

ESTIMATE OF TOTAL ACUTE MORTALITY TO BIRDS RESULTING FROM THE CHALK POINT OIL SPILL, SWANSON CREEK, MARYLAND, APRIL 7, 2000

INTRODUCTION

On 7 April 2000, approximately 126,000 gallons of a mixture of No. 2 and No. 6 fuel oils were released from a ruptured underground pipeline that transported oil to the Potomac Electric Power Company Chalk Point Facility, near the town of Aquasco, Maryland (Fig. 1). The spill spread into Swanson Creek, a tidal tributary of the Patuxent River. The main stem of the Patuxent River, associated shoreline habitats, and other tributaries were also impacted by oil after heavy winds on the evening of April 9 blew oil over containment booms placed at the confluence of Swanson Creek and Patuxent River. More details about the incident can be found at the following web site: www.darp.noaa.gov/neregion/chalkpt.htm

Wildlife rescue efforts began immediately, and resulted in the collection of 109 live birds and 55 dead birds. Most of the oiled birds were treated and released, with only 12 birds dying during rehabilitation (USFWS, 2000).

The number of birds retrieved after an oil spill represents only a fraction of the actual number of birds affected by the spill. Oiled and dead birds are not recovered because they sink, drift out to sea, are scavenged, are overlooked by search teams, or they hide. Several approaches can be used to estimate the actual mortality. Their applicability to the Chalk Point spill is discussed below:

1. Selection of a Multiplier. In this approach, the actual number of carcasses recovered is multiplied by a factor to arrive at an estimate of the total bird mortality. Burger (1993) summarized data for 21 spills where the actual and estimated bird mortalities were reported. On average, the estimates were 4.4 higher than the actual counts. For the *North Cape* oil spill off Rhode Island, the natural resource Trustees (NOAA, state of Rhode Island, and US Fish and Wildlife Service) used a multiplier of 6, after evaluating the spill conditions (Sperduto et al., 1998). However, this case and many others where seabird mortality has been well studied occurred in open coastal settings where dead seabirds drifted out to open seas. It is not appropriate to use multipliers developed on such different physical settings, compared to the restricted upper estuarine setting of the Chalk Point spill site. Furthermore, most of the birds affected were overwintering ducks at the end of their migration to breeding grounds. These oiled birds could have left the spill area and expired from the stress of migration. Thus, their carcasses would not be found in the surveys.
2. Computer Modeling. In this approach, computer models are used to analyze the trajectory of the oil, the spatial distribution of birds, and probability functions to predict the number of oiled birds. These models have been used for spills where large numbers of seabirds were affected or potentially at risk, such as the *Nestucca* spill off Washington where an estimated 56,000 birds were killed (Ford et al., 1991) and the *Apex Houston* spill in central California where over 10,000 birds were estimated to have died (Page et al., 1990). This approach is not cost-effective for the Chalk Point oil spill, considering the number of birds likely to have

