring was terminated; for these nests the outcome was unknown.

A summary of the nesting data from the lower, middle (spill area) and upper river sections are presented in Table 1 (Details in Appendices A and B). The lower section recorded 41 active nests, 31 were accessible with a known outcome. Fifty-eight active nests were located in the middle section where the oil spill occurred, 44 were accessible with a known outcome. Five of the inaccessible nests (with no known outcome) were located on the PEPCO property. An independent survey conducted in August 2000 indicated that all the nests located on PEPCO property had been abandoned (Ann Wearmouth, personal communication). Survey of upper section nests located 28 active nests, two nests were inaccessible, but the fate of all nestlings was able to be determined (i.e., 28 nests with a known outcome). The upper region of the Patuxent osprey population was not directly affected by oil from the spill.

In the lower section, 22 (71%) of the 31 active nests with a known outcome successfully fledged at least one young, with an average of 1.55 young per active nest (Table 1). The average number of young per successful nest was 2.18. In the middle section, 33 (75%) of the 44 active nests with a known outcome successfully fledged at least one young, with an average of 1.50 young per active nest. The average number of young per successful nest was 2.00. In the upper section, 24 (86%) of the 28 active nests with known outcomes successfully fledged at least one young, with an average of 1.79 young per active nest. The average number of young per successful nest was 2.08.

Affected Nests

Eleven nests located within the middle section of the river were determined to be directly affected by the oil spill as evidenced by discoloration or oiling of adults or eggs, the presence of oiled nesting materials or proximity to high shoreline activity (Table 2). Seven (64%) of the 11 nests successfully fledged at least one young, for an average of 0.91 young per nest. The average number of young per successful affected nest was 1.43 (Table 2).

Ten adult osprey were observed to be oiled, four of these were successfully trapped. The four captured birds (two pairs) were given to wildlife rehabilitation experts for heath evaluations, appropriate cleanup, and rehabilitation. One pair and their eggs were successfully returned to the nest and subsequently raised two young. The other pair was displaced at the nest site by new

osprey and driven away. Several days later, the female of that pair was found dead near Persimmon Creek. The cause of death is unknown. A total of 6 addled eggs were collected and archived.

Nest Success

The daily survival rates for the egg stage were 0.9708 and 0.9891, respectively for upper and middle sections of the river, and 0.9963 and 0.9968, respectively for the upper and middle section nests in the nestling stage. There was no significant difference in nest success between the upper and middle sections of the river for either the egg stage (P=0.5192) or the nestling stage (P=0.8498) (Table 3).

Nest Productivity

For purposes of evaluating potential impacts of the oil spill on osprey production, what is of interest in the loglinear analysis are the interaction terms. Statistically significant interactions would indicate differences in the number of chicks (i.e., productivity) among years (chick*year), river sections (chick*section) or both (chick*year*section). Results indicated no statistically significant relationships ($p > 0.05$) between the number of chicks and the other variables, for the entire period 1973-2000 or for 1999-2000 (Table 4). The significance of the "chick" term in the 1999-2000 interval indicates there are statistical differences in the number of young per nest when averaged across both year and river section. There was a significant effect of time ("year", $p=0.0025$) in the data from 1973 - 2000, implying a trend over time in the number of active osprey nests during this period (Figure 4). The lack of significance ($p=0.7466$) of this term in 1999-2000 implies no difference in the number of active osprey nests between these two years (Table 4). There were highly significant effects of river section over both time periods ($p<0.0001$ for 1973-2000, $p=0.0096$ for 1999-2000) indicating differences in the number of active osprey nests among the three sections of the river (Table 4). Finally, there was no significant interaction between time ("year") and section ($p= 0.8279$ for 1973-2000, $p=0.3543$ for 1999-2000) , suggesting that trends over time in the three sections of the river were similar over the period of the analysis (Table 4).

Discussion

Results of the monitoring study suggested that there were no detectable population-level impacts on the reproductive success of the ospreys nesting in the Patuxent River as a result of the April 7, 2000 Chalk Point oil spill. The mean of 1.50 young fledged per active nest in the middle section was similar to the 25 year average of 1.51 for the river (Cardano, unpublished data) and exceeded values determined to maintain a stable population. Henny and Wight (1969) determined that 0.95-1.30 young were required to fledge per nest in order to maintain a stable breeding population. In 2000, and most other years of the Patuxent study (except 1976, 1978, and 1989), ospreys have met or exceeded this average (Figure 5).

Comparison of nesting success between the middle and upper sections of the river in 2000 via the Mayfield method indicated no significant statistical differences in daily survival rates in the egg stage or nestling stage. In addition, results of log-linear analysis indicated that there were no significant differences in the productivity between the years 1999-2000 and in the previous years (1973-1999) of the study.

There is evidence that individual nests may have been adversely affected by the oil spill and associated clean-up activities. Of the ten ospreys that were observed to be discolored due to oil contact, two pairs of adults were trapped, cleaned, and released. One of those pair and their eggs were successfully returned to the nest and subsequently raised two young. The other pair was displaced at the nest site by new osprey and driven away. The female of this pair was later found dead, with the cause of death unknown. The new pair continued to incubate one of the three original eggs, which failed to hatch. The six other ospreys that were observed to be discolored by oil were not trapped for cleaning because of weather conditions, lack of eggs, or degree of discoloration. Three of those ospreys had preened the oil from their feathers and were noticeably cleaner by the end of the nesting season.

