CHALK POINT OIL SPILL:
LOST RECREATIONAL USE VALUATION REPORT

March 2001

Prepared for the
Chalk Point Trustee Council

Prepared by:

Heath Byrd
Eric English
Doug Lipton
Norman Meade
Ted Tomasi

NOTE TO READER

A sum of money equal to the monetary estimate of the value of lost recreational use contained in this report shall be spent on one or more restoration projects (including projects that can lead to the rehabilitation, replacement, or acquisition of equivalent natural resources and/or services) to make the environment and public whole for the loss. In compliance with the Natural Resource Damage Regulations implementing the Oil Pollution Act, 15 C.F.R. Part 990, the Trustees will identify a reasonable range of restoration alternatives to compensate for the lost recreational use, evaluate and select the preferred alternative(s) and include them in the draft restoration plan. The draft restoration plan will be provided to the public for comment once all of the injuries from the Chalk Point oil spill have been quantified and all of the preferred restoration projects have been selected and scaled appropriately.

TABLE OF CONTENTS

I. Executive Summary

This report presents the data and methods leading to a calculation of lost recreational-use damages due to the Chalk Point oil spill. The term "lost-use damages" refers in this case to the decline in value of recreational uses associated with a resource that has been affected by the spill. The presence of oil in the Patuxent River following the Chalk Point incident affected swimming, fishing, boating, backyard use and other activities. Determining the nature and extent of these effects and the value of the resulting losses is the purpose of the analysis contained herein.

Calculation of damages due to lost recreational use is part of the Natural Resource Damage Assessment (NRDA) process. Ecological damages, such as harm to wildlife or habitats, will also be included in the public NRDA claim and are described in other case documents. Commercial losses and spill-related out-of-pocket expenses to area residents are not part of the public claim. Total estimated lost recreational-use damages and the two sub-categories that comprise total damages are presented in the table below.

Summary of Lost Use Damages	
Recreational Trips Lost Due to the Spill	12,704
Total Value of Lost Trips	$343,010
Actual Trips Taken to the Spill Impact Zone	112,359
Diminished Value of Actual Trips	$110,489
Total Lost-Use Damages	**$453,499**

An estimated 12,704 recreational trips were lost due to the spill. These lost trips reflect the fact that some people who typically use the Patuxent River for recreation made fewer visits in the 2000 season (April through September) due to concerns about the spill. The total value of the lost trips is estimated to be $343,010. Data used in this analysis indicate that these losses began immediately after the spill in April and continued through early August.

In addition, recreational losses include the diminished value of trips taken to the spill impact zone during the months following the incident. An estimated 112,359 visits were made to the affected area from April through September 2000. The loss for each diminished trip represented a portion of the trip's total value soon after the spill and declined over the course of the season. The total diminished value of trips taken is estimated to be $110,489.

The values shown include losses for all types of recreational activities observed in the spill impact zone. The total monetary value of damages is estimated to be $453,499 through September 30, 2000. Damages are assumed to be zero from that point on.

II. Description of the Oil Spill Incident and Affected Area

On April 7, 2000, a break in the pipeline that supplies oil to the Potomac Electric Power Company (Pepco) Chalk Point Generating Station released an estimated 126,000 gallons of oil into Swanson Creek Marsh on the Patuxent River in Maryland. At the time of release, the pipeline was owned by Pepco and operated by ST Services. They are the two responsible parties (RP) identified in this case.

Booms to contain the oil were placed at the mouth of Swanson Creek, but a storm on the night of April 8 blew oil over the booms and into the Patuxent River and its tributaries. The U.S. Environmental Protection Agency initiated vigorous response efforts to contain the spill and mitigate the damage. Nevertheless, there was considerable oiling of shoreline and beaches downstream of the plant. An advisory against boating was in effect from April 8 to April 24 from Eagle Harbor to Broomes Island, a distance of roughly 15 miles.

Shortly after being notified of the spill, representatives from the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, the Maryland

Department of the Environment, and the Maryland Department of Natural Resources cooperatively initiated preliminary assessment activities. These four organizations comprise the natural resource Trustees overseeing the case. The Trustees determined that sufficient evidence of injury existed to proceed with the natural resource damage assessment, including the evaluation of losses related to recreational use of the river.

Land use in the area affected by the spill consists primarily of a mixture of private residences abutting the river, open agricultural land and forested uplands. The private homes along the river typically have lawns reaching down to the shore and often have a wooden pier extending into the water. The width of the river varies from about half a mile to two miles. Creeks join the river at several points in the affected area, the largest being Battle Creek, with waters suitable for motorized boating extending inland a little over two miles from the main channel of the Patuxent.