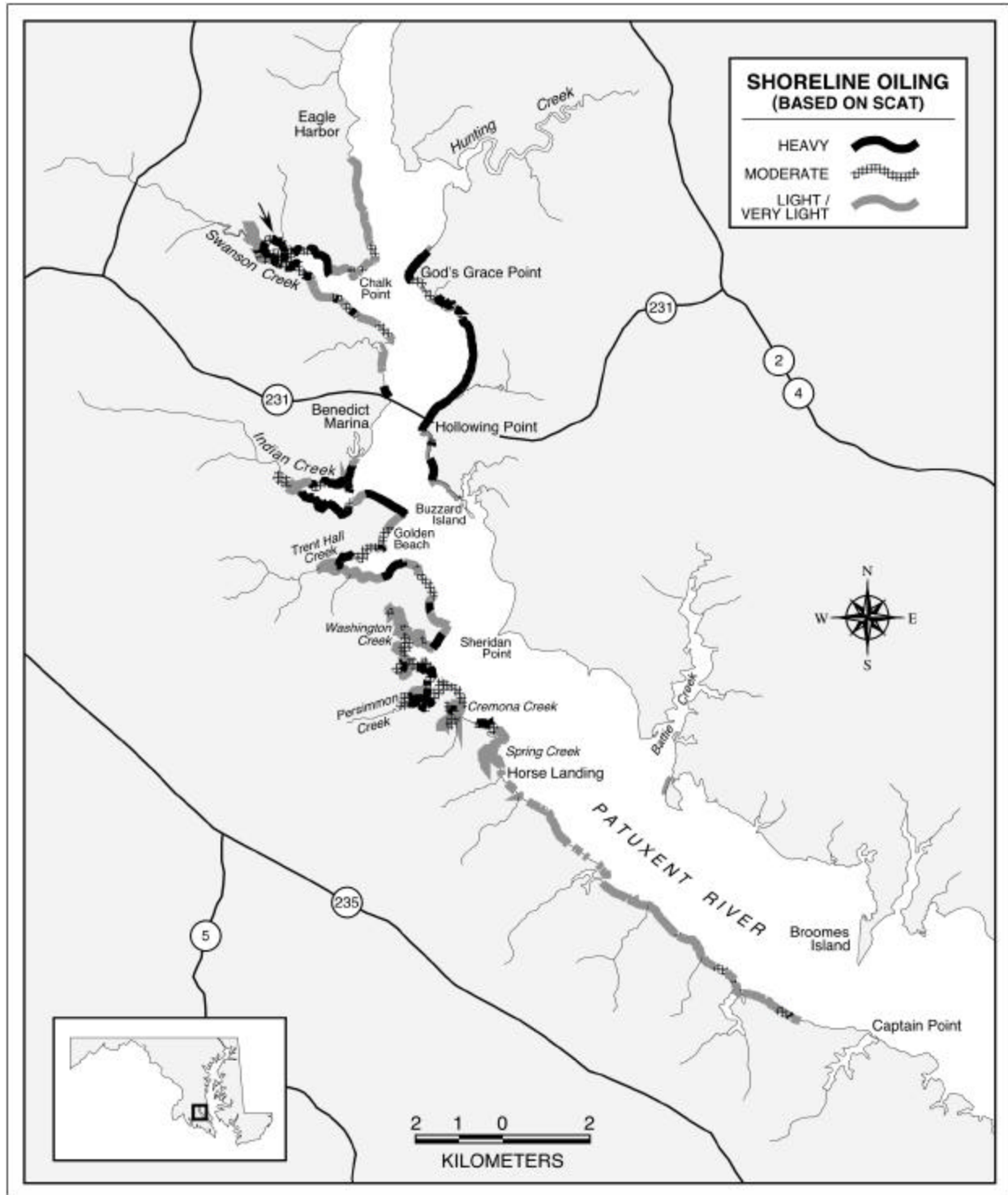


Figure 1. Map showing the spill site and the locations of place names cited in the text.

been killed and the costs of developing a model for the spill site and conditions.

3. Risk Assessment Approach. In this approach, data collected during the spill are used to estimate the population at risk and the percent of the population oiled, and data from the literature are used to estimate total mortality. It considers the life history and behavior of different groups of birds. This approach is appropriate where field teams can make good field observations during the spill. We selected this approach for the Chalk Point oil spill site. The specific methodology and assumptions for this assessment were developed cooperatively by the wildlife injury workgroup of the Chalk Point Oil Spill Natural Resource Damage Assessment (NRDA) Council. It uses a combination of field data and literature reviews, which are two of the assessment methods listed in the NRDA regulations (15 CRF Part 990).

BIRD RESCUE AND REHABILITATION

Wildlife rescue and rehabilitation efforts at the spill lasted from 7 April to 20 June. Detailed logs were kept of the animals that were rescued alive and turned into the rehabilitation center (Table 1). Only three birds turned into the rehabilitation center did not have visible oil on them: one common grackle, one house finch fledgling, and one mallard hen. Dead animals that were delivered directly to the morgue or died during rehabilitation are listed in Table 2. One dead osprey and one ring-billed gull were definitely not attributable to the spill (USFWS, 2000). As can be seen in Table 2, ruddy ducks were impacted the most, comprising nearly 60 percent of all known dead birds.

Table 1. List of birds recovered alive and the results of rehabilitation efforts during the Chalk Point oil spill during the period April 7 to June 20, 2000.