A total of 10 young fledged from the 11 monitored nests directly affected by the oil or clean-up activities for an average of 0.91 young per nest (Table 2). The average number of young per successful oiled nests was 1.43. These values are lower than the averages calculated for the population in the middle section of the river, which were 1.50 young per active nest and 2.0 young per successful nest, respectively. It was suspected that nest failure in one of the oiled nests could be due to its proximity to the oil spill cleanup efforts. The activity of workers near the nest may have kept the female away for long enough periods to cause the eggs to become cooled. Human disturbances near an active nest site in the early stages of incubation have been implicated in nest failure (Vana-Miller, 1987; Henny 1986). In addition, there were five active nests observed on PEPCO property that were inaccessible and not included in this study (Appendix A). An in-house survey conducted by PEPCO in the third week of August 2000 indicated all nests on PEPCO property had been abandoned (Ann Wearmouth, formerly of PEPCO, personal communication). Although osprey in Chesapeake Bay may naturally abandon the nest by the second week of August (Chuck Henny, U.S. Geological Survey, Biological Resources Division, personal communication), in the absence of monitoring or anecdotal information pertaining to these nests, we assumed these nests were abandoned before producing young. Abandonment of the nests was probably due to the high incidence of human activity that took place near those nests.

Because of the evidence suggesting localized effects of the oil spill on individual nests, we estimated the number of young lost from these nests in the following way. The number of affected nests was estimated to be 16 (11 that were monitored plus 5 nests on PEPCO property that were abandoned). The average number of young produced by unaffected nests was 1.70 (56 young/ 33 unaffected active nests in the middle section). This estimate is different than the average young produced in the middle section of the river (1.50) because the data from the 11 affected nests were deleted from the calculation. The expected number of young produced by affected nests was 27.2 (i.e., 16 nests * 1.70 young/nest). The observed number of young

produced in affected nests (10) was then subtracted, for a loss of approximately 17 osprey young.

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Figure 1. Extent of shoreline oiling resulting from the Chalk Point Oil spill.

Figure 2a. Map of upper Patuxent River region in which active osprey nests (n=28) were monitored for reproductive success during the PEPCO-Chalk Point oil spill in April, 2000.

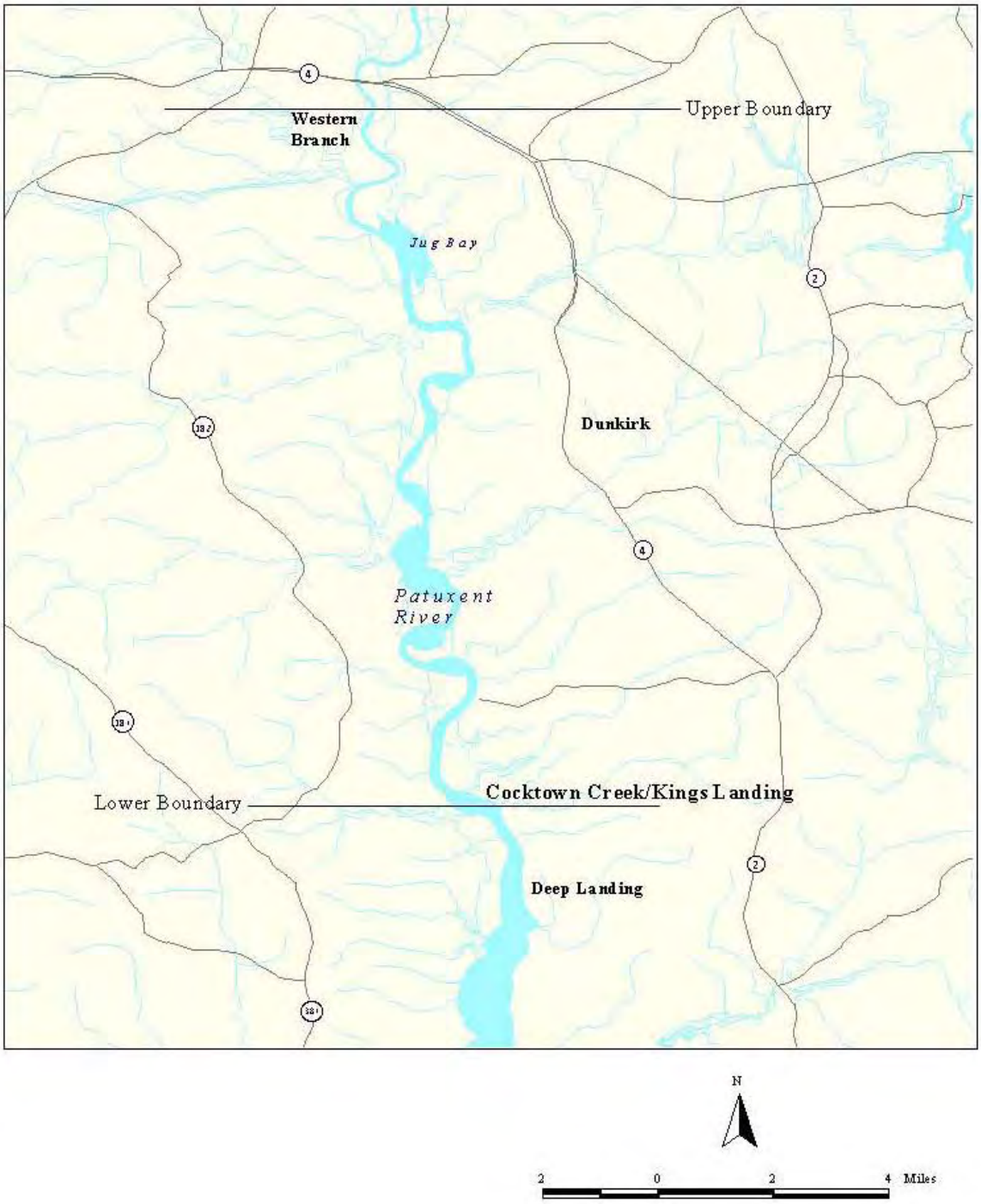

Figure 2b. Map of middle Patuxent River region in which active osprey nests (n=58) were monitored for reproductive success during the PEPCO-Chalk Point oil spill in April, 2000.