There are five marinas located in the spill zone. Two are approximately 1.5 miles south of the Chalk Point facility, another is located midway down the spill zone on the western shore of the Patuxent, and two are on Broomes Island at the southern end of the spill zone. Greenwell State Park, on the western shore of the Patuxent just south of Broomes Island, offers a variety of shoreline amenities including a beach and picnic area. There are several restaurants with outdoor seating directly on the water. Aside from the state park, there are limited sites for shoreline use with designated public access. Several sandy shoreline sites are accessible by boat or by small roads The shoreline community of Golden Beach maintains several recreational facilities open only to community residents. Most people using the Patuxent River are engaged in recreational activities like fishing, swimming, boating or picnicking.

III. Damage Assessment Methods and Results

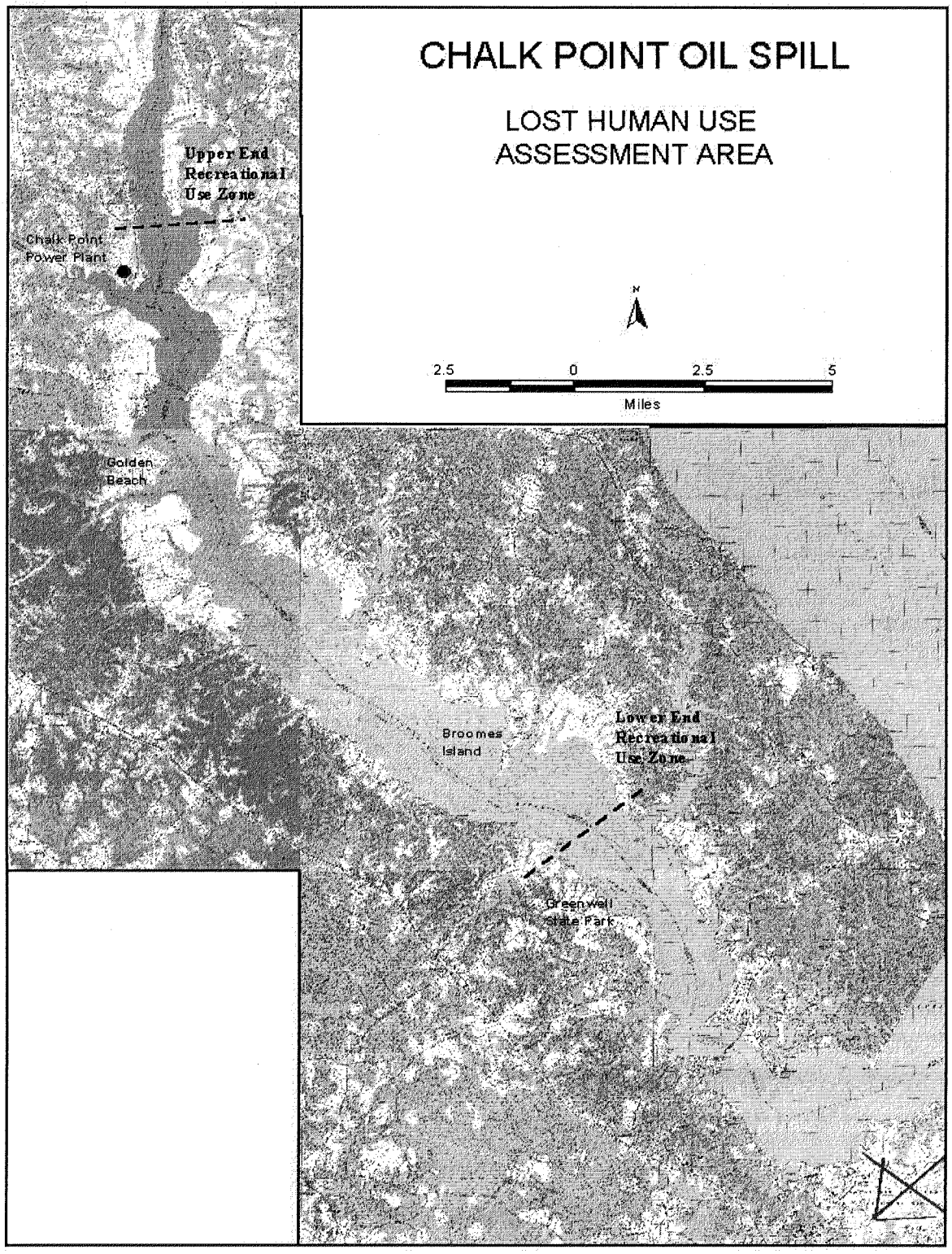
This section presents an overview of the study and analysis undertaken for this report, leading to a determination of lost-use damages. Details of the damage model are reserved

for the appendices, which include the relevant mathematical tables and the calculation of damages.