BIRD SPECIES	NO. RECOVERED FOR REHABILITATION	NO. DIED	NO. RELEASED
BIRDS			
Canada Goose	8	0	8
Double-crested Cormorant	1	1	0
Coot	3	1	2
Domestic & Hybrid Ducks	9	0	9
Grackle (not oiled)	1	0	1
House Finch (not oiled)	1	1	0
Mallard Duck (1 was not oiled)	37	1	36
Mute Swan	7	0	7
Osprey	4	0	4
Peking Duck	9	0	9
Ring-Billed Gull	1	1	0
Ruddy Duck	24	4	20
Savannah Sparrow	1	1	0
Barn Swallow	1	0	1
Virginia Rail	1	1	0
Warbler	1	1	0
BIRD TOTALS	109	12	97

Table 2. Summary of dead wildlife, including dead wildlife collected by field teams, and deaths incurred during rehabilitation at the Chalk Point oil spill from April 7 to June 20, 2000.

BIRD SPECIES	COLLECTED DEAD	REHABILITATION DEATHS	TOTAL DEAD
BIRDS			
Double-crested Cormorant	3	1	4
Coot	1	1	2
Great Blue Heron	2	0	2
Herring Gull	1	0	1
House Finch	0	1	1
Kingfisher	1	0	1
Loon	1	0	1
Mallard Duck	1	1	2
Osprey	3	0	3
Ring-Billed Gull	2	1	3
Ruddy Duck	35	4	39
Savannah Sparrow	0	1	1
Unidentified Tern	2	0	2
Unidentified Bird	1	0	1
Virginia Rail	0	1	1
Unidentified Warbler	2	1	3
TOTALS	55	12	67

WILDLIFE SURVEY TEAM OBSERVATIONS

The USFWS coordinated Wildlife Survey Teams to document wildlife impacts and use within the spill zone. The teams were made up of 2-4 individuals from the USFWS, Maryland Department of the Environment, Maryland Department of Natural Resources (MDNR), and later, by trained volunteers. Each team was equipped with a radio and assigned a specific shoreline zone to survey each day. All surveys were conducted from shore; sometimes the teams were transported from one area to another by boat. They recorded the following information on field data sheets:

- number and species of wildlife observed
- degree of oiling (none, light, medium, heavy) on wildlife
- extent of oiling (none, light, medium, heavy) on the shoreline

They reported by radio the location of oiled and live wildlife to the Wildlife Trailer, and a rehabilitation response team would be dispatched to attempt the capture of the impacted wildlife. The Wildlife Survey Teams were instructed not to attempt capture.

Wildlife surveys were conducted 9-17 April. The surveys were terminated when the numbers of oiled and dead wildlife dropped to minimum levels. The data sheets for each day were compiled onto base maps showing the shoreline sections surveyed and the field observations by species and degree of oiling, if reported. MDNR staff also conducted an aerial

survey of mostly the eastern shore of the Patuxent River on 13 April. Their observations were recorded onto base maps for analysis.

IMPACTS TO BIRDS

Estimates of the number of birds oiled and killed have been made for selected species or species groups, as discussed below. The spill impact area extends from Eagle Harbor in the north to Broomes Island in the south, based on field observations and the extent of shoreline oiling documented by the Shoreline Cleanup Assessment Teams (SCAT). Figure 1 shows the extent of shoreline oiling compiled by Entrix (2000) from the SCAT data.

Ruddy Ducks. For ruddy ducks, 59 birds are known to have been oiled; of these, 39 died. Table 3 lists the observations for ruddy ducks from the Wildlife Survey Teams for the period 10-15 April 2000, the period for which the most extensive surveys were conducted. The data sheets for 9 and 16 April were reviewed, and there were no observations of ruddy ducks in the area of concern on those days.

Based on the observations summarized in Table 3, it is difficult to determine the actual number of ruddy ducks present in the area affected by the oil spill. The number of ruddy ducks present is expected to change from day-to-day, because the spill occurred during the end of the migratory period. Ruddy ducks are highly mobile, and they could have moved to cleaner and less disturbed areas. According to Chris Swarth of the Jug Bay Wetlands Sanctuary, the Swanson Creek area has the highest density of wintering ruddy ducks in the Patuxent River; with 3,500 and 7,500 ruddy ducks there in February of 1999 and 2001, respectively. In the February 2000 count, only 30 ruddy ducks were observed, because of very cold weather before the count.

The wildlife surveys on 11 April were the most extensive, covering the western shoreline from Eagle Harbor south to Horse Landing and the eastern shoreline from the south shore of Hunting Creek to Buzzard Island. USFWS personnel used a spotting scope to count ruddy ducks on the eastern shoreline from the Highway 231 bridge north to Hunting Creek and on the western shoreline from Swanson Creek south to Indian Creek.