Figure 2c. Map of lower Patuxent River region in which active osprey nests (n=41) were monitored for reproductive success during the PEPCO-Chalk Point oil spill in April, 2000.

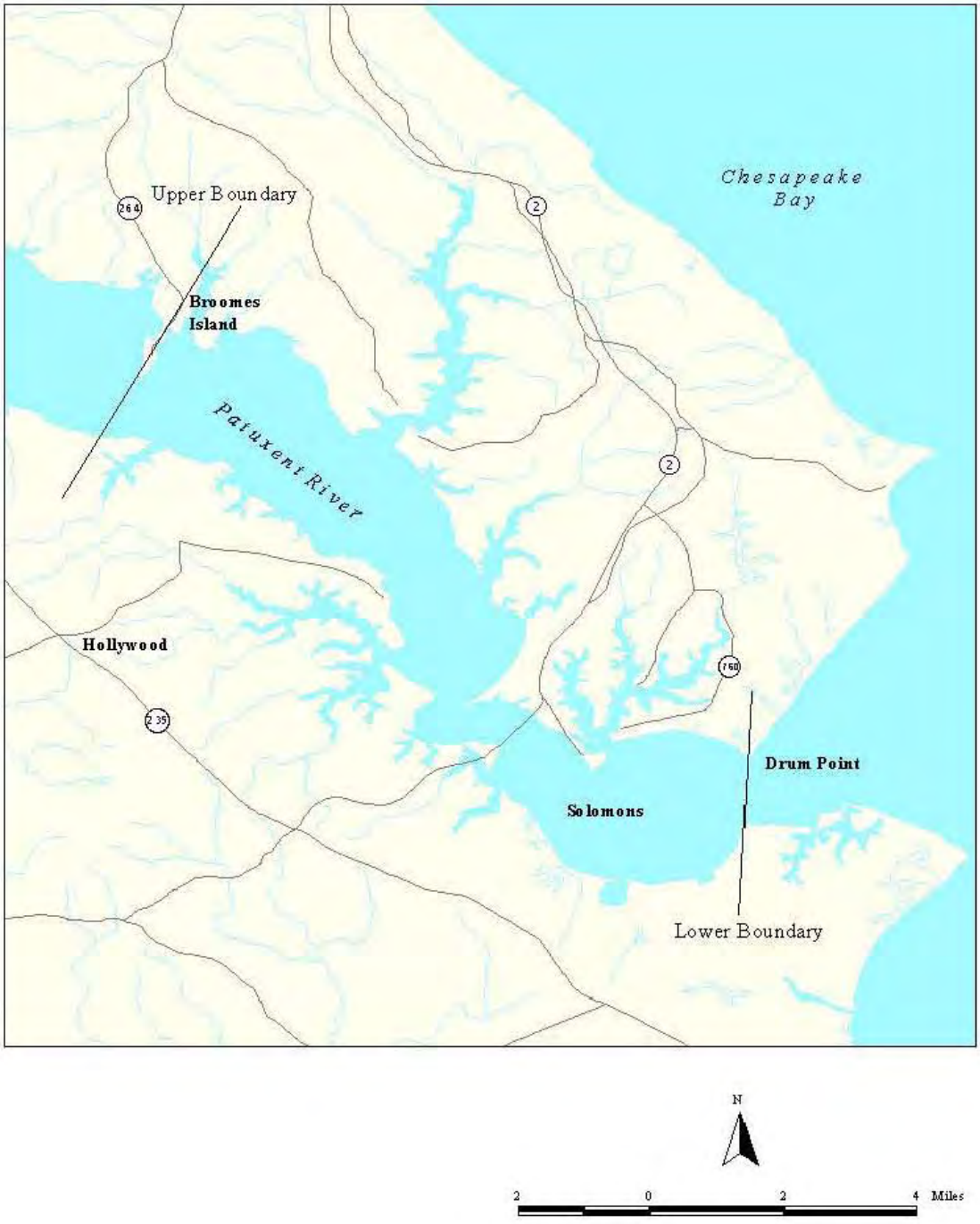

Figure 3. Moderately oiled male adult osprey captured for cleaning and rehabilitation during the PEPCO, Chalk Point oil spill in April 2000.

Table 1. Summary of reproductive measurements used to calculate nesting success for Patuxent River ospreys in 2000.

Reproductive Measurement	Lower Section	Middle Section	Upper Section	All Sections
Total active nests	41	58	28	127
Total accessible nests	33	44	26	103
Total active nests w/ known outcome	31	44	28	103
Total eggs laid	nd	118	nd	nd
% Hatching	nd	70 (83)	nd	nd
Total young fledged	48	66	50	164
Ave. young fledged per active nest w/ known outcome	1.55	1.50	1.79	1.59
Total number successful nests	22 (71%)	33 (75%)	24 (86%)	79 (77%)
Ave. young per successful nest	2.18	2.00	2.08	2.08

nd = no data. Regular monitoring in the upper and lower sections did not begin until the majority of eggs had hatched.

Table 2. Number of young osprey fledged in nests that were: oiled and /or had adults that were oiled; eggs that appeared abnormal; or were located in areas with high shoreline activity.