In order to determine economic damages it is necessary to compare the level of recreational activity had the spill not occurred with the activity that actually occurred subsequent to the spill. In gathering the appropriate information, it was decided that a phased approach would be used, whereby initial investigations would determine the extent of the research effort required. One possibility for obtaining the necessary information was to undertake primary data collection using sample survey methods. Following the initial investigations, it was judged that such an approach involved a level of effort and cost disproportionate to the expected amount of damages in this case. Representatives of the Trustees and the responsible parties made this judgment based on visits to the site and the characteristics of the spill and the affected zone. It was determined that existing data sources, augmented by limited primary data collection, were sufficient to adequately assess recreational damages from the spill.

The most appropriate source of data available that allowed the comparison of baseline and actual use levels was a set of records kept for a group of community recreational sites in Golden Beach, Maryland. It was a major assumption of the analysis that the level of decline in activity observed in Golden Beach is representative of the decline in activity in the area as a whole. Additionally, the absolute level of activity at Golden Beach needed to be extrapolated to the absolute level of activity in the entire area impacted by the spill. To accomplish this, helicopter overflights were conducted that allowed us to compare activity in the entire spill impact zone to the level of activity at Golden Beach. The location of Golden beach is shown in Figure 1.

Figure 1: Lost Human Use Assessment Area



Overview of the Data

Trustee and RP representatives conducted a series of site visits to the Patuxent River to investigate the location of recreational sites and the types of recreational activities potentially affected by the spill. In addition, they gathered information from a variety of sources regarding the level of recreational use on the river over time, historical weather patterns, and the monetary value of the types of recreation observed. What follows is a description of the data directly relied upon for the lost-use damage assessment.

- **Recreational use data** – Historical data were compiled showing the level of use in 1999 and 2000 at five recreational sites in Golden Beach, Maryland, a residential community on the west shore of the spill zone. The data are based on daily records kept by the Beach Management Corporation, a private organization that maintains the sites and began keeping a daily log of recreational activity at the start of the 1999 season.
- **On-site surveys** – Trustee and RP representatives conducted an informal survey of people using the Patuxent River on two weekends in late summer 2000. Respondents described their visits to the river that season and whether their knowledge of the oil spill had affected their recreational choices. The survey was informal in that it relied on convenience sampling rather than a statistically rigorous probability sample.
- **Impact-zone overflights** – Five helicopter overflights were conducted to record current recreational use in the spill impact zone. These overflights resulted in a count of the total number of people using the shoreline and open water at a given time during the hours of peak use.
- **Meteorological data** – Records showing temperature, rainfall, cloud cover and other weather variables that could affect recreational use were retrieved from the National Climatic Data Center. The monitoring station for the relevant NCDC data is at the Patuxent River Naval Air Station on the west shore of the river.
- **Economic studies on the value of recreation** – Previous studies that place a value on recreation were drawn from the economics literature.

Additional information that was not directly used in the current analysis nonetheless supports the conclusions drawn. For example, informal discussions with marina operators on the Patuxent River indicated that there was concern by boaters about the effects of the spill and that activity was lower than usual following the spill. None of these operators were able to provide specific records useful for this analysis. Managers of local parks not affected by the Patuxent River spill indicated that foul weather had caused a modest decline in recreational use during the spring. These anecdotal impressions were in accordance with the meteorological information incorporated into the lost-use calculations.

Recreational Trips Lost Due to the Spill

The calculation of lost recreational trips is based on a comparison of activity at Golden Beach between 1999 and 2000. Adjustments are made for differences in weather and the results are extrapolated to the entire recreational use impact zone using data from helicopter overflights. The size of the relevant impact zone was assumed to stretch from Potts point, just north of the Chalk Point power plant, to Broomes Island. This delineation was based on the area of impact of oil on shorelines, the area of clean up activity, and responses to the on-site survey. See Figure 1.

The data from Golden Beach show the level of daily activity at five community recreational sites. To extrapolate from Golden Beach to the entire spill impact zone, it is important to assume that the pattern of recreational activity there is typical of the larger region. Based on information from site visits, the on-site surveys, and overflights, this assumption would seem to be warranted. Most recreation trips in the impact zone appear to be taken by residents of the local area, as is the case at Golden Beach. Furthermore, the Golden Beach sites include beaches, picnic areas, boat ramps, piers and mooring buoys. These types of facilities are representative of the facilities and activities observed throughout the spill impact zone.