In Table 3, note that there are no counts of ruddy ducks in Trent Hall Creek on 11 April; the field form only notes that there were "ruddies" present. Of the 35 dead ruddy ducks collected, 27 came from Trent Hall Creek, including 14 on 13 April. Also, of the 24 live ruddy ducks rescued, 17 came from Trent Hall Creek between 12 and 16 April. Thus, a total of 41 ruddy ducks came from this area, although the maximum reported on any day was 13. The videotapes from the aerial overflights of Trent Hall Creek on 11 April were viewed, but the flight was too high to observe the number of ducks present. Therefore, the number of oiled ruddy ducks in Trent Hall Creek on 11 April is assumed to be at least 41 (the number of oiled ruddy ducks collected from this area between 12-16 April). The number of ruddy ducks in the spill area is estimated by the Trustees to be 851 birds on 11 April.

Table 3. Observations of ruddy ducks in the Chalk Point area of the Patuxent River, April 2000, as reported by Wildlife Survey Teams and a MDNR aerial survey over mostly the eastern shore on 13 April 2000. A (-) indicates that the zone was not surveyed on that date. For each date, the number of ruddy ducks and the degree of oiling (heavy, medium) are listed. The entry "NR" is used when information on the degree of oiling was not reported.

Date/ Zone	4/10	4/11	4/12	4/13	4/13 MDNR Aerial	4/14	4/15
<i>West Shore</i>							
Eagle Harbor to Swanson Ck	-	0	0	-	-	2, no oil	-
Swanson Creek	70, 10% oiled 2, heavy oil	110, oil NR 80, medium oil	6 ducks, oiling NR	0	-	0	-
Swanson to Indian Ck	-	120, oiled	30, light 3, no oil	1, heavy oil 1, no oil	2, oil NR	0	-
Indian Creek	150, no oil 151, heavy oil	150, oil NR	12, medium oil	1, no oil	15, oil NR	0	0
Trent Hall Creek	1, heavy oil	"ruddies"	3, heavy oil; 8-10, oil NR 18 ducks, oil NR	-	0	1, oil NR 2, dead	1, dead
<i>East Shore</i>							
Hunting Creek	-	180, oil NR	15-20, no oil	-	295, oil NR	-	-
Gods Grace to Hallowing Pt.	-	90, some oiled 80, oil NR	2, heavy oil 20 ducks, oil NR	41, heavy oil 1, dead	0	0	0
Hallowing to Sheridan Pt	-	-	6, heavy 4, no oil	3, no oil	0	0	23 ducks, oil NR
TOTAL	374	810+	134	48	335	5	24

The Responsible Party (RP) agreed with using the overall approach, but disagreed with the inclusion of the ruddy ducks in the Hunting Creek area in the population at risk. They believed that this area fell outside of the area impacted by the spill, hence it was unlikely birds in this area would become oiled. The Trustees believed that the proximity of these birds to the spill zone and observations indicating birds were moving around in the area put them at a high risk of exposure to oil. The Trustees and RP could not agree on this issue, therefore the bird injury was estimated with and without the Hunting Creek bird count.

Table 4 shows the calculations for determining the estimated number of birds that were oiled and died in the field, by species. Where the field teams made estimates of the number of oiled ruddy ducks, the estimates were usually about half of the total number of ducks that were observed in the spill area. Therefore, it is estimated that 50 percent of the ruddy duck population

Table 4. Calculations to estimate the number of birds oiled and dying in the field.

Species	Number Observed in Field	Number Observed/ Estimated to be Oiled	Total Number Collected (birds collected live and dead)	Estimated Number Not Collected	Estimated Mortality Rate in the Field	Estimated Number Dying in the Field
Ruddy Duck (Trustees)	851	426 (est. 50% of number in field)	59	367	0.85	312
Ruddy Duck (RP ¹)	671	336 (est. 50% of number in field)	59	277	0.85	236
Greater Scaup	41	10 (est. 25% of number in field)	0	10	0.85	9
Green-winged Teal	50	12 (est. 25% of number in field)	0	12	0.85	10
Canada Goose	13	12 (observed)	7	5	0.23	1
Mallard	29	53 (est. 50% of number in field + all 38 recovered)	38	15	0.5	8
Double-crested Cormorant	200	50 (25% of number in field)	4	46	0.85	39
American Coot	40	40 (observed)	4	36	0.85	31
Virginia Rail	0	1 (observed)	1	0	-	0
Osprey	15	6 (observed)	6	0	-	0
Great Blue Heron	7	7 (observed)	2	5	0.23	1