Nest #	Location	Comments	Outcome
4	ONP Chalk Point	adults oiled/cleaned and released	fledged 2
5	Pylon "A" Chalk Point	oiled vegetation/male oiled legs to head	fledged 2
6	Pylon "B" Chalk Point	oiled veg./oiled adults trapped&cleaned/pair replaced/female found dead	fledged 0
7	Pylon "C" Chalk Point	eggs found to be darker than normal	fledged 1
10	ONP s Hunting Creek	female oiled on chest and neck	fledged 2
23	ONP Buena Vista	two eggs discolored a muddy gray	fledged 1
27	ONP Indian Creek	oiled veg. in nest/ high clean-up activity/ one egg muddy-gray	fledged 1
29	Chan. Mrk. #25 Teague Pt.	female with oil on legs/ one egg discolored muddy-gray	fledged 0
30	Chan. Mrk. #23 Long Pt.	adults lightly oiled/ eggs darker brown than normal	fledged 0
32	ONP Persimmon Creek	high clean-up activity along shoreline	fledged 0
52	old pilings at Sandy Point	female oiled/ collected two addled eggs	fledged 1

Note: ONP = On Nesting Platform

Table 3. Mayfield estimates of nest success for the upper and middle regions of the Patuxent River in 2000 and results of statistical comparisons of survival rates.

Region of River	Daily survival rate during egg stage	Survival rate to hatching[a] (A)	Daily survival rate during nestling stage	Survival rate to fledging[b] (B)	Nest Success (AxB)[C]
Upper	0.9708	0.3148	0.9963	0.8216	0.2586
Middle	0.9891	0.6522	0.9968	0.8438	0.5503
P-value	-	0.5192	-	0.8498	-

[a] Calculated as daily survival rate to the 39th power accounting for a 3-day laying period and a 36-day incubation period.

[b] Calculated as daily survival rate to the 53rd power accounting for a 53 day fledging period.

[C] Defined as probability of an egg surviving to the fledging stage.

Table 4. Chi-square statistics, degrees of freedom (df), and p-values for terms in the loglinear models (significant terms are in bold).

TERM	**SURVEY YEARS**					
	1973-2000			**1999-2000**		
	$\chi 2$	df	P-value	$\chi 2$	df	P-value
Chick	1.78	3	0.6193	19.90	3	**0.0002**
Year	49.42	25	**0.0025**	0.10	1	0.7466
Chick*Year	38.82	75	0.9998	0.42	3	0.9357
Section	28.22	2	**<0.0001**	9.29	2	**0.0096**
Chick*Section	0.89	6	0.9894	1.95	6	0.9240
Year*Section	40.54	50	0.8279	2.07	2	0.3543
Chick*Year* Section	128.02	150	0.9029	7.80	6	0.2531

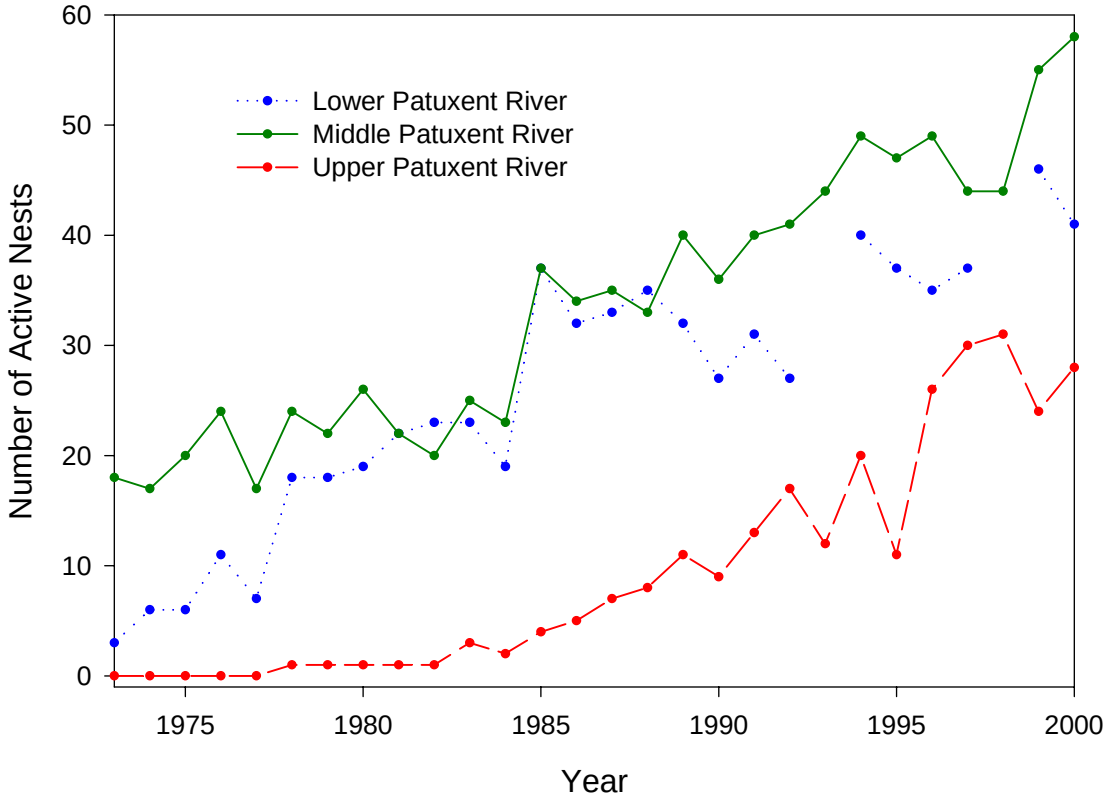

Figure 4. Number of active osprey nests in the three sections of the Patuxent River, 1973 - 2000.