The area of impact for the purposes of assessing damages, referred to here as the "spill impact zone," was assumed to include portions of the river and adjoining shoreline beyond the area where oil was actually observed. The physical impacts of the oil varied within this zone and some portions of shoreline within this zone were not physically impacted by oil. Assumptions about the geographic extent of the area of impact were supported by on-site surveys. Concerns over the potential for finding oil at a given site or the possible presence of oil even where it is not visible apparently deterred some visitors. One respondent using the river upstream of the spill site at Eagle Harbor indicated that his use of the river had been affected by the spill. Other respondents using sites at Battle Creek and Broomes Island, which are south of the area where oil came ashore, expressed similar concerns. It is likely that respondents' use was most affected near the Chalk Point facility and the effect declined as the area of use moved farther away.

Based on the pattern of responses, as well as other factors discussed earlier, the spill impact zone for lost recreational-use damages includes the area from just south of Eagle Harbor at Potts Point in the north to Greenwell State Park and Peterson's Point in the south. This represents a region of about 17 miles in length, somewhat larger than the actual area of closure following the spill. It should be noted that this delineates the area of use, not the origin of recreational users. Anyone who might potentially visit sites in the impact zone is counted in the study regardless of where they may live.

Overflight data were used to extrapolate activity at Golden Beach to the entire impact zone. Recreation throughout the impact zone was counted visually and recorded on videotape from a helicopter. By combining the overflight counts with data from Golden Beach, daily use throughout the impact zone was estimated for the 1999 and 2000 recreation season. Details of this estimation procedure are described in Appendix I.

Had the spill not occurred, it was assumed that the pattern of use in 2000 would be similar to use in 1999, but for the effects of weather. By adjusting 1999 figures for differences in weather as described in Appendix III, a baseline level of expected use in 2000 is estimated. By comparing this baseline to an estimate of actual use in 2000, the

number of lost trips is estimated. For example, baseline trips for 2000 were estimated to be 2,832 in April, 19,699 in May, and so on. Actual trips were estimated at 0 in April and 15,196 in May, resulting in an estimate of lost trips equal to 2,832 and 4,503 for those two months, respectively. The total for April through September is 12,704 lost trips.

The Value of a Recreational Trip

Economists value recreational trips using the concept of consumer surplus. Consumer surplus is the difference between what a person would be willing to pay for a good and the actual cost of the good. The additional amount a visitor would be willing to pay to use the Patuxent River beyond any expenses actually incurred represents the consumer surplus, or economic value, for a given trip.

Over the past 30 years, numerous published studies have sought to determine the appropriate consumer-surplus value for recreational activities in various settings. It is common practice in resource damage assessments to rely on previous estimates of value when a relatively costly, site-specific valuation study does not appear warranted given the likely magnitude of damages. This reliance on previous value estimates is known as the benefit-transfer method, and the details of how it is used in this study appear in Appendix IV.

The economics literature shows that the value of a recreation trip depends on the context of the experience. The quality and features of the site, its proximity to population centers, the availability of substitute sites, as well as technical details of the valuation method itself all affect the value of a trip. Based on a review of the recreation valuation literature, as well as knowledge of recreation use in the spill zone, it was determined that $27 was an appropriate estimate of the average value of a recreational trip to the Patuxent River.

The $27 figure represents an average value for the combination of recreational activities that were observed in the impact zone, such as fishing, boating, swimming, backyard use,

etc. Fishing and boating are typically valued more highly than swimming and backyard use. This was the case in this study as well, with boating and fishing valued at $35 per trip compared to $20 per trip for swimming and backyard use. The fishing values reflect a variety of species targeted on the Patuxent, including croaker and striped bass. The value for shoreline uses like swimming reflects the fact that many people using the Patuxent live on the river or close by. They therefore are likely to place a high value on local sites compared to those who may travel from further locations for the same activity and who could more easily seek out substitute recreation sites. Further details of this analysis appear in the appendix.

Recreational Trips Diminished Due to the Spill

For those visitors who continued to use recreational sites in the impact zone following the spill, the presence of the oil likely detracted from their enjoyment. The diminished value of trips taken throughout the 2000 season is a component of the estimated spill-related losses in this assessment. Based on a previous study examining diminished recreational trips (Hanemann 1997) it was estimated that a trip taken to the spill zone soon after the closure was lifted in late April would be reduced in value by 20 percent. On the basis of impressions obtained from responses to the on-site survey, it was assumed that the amount of the loss per trip would decline to about 5 percent of the full value of a trip by mid-June and that the losses would fall to zero at the end of September. Details of this calculation are presented in Appendix 1.