¹ Does not include the 180 ruddy ducks in Hunting Creek

in the spill impact zone was oiled, for an estimated total of 426 oiled ruddy ducks, or 336 ruddy ducks using the RP numbers. A total of 59 oiled ruddy ducks were collected (both alive and dead), so the number of oiled birds not collected is 367 birds, or 277 birds using the RP numbers (Table 4).

Other bird species were expected to have a lower probability of exposure to oil either because of their behavior or because they were observed in areas that were not heavily oiled. Consequently, the Trustees assumed that 25% of the number of scaup, teal and cormorants present in the area affected by the spill were oiled. This estimate is half of the field observations of the percent of ruddy ducks that had visible oiling. The Trustees used this estimate because the other waterbirds were mostly in areas with lower amounts of surface slicks, and it is based on the experience of the Trustees from other oil spills. The Trustees used the actual observed percent of the population that was oiled for the remaining species (coot, rail, osprey, heron).

Some of the oiled birds that were not collected for rehabilitation are expected to have died in the field. The only data from the literature is on the survival of oiled, rehabilitated, and released birds, and these data were extrapolated as follows. For large birds such as geese and herons, the 23 percent mortality rate of Anderson et al. (1996) for pelicans was used directly. For migratory ducks, coots, and cormorants, there were no data, but it was the judgment of the

workgroup that mortality would be very high. A mortality rate of 85 percent was considered reasonable, since some of the birds were very lightly oiled and likely to survive. For mallards, a mortality rate of 50 percent was used, based on the work of Anderson et al. (2000), discussed below.

Birds that were oiled, rehabilitated, and released are also estimated to have been affected (Table 5). Anderson et al. (2000) studied the survival, condition, and behavior of oiled/rehabilitated American coots, compared to unoiled, wild-caught coots over a four-month period. Both groups were randomly mixed and released into fenced marshes. They reported 51 percent mortality in the oiled/rehabilitated birds, compared to 24 percent for unoiled birds. For oiled migratory ducks, it is estimated that 50 percent of the oiled/rehabilitated birds eventually died as a result of the spill. The mortality rate for mallards was estimated to be half that for migratory ducks, so 25 percent of the oiled/rehabilitated mallards were assumed to have died as a result of the spill. For larger aquatic birds, the 23 percent mortality rate for pelicans from the Anderson et al. (1996) study was used. Table 5 shows the estimated mortality for oiled birds dying after release alive.

Table 5. Estimated number of birds dying after release alive.

Species	Number Oiled Released Alive	Mortality Rate After Release	Estimated Number Dying After Release
Ruddy Duck	20	0.5	10
Greater Scaup	0	-	0
Green-winged Teal	0	-	0
Canada Goose	7	0.23	2
Mallard	36	0.25	9
Double-crested Cormorant	0	-	0
American Coot	2	0.5	1
Virginia Rail	0	-	0
Osprey	4	0.23	1 (was collected)
Great Blue Heron	0	0.23	0
Other	20	-	-
Total	96		22

The total estimated number of ruddy ducks that died as a result of the spill is 361 (or 285 using the RP numbers), as shown in Table 6. For comparison, Perry et al. (1978) reported that an estimated 12,500 ruddy ducks were killed during five winter spills in the upper Delaware River over the period 1973-1976. They also reported on two spills in the Chesapeake Bay where an estimated 350 and 90 ruddy ducks were killed, respectively (Perry et al., 1978).

Other Migratory Ducks. Wildlife Survey Teams reported other migrating ducks in the oiled area as follows: 12 greater scaup, three oiled on 11 April; 41 greater scaup, none visibly oiled on 12 April, and 50 green-winged teal with no information on oiling degree on 13 April.

Table 6. Summed columns to calculate total number of dead birds.