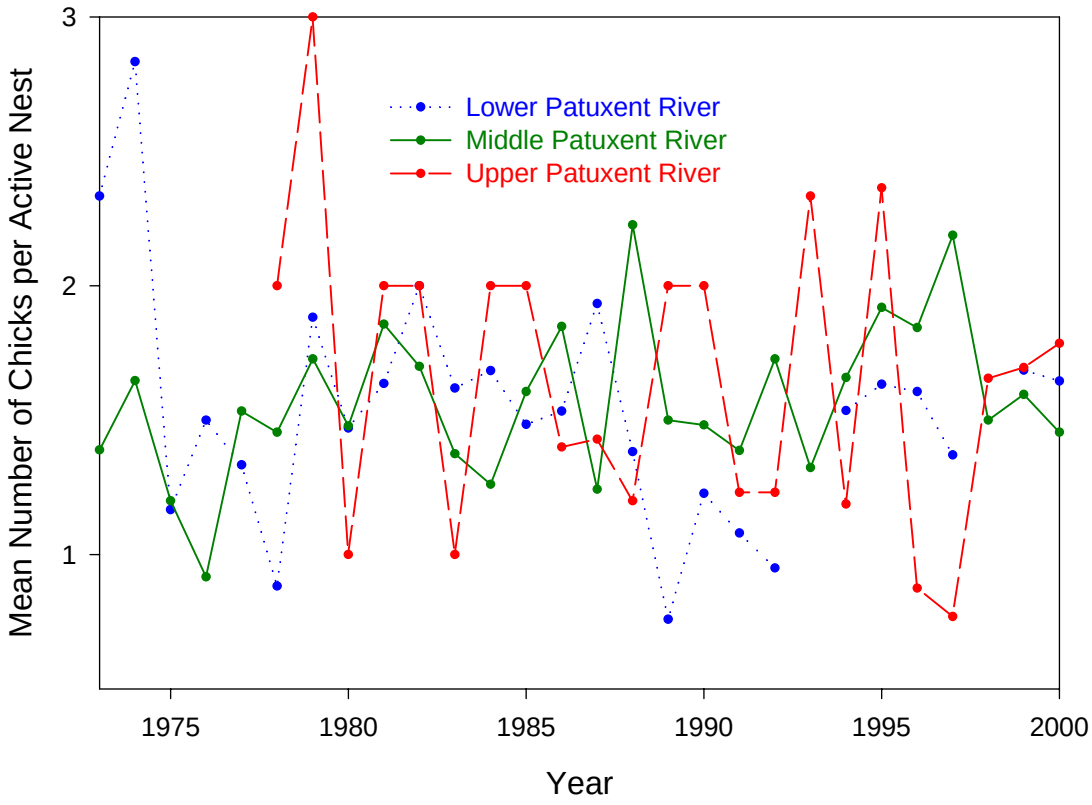

Figure 5. Mean productivity of active osprey nests in the upper, middle, and lower sections of the Patuxent River, 1973-2000.

Appendix A. Summary of osprey nest survey data collected in 2000 for the upper, middle, and lower Patuxent River regions (e= egg, y=young;F=female, M=male; IA=Inaccessible).

Nest #	Substrate	Location	Apr 11	Apr 19	Apr 20	May 7	May 19	May 26	Jun 8	Jun 29	Remarks
1	pilings	Centerspan Rt. 231 Br.	1		2	2	2y	2y	2y	2y	1 banded
2	ONP	w end Rt. 231 Br.	2		3	3	2y 1e	3y	3y	2y	1 banded
3	ONP	Teague Point	3		3	1e 2y	empty				young predated?
4	ONP	Chalk Point	3		3	2e 1y	2y 1e	2y	2y	2y	oiled adults cleaned/released
5	pylon A	Chalk Point	3		3	1e 2y	3y	2y	2y	2y	1y found dead 5/26;M mod. oiled
6	pylon B	Chalk Point	3		3	1	1	2	empty		oiled adults cleaned/pair replaced
7	pylon C	Chalk Point	3		3	3	2y 1e	2y	2y	1y	too old to band
8	pylon D	Chalk Point	3		3	3	3y	3y	3y	3y	3 banded
9	pylon	on land - Calvert Side									IA
10	ONP	s entrance Hunting Cr.	3		3	3y	2y	2y	2y	2y	2 y banded 06-08-00;F light oiled
11	ONP	@ entrance Hunting Cr.	3		3	3	3y	3y	2y	2y	2 banded
12	ONP	inside Hunting Cr.	1		3	3	2y	1y	1y	1y	1 banded
13	boathouse	e Eagle Harbor									IA
14	chnl. mk.	# 32 Trueman Pt.			3	3	1y 2e	3y	3y	3y	too windy
15	ONP	n Eagle Harbor			4	4	2y 2e	3y 1e	3y	3y	unstable nest platform
16	ONP	Deep Landing					2y		2y	1y	1 may have fledged and not seen
17	boathouse	Deep Landing									IA
18	tower	PEPCO property									IA
19	tower	PEPCO property									IA
20	light pole	coal yard PEPCO									IA
21	light pole	coal yard PEPCO									IA
22	tele. pole	near hatchery PEPCO									IA
23	ONP	Buena Vista	2		2	2	1y 1e	1y 1e	1y 1e	1y	1 banded
24	ONP	Welches, Benedict			4		3y	3y	3y	2y	1 banded;1y drowned in fish line