Total Damages: The Total Value of Lost Trips and the Diminished Value of Actual Trips

By multiplying the estimated number of lost trips by the value of each trip, the value of lost trips is calculated to be $343,010. The diminished value of trips taken is calculated on a daily basis because the amount of the loss per trip declines each day throughout the season. Adding up these daily losses produces a damage figure of $110,489. Based on the two categories combined, total damages are calculated to be $453,499.

IV. Conclusion

As in any such assessment, decisions and assumptions must be made in the course of analysis that affect the study results. Some of the assumptions made here may lead to a conservative damage assessment. For example, no damages are calculated for recreational activity that might typically have occurred from April 7, the date of the spill, through April 15, when data first becomes available for this analysis. Recreational activity before 6 a.m. and after 9 p.m. is also ignored. These conservative assumptions may be balanced by other factors that could lead to a higher estimate of damages. For example, the Golden Beach sites on which these calculations are based are located in areas more heavily affected than some other areas in the spill zone and changes in use at Golden Beach may overstate losses at other locations. The authors of this study believe, however, that the estimate of damage herein results from a reasonable integration of the relevant data and will assist the Trustees in obtaining appropriate compensation for recreational-use losses and in carrying out restoration planning.

Appendix I: Damage Assessment Data and Methods

Appendix I: Damage Assessment Data and Methods

What follows is a detailed description of the data and methods used to calculate lost recreational-use damages for the Chalk Point oil spill. The narrative description below is followed by a set of equations that present the calculations in their entirety. The damage model itself is presented in a series of numbered tables contained in Appendix II.

The Golden Beach Data

Historical data records were collected showing the level of use in 1999 and 2000 at five recreational sites in Golden Beach, Maryland, a community on the west shore of the spill zone. See Figure 1 in the text for the location of golden Beach. These records were found to be more useful for this analysis than other historical data available, and were deemed sufficient as a benchmark measure of use throughout the spill zone for several reasons. First, the five sites encompass a variety of uses such as boating, swimming and picnicking, much like the variety of activities at recreation sites throughout the spill impact zone. Second, the data were maintained in a consistent fashion throughout the years 1999 and 2000, thereby permitting a comparison of recreational use between years. Third, the records were kept on a daily basis allowing for site-specific analysis of the effects of weather and a detailed examination of damages over time, including the determination of the appropriate date to end the period of estimated damages.

The Golden Beach data were maintained by the Beach Management Corporation and were recorded on documents entitled "Security Daily Log." These daily logs show the number of cars parked in lots for each of the five sites, recorded at various times throughout the day. The records cover the period April 15, 1999 through September 30, 1999 and the period May 1, 2000 through September 30, 2000. According to officials at Beach Management Corporation, records were not maintained in prior years. Records are not available for April 2000 because all of the Golden Beach sites were closed due to the spill. It was assumed that there were zero damages between April 7 and April 15 (when 1999 data collection began). Officials at Golden Beach indicated that there was no use of

the Golden Beach sites in 2000 between April 15 and May 1 (when data collection began in 2000).

As an example of the Golden Beach recreational use data, the data for July 17, 1999 are presented in Tables 1 and 2, below. Table 1 shows the data as recorded by officials at Golden Beach. Table 2 is a restatement of the same data, allocated to the appropriate hourly interval. These are the hourly counts referred to in the text. For example, the 8 a.m. count for the "Benson's" site at Golden Beach is 8 cars.

Table 1: The Golden Beach Data For July 17, 1999

Finish Time	Benson's	Long Point	Small Beach	Trent Hall	Main Beach
5:40 AM	4	0	0	0	0
7:44 AM	8	0	1	1	0
8:55 AM	8	2	1	1	0
10:22 AM	9	2	0	1	0
11:47 AM	6	8	0	0	1
12:00 PM	Na	20	na	na	na
12:20 PM	7	na	1	0	1
1:45 PM	6	na	0	0	2
3:00 PM	Na	10	na	na	na
3:10 PM	10	na	0	0	1
4:35 PM	11	na	0	0	0
6:00 PM	8	na	0	0	0
6:00 PM	Na	7	na	na	na
7:30 PM	5	na	0	0	0
9:00 PM	3	na	0	0	0