Species	Number Collected Dead	Number Oiled Dying In Rehab	Number Dying After Release	Number Dying in Field	Total Number of Dead Birds
Ruddy Duck (Trustees)	35	4	10	312	361
Ruddy Duck (RP ¹)	35	4	10	236	285
Greater Scaup	0	-	0	9	9
Green-winged Teal	0	-	0	11	11
Canada Goose	0	-	2	1	3
Mallard	1	1	9	8	19
Double-crested Cormorant	3	1	0	39	43
American Coot	1	1	1	31	34
Virginia Rail	0	1	0	0	1
Osprey	2	0	0	0	2
Great Blue Heron	2	0	0	1	3
Other	7	2			9
Total (Trustees)	51	11	22	412	495
Total (RP¹)	51	11	22	336	419

1 Does not include the 180 ruddy ducks in Hunting Creek

Most of the teal and scaup were located in the southern half of the oiled area and were likely at a lower risk of oiling. The only field count of the percent of birds oiled was 25 percent on 11 April. Therefore, it was estimated that 25 percent of the scaup and teal in the area affected by the oil spill were oiled (Table 4).

Three American coots were collected and rehabilitated from Benedict pier, Golden Beach, and Washington Creek. One dead coot was recovered from Indian Creek. For the area between Benedict and Indian Creek, Wildlife Survey Teams reported 40 oiled coots on 11 April, 8 coots 12 April, and one on 13 April.

Calculations for estimating the number of migratory waterfowl that died in the field are shown in Table 4. An estimated nine scaup, ten teal, and 31 coots died in the field as a result of the spill. Two oiled/rehabilitated coots were released, and it is estimated that one of them died (Table 5). Total mortality for migratory ducks is estimated to be nine scaup, eleven teal, and 34 coots (Table 6).

Mute Swans. Seven oiled mute swans were collected and rehabilitated. No mortalities were observed or are estimated to have occurred. Mute swans are large, white birds that are readily observed as to their oiling and survival post-oiling. It is believed that all of the oiled birds were collected and survived rehabilitation efforts, thus they are not listed in Tables 4-6.

Canada Geese. One unoiled and seven oiled birds were collected and rehabilitated. Six came from the Golden Beach/Trent Hall Creek area from 12-15 April, one from Benedict marina on 11 April, and one with no oiling from Route 4 highway on 17 April. Eight oiled Canada geese and three without oiling descriptors were observed on 12 April, including the three heavily oiled birds in the Trent Hall Creek area that were collected that day. Thus, twelve Canada geese were observed oiled, and five oiled Canada geese remained in the field. Of these five, one is estimated to have died in the field (Table 4).

It is likely that most of these large birds were able to survive oiling and rehabilitation efforts. The survival rate for oiled, rehabilitated, and released brown pelicans following the *American Trader* oil spill in southern California in the first 60 days after release was 77 percent (Anderson et al., 1996). It is assumed that oiled Canada geese had a survival rate of 77 percent, similar to that reported for pelicans. For the seven rehabilitated birds that were released alive, it is estimated that 23 percent of them (2 birds) eventually died (Table 5). Thus, a total of three Canada geese are estimated to have died as a result of the spill (Table 6).

Mallards. Most of the 38 live mallards collected came from two areas: Benedict and Golden Beach from 11-18 April. Only one dead mallard was recovered, and one mallard died in rehab. The numbers of mallards observed by the Wildlife Survey Teams in other areas were 29 on 11 April, 22 on 12 April, 24 on 13 April, nine on 14 April, and 27 on 15 April. When provided, the number of oiled mallards was about half of the total number observed. The total number of oiled birds is estimated to be 53, half of the birds observed in the field plus the 38 recovered. Half of those not recovered are estimated to have died, for a total of eight mallards dying in the field (Table 4).

According to the wildlife specialists at Tri-State Bird Rescue and Research Center, mallards have a high survival rate after being oiled and rehabilitated (Eileen Gilbert, pers. comm, 2000). Therefore, the mortality rate after release is estimated to be 25 percent, half that of other ducks, resulting in nine mallards dying after release (Table 5). Total mallard mortality is estimated to be 19 birds (Table 6).