Nest #	Substrate	Location	Apr 11	Apr 19	Apr 20	May 7	May 19	May 26	Jun 8	Jun 29	Remarks
25	ONP	Whitey, Benedict		3	3	2	1y 1e	1y 1e	1y	1y	windy
26	tele. pole	Benedict									IA
27	ONP	entrance, Indian Cr.				1y 1e	2y	2y	2y	2y	too old to band;oiled veg. in nest
28	ONP	n side Golden Beach				3	3y	3y	3y	3y	too old to band
29	chnl. mk.	# 25 Teague Pt.			3	3	1	empty			F light oiled; eggs oiled
30	chnl. mk.	#23 Long Point					3	3		empty	adults oiled
31	ONP	Trent Hall, near house									IA
32	ONP	Persimmon Cr.					3	1		empty	high cleanup activity at site
33	ONP	Cremona			3		3y	3y		2y	2 banded
34	duckblind	Marsh Pt.			3		3y	3y		3y	3 banded
35	ONP	inside Marsh Pt.			3		3y	3y		2y	too old to band
36	ONP	2nd inside Marsh Pt			3		3y	3y		3y	2 banded
37	ONP	near Drift Inn			3		3y	3y		empty	y predated ?
38	ONP	Queentree Landing					2e 1y	1y 1e		1y	1 banded
39	ONP	s Cape St Mary's								2y	2 banded
40	ONP	s Sandgates									IA
41	chnl. mrk.	#1 Nans Cove					3y			1y	banded
42	chnl. mrk.	#3 Nans Cove					2y 1e			2y	
43	ONP	n Broome Island					3y			3y	
44	ONP	Brisco's n Broomes Is.					3y			destr.	nest platform collapsed
45	chn. mrk.	# 18 Jack Bay					2y 1e	2y		2y	2 banded
46	chn. mrk.	# 3 Battle Creek					2	2		empty	abandoned
47	ONP	Battle Creek					3y	3y		3y	3 banded
48	ONP	old piling, Battle Creek					3y	3y		1y	
49	old piling	Sheridan Pt.					3	3		2y	1 banded
50	chnl. mrk.	# 21 Sheridan Pt.						3		2y	2 banded
51	ONP	Mac's Hollow									IA
52	old piling	Sandy Point				3	3	3		1y	early nest collapse/oiled female
53	boathouse	Buzzard Is. Creek					empty				IA
54	old tree	Buzzard Island									early nest collapse/2nd attempt

Nest #	Substrate	Location	Apr 11	Apr 19	Apr 20	May 7	May 19	May 26	Jun 8	Jun 29	Remarks
55	sign	Sea Gulls Nest			1	empty		2			
56	ONP	Hallowing Point	3		3		2y 1e	2y 1e	empty		y predated, 1 found dead on beach
57	tree nest	n Broomes Island									IA
58	ONP	s Deep Landing									to old to band
Lower Patuxent River, south of Broomes Island										30-Jun	
59	chnl. mrk.	#5 Hog Point								2y	5 weeks
60	ONP	Sea Plane Lndg. area									IA
61	chnl. mrk.	6A Sandy Pt.								2y	3-4 weeks, outcome unk.
62	chn. mrk.	#6								1y	2 weeks- outcome unk
63	chnl. mrk.	#2 Drum Point									IA
64	ONP	.25 m nw Drum Point								3y	
65	chnl. mrk.	#2 Solomon's Entrance								empty	
66	chnl. mrk.	#3 Solomon's entrance								3y	
67	chnl. mrk.	Junction Bouy entrance									IA
68	ONP	Solomon's entrance								3y	
69	chn. mrk.	#2 Mill Creek								3y	
70	crane	LNG dock									IA
71	chnl. mrk.	#4 Mill Creek								3y	
72	chnl. mrk.	Junction Bouy Mill Cr.								empty	
73	chnl. mrk.	#3 Mill Creek								2y	
74	chnl. mrk.	#3 CBL								1y	
75	ONP	s of ONP #76								2y	
76	ONP	@ Danger Shoal Mrk.								2y	
77	chnl. mrk.	entrance Town Creek									IA
78	chnl. mrk.	#2 Second Cove								3y	
79	bridge pyl.	s side of Rt. 4 Bridge									IA
80	chnl. mrk.	#8 Pt. Patience								2y	
81	chnl. mrk.	#9									IA seas too rough to check

Nest #	Substrate	Location	Apr 11	Apr 19	Apr 20	May 7	May 19	May 26	Jun 8	Jun 29	Remarks
82	chnl. mrk.	#11									IA seas too rough to check
83	chnl. mrk.	#4 Clarkes Lndg.								2y	1 addled egg
84	pilings	Clarkes Lndg.								2y	
85	ONP	Clarkes Lndg.								empty	
86	ONP	n Half Pone Point									IA
87	ONP	St. Cuthbert's Wharf								empty	
88	chnl. mrk.	#13								empty	
89	ONP	n of mrk. # 13									IA
90	chnl. mrk.	# 15 Sotterly Point								2y	
91	chnl. mrk.	# 16 Broomes Is.								empty	
92	ONP	Intake @ PANS								2y	
93	chnl. mrk.	#14 St. Leonard's Cr.								2y	
94	ONP	n side St.Helen's Cr.								2y	
95	ONP	s side St.Helen's Cr.								2y	
96	ONP	n of Hungerford Cr..								2y	
97	ONP	at end of jetty,Hunger. Cr.								2y	
98	ONP	@old duckblind-Nav.rec								empty	
99	pilings	n Pt. Patience								1y	y flying, maybe others
Upper Patuxent River, north of Deep Landing							24-May	1-Jun	14-Jun	7-Jul	
100	ONP	Gun Club-Jug Bay					2y	2y	2y	2y	2 banded
101	ONP	Jackson's Landing					2y	2y	2y	2y	2 banded
102	ONP	Bristol duckblind site					3	1y 2e	2y	2y	2 banded
103	ONP	Monday's Creek					3y			3y	3 banded
104	ONP	Western Branch #1					3y 1e	3y	3y	3y	2 banded
105	ONP	Galloway Creek					1y 2e	1y 2e	1y 2e	1y	1 banded
106	ONP	Lookout Creek					1y 1e			3y	1 banded
107	ONP	#2 Nottingham					2y 1e			1y	1 banded