Table 2: Golden Beach Data For July 17, 1999, Allocated to Hourly Intervals

Start		Finish	Benson's	Long Point	Small Beach	Trent Hall	Main Beach	Total
6:00 AM	to	7:00 AM	na	na	na	na	na	na
7:00 AM	to	8:00 AM	8	0	1	1	0	10
8:00 AM	to	9:00 AM	8	2	1	1	0	12
9:00 AM	to	10:00 AM	na	na	na	na	na	na
10:00 AM	to	11:00 AM	9	2	0	1	0	12
11:00 AM	to	12:00 PM	na	20	na	na	na	na
12:00 PM	to	1:00 PM	7	na	1	0	1	na
1:00 PM	to	2:00 PM	6	na	0	0	2	na
2:00 PM	to	3:00 PM	na	10	na	na	na	na
3:00 PM	to	4:00 PM	10	na	0	0	1	na
4:00 PM	to	5:00 PM	11	na	0	0	0	na
5:00 PM	to	6:00 PM	na	7	na	na	na	na
6:00 PM	to	7:00 PM	na	na	na	na	na	na
7:00 PM	to	8:00 PM	5	na	0	0	0	na
8:00 PM	to	9:00 PM	3	na	0	0	0	na

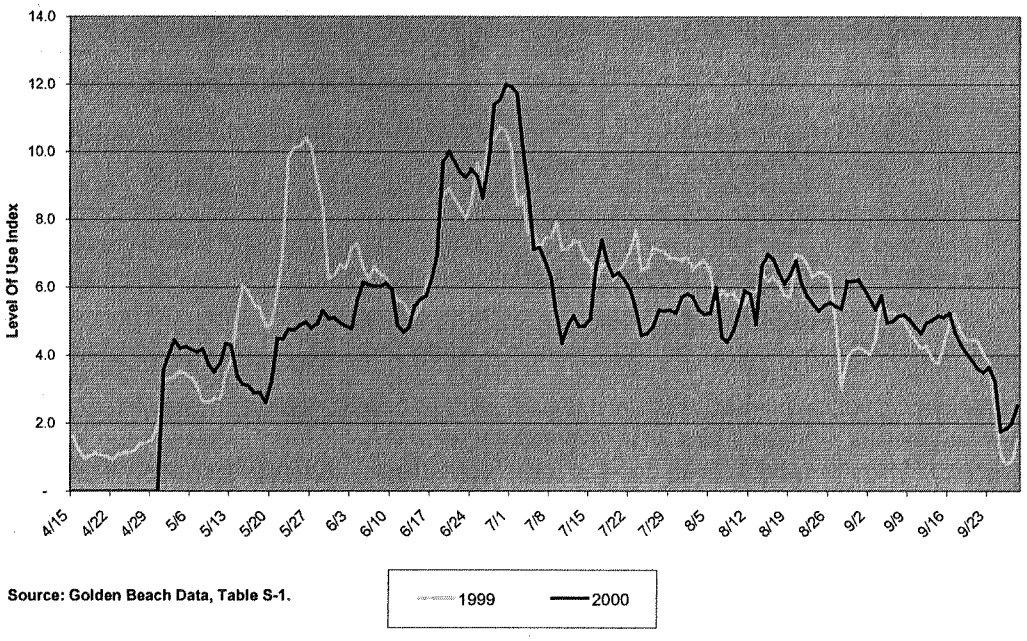
The data from Golden Beach were used in the damage assessment model in two ways. First, the daily level of activity, as indicated by the total number of cars recorded parked at the five sites, was captured in a daily index of use intensity. This index formed the basis of calculations comparing 1999 and 2000 recreational use. Second, the typical pattern of use throughout the day was determined. This refers to the relative level of use at each hour throughout the day. This was estimated by combining the use pattern for all days in 1999 into a single average hourly pattern. Using this result, a reasonable estimate of total daily use was made based on a snapshot of activity recorded at a particular time on a particular day.

These two calculations using Golden Beach data were combined with user counts from helicopter overflights to estimate use throughout the impact zone. The overflight user counts provided a snapshot of activity that can be expanded into an estimate of total daily use based on the Golden Beach pattern of use throughout the day. By comparing these estimates of total daily use to the Golden Beach index for days when overflights were taken, a multiplier was calculated allowing the Golden Beach data to be extrapolated to the entire impact zone throughout 1999 and 2000.

The Golden Beach Level-of-Use Index

The Golden Beach index used in the damage model represents the relative daily level of activity over time. It is based on the average number of cars parked at the five sites throughout a given day. The car counts were not recorded at regular times each day, nor were they recorded the same number of times at different sites on a given day. They are based on a series of snapshots of use rather than a record of the total number of cars coming and going. To create a consistent index of use, the average number of cars recorded at all sites from 6 a.m. to 9 p.m. was calculated for each day. This was accomplished by taking the average of the car counts on a given day for each of the five sites, then adding the five averages together. Thus, an index figure of 10 could mean there were 2 cars at each of the five sites all day long, or 20 cars at one site for half the day, and so on.