Double-crested Cormorants. One oiled cormorant was collected near Chalk Point, and it died in rehab. Three dead birds were collected: one at Captain Point on 14 April (no visible oil), one at Benedict on 20 April, and one at Cremona Creek on 1 May (no visible oil). Wildlife Survey Teams reported decreasing numbers of cormorants over time: 200 on 11 April (all within the area of surface slicks), 30 on 12 April, 15 on 13 April, four on 14 April, and 0 on 15 and 16 April. They were usually not able to determine if the birds were oiled. Recovery rates for cormorants are low because they seldom come ashore. This behavior is even more prevalent where there are numerous isolated areas available for roosting, such as the many structures over water on the Patuxent River. It is assumed that 25 percent of the cormorants in the area were oiled, for a total of 50 oiled cormorants. Once oiled, cormorants are expected to have low survival in the wild, so the 85 percent mortality rate was used. Therefore, 39 cormorants are estimated to have died in the field (Table 4). No cormorants were released alive, so the total estimated mortality is 43 (Table 6)

Virginia Rails. Only one Virginia rail was collected, and it died in rehab. Rails are very secretive and are not likely to be found. To determine the potential population of rails at risk, contact was made with Gregg Kearns, of the Maryland National Capital Park and Planning Commission, a local naturalist who has extensive experience in conducting bird surveys on the Patuxent River. He advised that few rails overwinter in the Swanson Creek area. Rails usually start arriving mid-April and the migration peaks in May. He did a survey of the break site a few days after the spill and did not see or hear rails in the area. He also noted that the Swanson Creek area is not good rail habitat. Based on this information, it is estimated that one Virginia rail died as a result of the Chalk Point oil spill (Table 6).

Osprey. Four live, oiled osprey were collected, rehabilitated, and released. Three dead osprey were turned into the morgue, including one of the birds that had been treated and released, and one whose death was not related to the spill. Thus, two osprey were directly killed as a result of the spill. Fifteen osprey were observed on 11 April, three were described as oiled. Six were observed on 12 April, of which three were oiled. Ten were observed on both 14 and 15 April, of which one was oiled. The total number of oiled osprey is estimated to be six. Because of the successful efforts to capture oiled birds and rehabilitate them, it is assumed that the two dead oiled osprey in the morgue represents those killed as a result of the spill (Table 6).

Impacts to osprey nesting success were assessed in a separate study (Cardano, 2001). Results of the reproductive success study showed that the number of young osprey produced per nest met or exceeded the values determined to maintain a stable population (0.95-1.30). Statistical analysis of the data showed that there were no differences between upstream and middle river nests. Overall, the Chalk Point spill did not have an effect on osprey brood production for the Patuxent River.

Bald Eagles. A separate study was conducted to monitor potential impacts on bald eagle reproductive success (Wearmouth, 2000). Of the three bald eagle (two in Swanson Creek, and one at Cremona Creek) nests selected for monitoring, only the Cremona Creek nest was monitored for the entire nesting season. The other two nests were destroyed early in the monitoring period by high winds (Stanley Run), and failure of a young eagle pair to produce eggs (mouth of Swanson Creek). The Cremona Creek eagles successfully fledged two young, exceeding the 0.7 per nest required to maintain a stable Chesapeake Bay population, and the 1.1 per nest value established by the Chesapeake Bay bald eagle recovery team.

Great Blue Herons. Two dead great blue herons were turned into the morgue, collected on 17 April from Chalk Point and on 19 April from the Benedict boat ramp. Five oiled great blue herons were observed on 12 April. It is assumed that five oiled birds were not recovered and one of these birds eventually died (mortality rate in the field of 23 percent, Table 4). Thus, three great blue herons are estimated to have died as a result of the spill (Table 6).

Impacts to great blue heron nesting colonies were assessed in a separate study (McGowan et al., 2001). Overall survival rates of great blue heron nestlings in the Swanson Creek colony were not statistically different from survival rates at an upstream reference site. In addition, both populations exhibited survival rates that were similar to or higher than values reported in the literature. There were also no statistical differences in nest productivity (defined as the number

of young per successful nest); however, productivity values for both colonies appear to be on the low end of the range of literature values from other areas along the east coast. Productivity of both great blue heron populations may have been affected by the weather, because April 2000 had the highest precipitation recorded for the month in 30 years. There is some uncertainty associated with the study results due to the delay in initiating monitoring and questions concerning the appropriateness of the reference site. As a follow-up to this study, the Trustees will be conducting a nesting pair survey at both colonies in the Spring 2001..