108	ONP	#1Nottingham					2			empty	
Nest #	**Substrate**	**Location**	**Apr 11**	**Apr 19**	**Apr 20**	**May 7**	**May 19**	**May 26**	**Jun 8**	**Jun 29**	**Remarks**
109	tree	Shores of Calvert								3y	IA
110	ONP	Merkle WMA Driving Tour					3y	3y	3y	3y	2 banded
111	ONP	Merkle WMA boardwalk					1	1y	1y	empty	
112	Silo	Merkle WMA								2y	IA
113	ONP	Merkle WMA Pier								1y	1 banded
114	ONP	Billingsly Creek								3y	3 banded
115	ONP	Railroad Creek					3y			3y	3 banded
116	ONP	Duttons Landing					1y 2e	3y	3y	3y	3 banded
117	ONP	Western Branch #2					3	3	3y	empty	
118	ONP	Selby's Landing					1y	1y	1y	1y	1 banded
119	ONP	Hall's Creek								1y	1 banded
120	tree	Mattaponi Creek					2y	2y	2y	2y	
121	ONP	Selby's Island					2	2	1y 1e	1y	1 banded
122	ONP	Shores of Calvert					2y 2e	2y 1e	2y	2y	1 banded
123	ONP	JBWS s Glebe Marsh					3y	2y	2y	1y	1 banded
124	ONP	JBWS observation deck								2y	2 banded
125	ONP	JBWS RR					3y			3y	3 banded
126	duckblind	JBWS Swan Pt.					2y	2y	2y	2y	2 banded
127	ONP	Windsor					3y			empty	

APPENDIX B: Summary of osprey monitoring activities

April 11, 2000
The first survey of the effects of the oil spill on the nesting ospreys occurred four days after the spill. Rain and inclement weather hampered early survey attempts in April and May. On April 11, 2000, 15 nests were examined in the spill area, 12 by boat and two by car. The contents of 12 nests could be examined. Three nests were inaccessible and those adults were not close enough to determine if they were discolored due to contact with oil. Three of the 12 nest sites examined were affected by oil. Nest number five contained some oiled sticks and small twigs. The adult male was moderately discolored from the legs to the head. Nest number six contained small spots of oil in the nest. The adult male's feet, which are normally a light blue, were darkened by oil. The only other significant occurrence was at nest number 10 where the female was observed to be oiled on the upper chest and neck.

April 16, 2000
Checked nest number two at Teague Point. Female appeared normal in coloration. Both adults at nest number four at Chalk Point were found to be moderately oiled and in need of cleaning. A noose carpet was place in the nest to catch the incubating female. She was caught and banded (788-29462) and taken to the shoreline to meet waiting cleanup team from TriState Bird Rescue. After the male resumed incubating duties, he was caught using the noose carpet. The male, which was previously banded on the Patuxent River in 1995 by Cardano, was then handed over to cleanup team. The nest contained three eggs. One egg was transferred to the clean up team to be placed in an incubator. The other eggs were placed in foster nests at Teague Point and platform nest at the West End of Rt. 231 bridge. The foster nest females assumed incubating duties after introducing the foster egg.

April 17, 2000
The adults from nest number 4 at Chalk Point were cleaned and released the following day. The incubated egg was placed in the nest prior to release. The female, upon release at the Chalk Point shoreline flew immediately to the nest with the one awaiting egg.

April 19, 2000
Examined adults at 13 nest sites from Benedict to Long Point. Feather coloration in all adults observed appeared normal except for the female at nest number 52 at Sandy Point. Eggs were not present. It appeared the nest (built on old pilings) had collapsed and the nest had been rebuilt. The female was moderately oiled. The male was not observed. Because of the absence of eggs it was decided not to capture the female.

April 20, 2000
The two other eggs were retrieved from the foster nests and returned to nest number four at Chalk Point. The pair hatched and fledged two young.

Examined adults and nest contents at 18 nest sites from Benedict to Eagle Harbor. The female at nest number 29 on Channel Marker #25, north of the Rt. 231 Bridge, had a small amount of oil discoloration on the legs. The male was observed and appeared normal.

Nest number six at Pylon "B" contained three darkened eggs. Both male and female were moderately oiled from legs to neck. Both adults were trapped using the noose carpet. The female was caught first. She was previously banded (608-52371). The male was caught next and banded (788-29463) before handing over to the Tri State Rescue team on shore. The three eggs were transferred to incubators.

The trapped birds were cleaned and release was attempted later that evening. The female was still too wet to fly and ended up in the water. It had to be retrieved by release team. Both adults were kept overnight for possible released the following morning.

April 21, 2000
The three eggs were placed in the nest and the birds were released. It was observed that a new pair of birds had taken over the temporarily abandoned nest site. Eyewitnesses observed the birds fighting and were not sure which birds were driven away. But, on April 23, 2000 the banded female (608-52371) was found dead downriver near Persimmon Creek. Its cause of death has not been determined as of this writing.