Figure I-1
Recreational Use At Golden Beach
7-Day Moving Average
1999 - 2000



Source: Golden Beach Data, Table S-1.

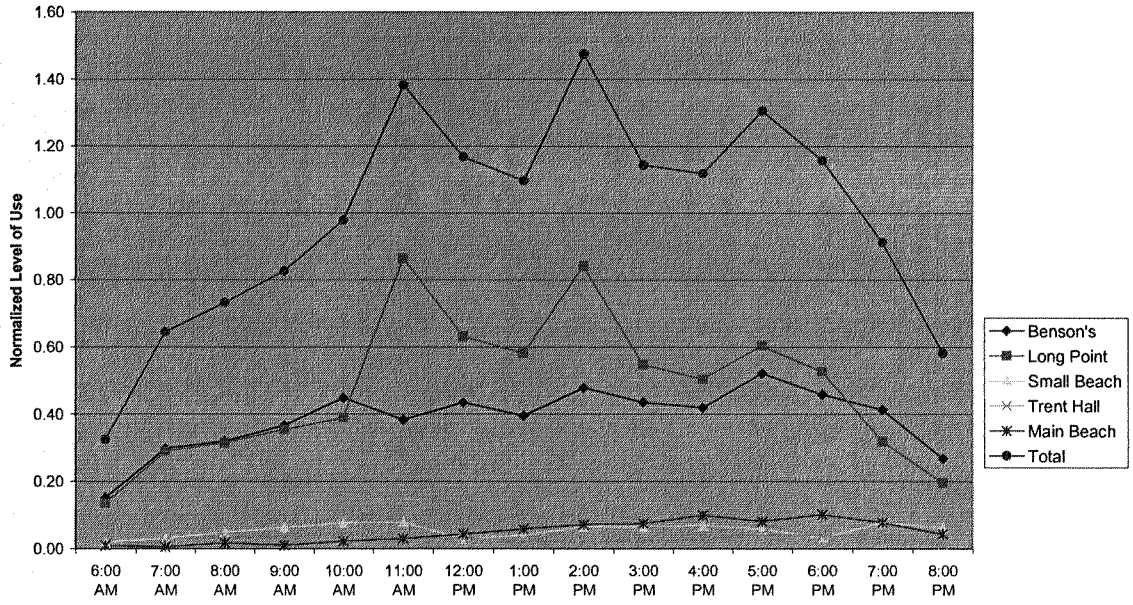
Figure I-1 shows recreational use at Golden Beach in 1999 and 2000 using this level-of-use index in a seven-day (forward-looking) moving average. No weather adjustments

were made at this point. These weekly averages smooth over daily fluctuations and make the overall trends easier to see. Use in 2000 briefly rose above use in 1999 immediately following the delayed opening of the sites, and again over the weekends of June 24th and the 4th of July. With these exceptions, use was lower in 2000 compared to 1999, up until early August.

The Average Daily Pattern of Use

As mentioned above, the historical data from Golden Beach were also used to determine the average pattern of use throughout the day at the five sites. See Figure I-2, below. This calculation required that the data be normalized, so that the line showing total use at all sites is centered about one on the vertical axis. This graph is based on 1999 data only, since disruption from the oil spill might create unusual patterns in the 2000 data.

Figure I-2
Normalized Hourly Level of Use At Five Golden Beach Sites



Source: Golden Beach Data, Table S-2.

To better understand how this graph was created, an example will illustrate. For the site called "Long Point" and the time slot 11 a.m. to 12 p.m. (marked "11:00 AM" in the graph), some daily logs throughout 1999 had car counts recorded and some didn't. To build the "Long Point" graph above, all available car counts for the 11 a.m. time slot

were combined and compared to the combined Long Point car counts for each of the other 14 time slots. To make the information comparable across days, each car count was normalized: it was divided by the level-of-use index for that day. All the available normalized car counts for Long Point at 11 a.m. were then averaged together. The average was weighted by the daily index, so that busier days had greater influence on the results than days of light use.

The same weighted average was calculated for each time slot at Long Point, and each time slot for each of the four remaining sites. These site-specific averages for each time slot were then added together to get the "total" line shown in the graph.