Other Birds. Three dead gulls were turned into the morgue, including one that was reported as unoiled and collected from tangled wires on an unfinished pier. Other oiled dead birds included a belted kingfisher, two terns, one loon, and one unidentifiable bird. Dead birds with no visible oil on them (and so are not attributed to the spill) that were turned into the morgue included two warblers, a house finch fledgling, and a common grackle. Therefore, seven other species of birds that were collected dead are attributed to the spill. One heavily oiled savannah sparrow and one moderately oiled common yellowthroat (warbler) died in rehab. Two lightly oiled gulls were reported by Wildlife Survey Teams for the period 9-16 April. Thus, nine other dead birds can be attributed to the Chalk Point oil spill (Table 6).

In summary, the total number of adult birds estimated to have died is 495 using the Trustee numbers and 419 using the RP numbers.

ESTIMATING PRODUCTION FOREGONE

Based on the number of adult birds killed, the Trustees decided that the ruddy duck was the only species for which the adult injury was large enough to potentially affect productivity. Ruddy ducks that overwinter on the Atlantic coast have a steady population and are expected to recover within one breeding cycle (Mike Haramis, Patuxent Wildlife Research Center, USFWS, Laurel Maryland). In 1999, 64,000 ruddy ducks were killed by hunters, 26,000 of which were in the Atlantic Flyway (John Debney, Delta Waterfowl Research Station, Manitoba, Canada, pers. comm.). Thus, estimates were made for the loss associated with the first generation of fledgling ruddy ducks that would have been produced by the birds affected by the spill.

Production foregone calculations for ruddy ducks were based on life history information taken from Johnsgard and Carbonell (1996) and Bellrose (1978). The calculations are based on the following information:

- Ratio of males to females = 1.63:1 (38% females in the spring population)
- Percent of females that are active nesters = 79%
- Broods per season = 1 (double brooding occurs only occasionally)
- Mean clutch size = 8 eggs
- Mean hatching success = 50%
- Mean brood reduction = 25% (fully feathered young)
- Total number of birds unable to reproduce in 2000 (Trustees) = 361 dead birds + 55 birds estimated to be oiled that survived (15 percent of 367, the total oiled and not collected in the field in Table 4) + 10 oiled birds that were treated, released and survived (Table 5) = 426 birds

- Total number of birds unable to reproduce in 2000 (RP) = 285 dead birds + 42 birds estimated to be oiled that survived (15 percent of 277, the total oiled and not collected in the field in Table 4) + 10 oiled birds that were treated, released and survived (Table 5) = 337 birds

It is assumed that birds that were oiled but survived did not attempt breeding. This assumption is based on studies by Anderson et al. (1996) of oiled, rehabilitated, and released brown pelicans that showed no breeding activity in the two years after oiling, compared to unoiled control birds that were active at breeding colonies over the same period. Ruddy ducks, being smaller and having to undertake a significant migration, are expected to be significantly stressed and not attempt nesting after being oiled.

The sex ratio for ruddy ducks varies depending on which population is surveyed. Bellrose (1978) reported that a compilation of sex ratios from several areas indicated that males comprised 62 percent of spring populations. Johnsgard and Carbonell (1996) reported a 3:1 male to female ratio on the breeding grounds. Because the birds were oiled in their overwintering areas, the sex ratio for the spring populations is the appropriate one to use.

The calculations using the Trustee numbers are shown below.

Number of females that were oiled: $426 \times 0.38 = 162$ females

Number of females that were active nesters: $162 \times 0.79 = 128$ nesting females

Number of eggs laid: 128×8 (mean clutch size) = 1024 eggs

Number of hatched young: $1024 \text{ eggs} \times 0.5$ (mean hatching success) = 512 young

Number of fully fledged young: $512 \text{ young} \times 0.75$ (25% brood reduction for fully feathered young) = 384 fully feathered young

$384/128$ nesting females = 3 fledged young produced per nesting female

Johnsgard and Carbonell (p. 109, 1996) state "that each nesting female produces an average of about 3 fledged young."

The calculations using the RP numbers are shown below.

Number of females that were oiled: $337 \times 0.38 = 128$ females

Number of females that were active nesters: $128 \times 0.79 = 101$ nesting females

Number of eggs laid: 101×8 (mean clutch size) = 808 eggs

Number of hatched young: $808 \text{ eggs} \times 0.5$ (mean hatching success) = 404 young

Number of fully fledged young: $404 \text{ young} \times 0.75$ (25% brood reduction for fully feathered young) = 303 fully feathered young

Production foregone is estimated to be 384 fledged young ruddy ducks using the Trustee numbers, or 303 fledged young ruddy ducks using the RP numbers.

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