May 7, 2000
Adults and contents of 32 nests from Buzzards Island Creek northward to Eagle Harbor were checked. The new female was on the nest incubating at nest number five at pylon "B" at Chalk Point. There was only one egg and it was darkened over its entire surface. The three eggs at nest number seven on pylon "C" were darker than normal. Adults at each of these nests did not appear discolored by oil. Oiled sticks and twigs that were recorded at pylon "A" on April 11, 2000 were covered up by new clean vegetation, clumps of grass, and small and large sticks.

Nest number 29, where there was an earlier report of some oil discoloration on the female contained one egg out of three that was gray to muddy in color. Nest number 23, which is just east of number 29 at Buena Vista had two eggs of the same muddy-gray color. The osprey nest platform at the entrance of Indian Creek (nest number 27) was examined for the first time. Oil booms had prevented up close examination prior to this. The nest had one young, approximately two days old, and one grayish-brown egg. The nest contained some oiled vegetation.

Nest number 52 at Sandy Point, had three eggs of normal coloration. The female had oil discoloration on the abdomen and legs. The male was normal in appearance.

May 19, 2000
Fifty nests were examined from Broomes Island northward to Deep Landing. Nest number 30, on Channel Marker 23 at Long Point was new. The birds had started nesting at the nearby nest platform but moved to the Channel Marker. The male was wet but appeared discolored by oil. The female was oiled on legs and belly. The nest contained three eggs that were darker than normal. The osprey nest platform, nest number 3 at Teague Point, was predated. On May 7th the nest contained two newly hatched young and one egg. On this day the nest was empty and the adults were absent.
The new female at pylon "B", nest number 6, was still incubating. The egg was probably addled by this date but it was decided not to remove it so as not to disrupt the bird's attachment to the site. Nest on Channel Marker 25 contained one darkened egg. The female was still discolored on legs and belly.

All other nests checked appeared normal. Ospreys added additional vegetation to nests and covered up any signs of oiled nesting material. Except where noted all adults appeared normal in plumage characteristics.

May 26, 2000
Checked 43 nests from Battle Creek to Eagle Harbor. The three eggs at nest number 30, on Channel Marker 23, were still unhatched and darker than normal. Female's legs and belly were whiter than seen a week earlier.
A new nest was found at new pylon "C" at Chalk Point. It was not considered an active nest. A young pair or a "frustration" nest from an earlier failed attempt may have built it.
June 8, 2000
A total of 24 nests were examined from Long Point to Hunting Creek. Collected addled eggs from nest numbers five,

six, and 23. Nest number six, with the new female, previously recorded with one egg, now had two. Additional vegetation may have covered one of the eggs during inspections. Both eggs were addled and one was removed.

The osprey nest platform south of the entrance of Hunting Creek contained two young that were five weeks old that weighed 1750g and 1850g respectively. It was decided to band these birds while at the nest.

Osprey nest number 56, in front of PEPCO's Hallowing Point Lab, was empty. It previously contained two young at two weeks of age. One young was found dead and partially decomposed on the sandy beach in front of the lab.

June 29, 2000
Forty-one nests were examined in the middle region of the Patuxent River. Thirty-two young were banded with USGS aluminum leg bands. Three addled eggs were collected. One from nest number 39, south of Cape St. Mary's and two eggs from nest number 52, at Sandy Point. One of the three eggs at Sandy Point had hatched and produced one fledgling.

United States Department of the Interior

U. S. GEOLOGICAL SURVEY

Biological Resources Division
Forest and Rangeland Ecosystem Science Center
3200 SW Jefferson Way
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October 1, 2001

Mr. Peter McGowan
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

Dear Mr. McGowan:

I have received your Draft Final Report dated September 2001 and the associated Confidentiality Agreement which I have signed and enclosed.

Overall, the report is an excellent document. There are a few minor details that need to be addressed and a question about some specific observation dates. I will cover them point by point below (I have numbered the paragraphs from 1 to 29).

para 3. Palmer (1988) is <u>not</u> in the literature cited. Actually, the Osprey chapter was written by Henny, so it could be cited as Henny (in Palmer 1988). The 1988 reference is Handbook of North American Birds Vol. 4, Yale Univ. Press.

para 19. I believe it is important to know the actual date of the August 2000 survey on the PEPCO property (this relates to the 5 nests that failed). I personally know that Chesapeake Bay Ospreys nest earlier than those here in Oregon by a few weeks. Most (87%) young Oregon Ospreys make their first flight between 24 July and 14 August. Some data from Chesapeake Bay (McLean 1986, M.A. Thesis, College William and Mary) shows that Ospreys make their first flight between 30 June and 20 July. Birds regularly return to the nest for a couple weeks, but then, the nest is abandoned. My concern about the 5 nests reported abandoned in August is that the birds may have already fledged which becomes more likely the later the survey date in August.

para 29. The calculation of the oil-related loss of 17 Osprey young includes: (11 nests with 10 young that should have produced 18.7 young [negative 8.7 young]) and (5 nests surveyed in August that produced 0 young that should have produced 8.5 young [negative 8.5 young]). This totals 17.2 young lost. I agree with your calculations procedure; however, if the 0 young counted on PEPCO property was based upon only one survey in middle or late August, it is likely that some young would no longer be associated with the nest, i.e., they would have fledged. In summary, one could

question some of the reported loss (8.5 of the 17.2 young) unless the survey was conducted early in August, or you have additional information about the nests failing at an earlier date.

References

There are some inconsistencies in capitalization. Audet *et al.* has lots of caps in the title of the paper and no date, while words are not capped for other papers. Henny (1986) has several typos and "haliaetus" should not be capped. Palmer (1988) reference is omitted. Poole has typo for New York. Postupalsky has lots of caps in title and a typo.

Sincerely yours

Charles J. Henny
Wildlife Biologist (Research)