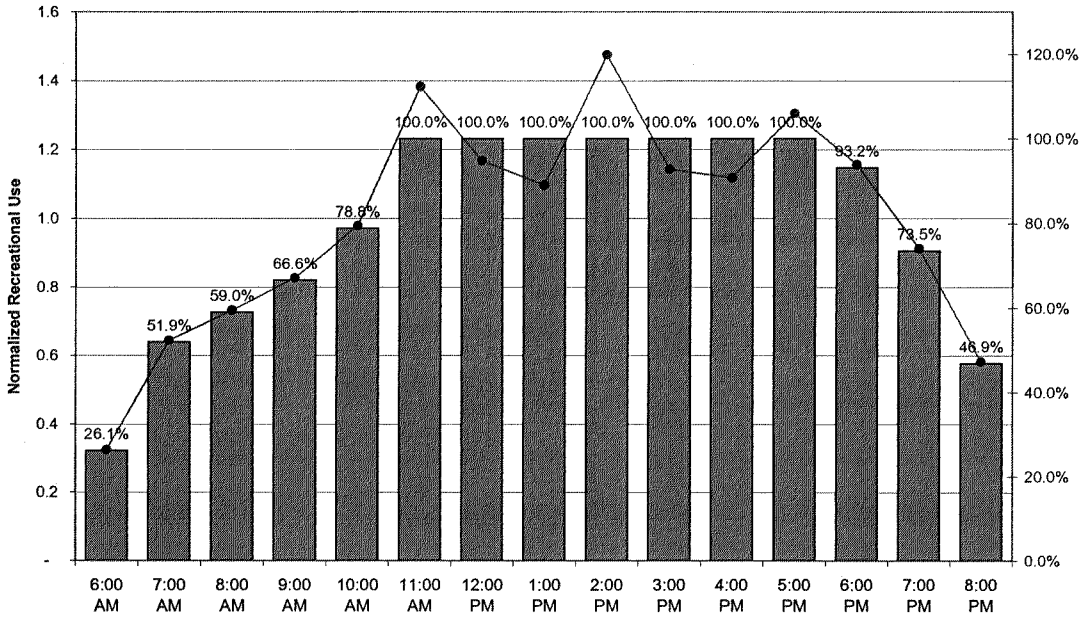
Recreational Trips Per Peak User Observed

As discussed above, the purpose of establishing the daily pattern of use is to calculate the whole day's activity based on helicopter observations that provide a snapshot of recreational activity in the spill zone recorded during hours of peak use. To perform this calculation, an estimate of recreational trips per peak user was employed.

The graph in Figure I-2 was converted into a bar chart showing the hourly level of use as a percentage of peak use at Golden Beach. This is provided in Figure I-3, using the graph of total use at all five sites. Peak use appears to occur from 11 a.m. to 5 p.m. The average peak use over that time period represents "100-percent" use in the bar chart. Use in the remaining time slots was divided by the average peak use to arrive at the percentages shown. These calculations are also presented in Table 4 of Appendix II.

It was assumed that this pattern of use was relatively consistent from day to day and throughout the region. Thus the total number of recreational person-hours spent at sites in the spill impact zone on a given day was estimated by observing the number of peak users. Each additional person observed during peak hours would imply that additional

Figure I-3
Recreational Use And Hours Per Peak User



Source: Golden Beach Data, Table 4.

recreation occurred throughout the day. For example, if there are 100 people on the beach from noon to 1 p.m., we inferred that there were 93 people from 6 p.m. to 7 p.m., and so on. Those 93 people represent 93 hours of recreational use. On average, the total daily recreational use would amount to 12 hours per peak user, or the total area of the bars shown in the chart.

Typically, recreation is valued not by the hour but by the trip. To convert hours to trips, the average length of a recreational trip was determined. This was done using an informal survey of people recreating on the Patuxent River, which generally accorded with recreational literature estimates of the duration of a recreational outing. The survey was conducted over a period of a few days in late August and early September and responses were gathered from 52 people selected by convenience sampling. The results of the survey are presented in Table 5 of Appendix II. The average length of a trip was 4.6 hours. Thus, on average, there are 12 / 4.6 = 2.6 trips taken for each peak user observed in the spill zone, including Golden Beach.

Total Impact Zone Trips

Five overflights were conducted in the spill impact zone during peak hours and the number of people engaged in recreational activities was recorded. These recreational counts are presented in Table 6 of Appendix II. Each of the five peak-user counts was multiplied by the number of trips per peak user as determined above. Thus the total number of impact zone trips was estimated for the five days when overflights were conducted. These estimates include activity at Golden Beach observed during the overflights. The Golden Beach car counts were not used to directly estimate trips at Golden Beach. Rather, the index is a separate calculation, allowing the overflight counts for the entire impact zone to be extended throughout the season.

To perform this extrapolation, the estimates of impact zone trips were compared to the Golden Beach index (also shown in Table 6 of Appendix II) and a multiplier was calculated: On average, there were 133 trips throughout the impact zone for every index unit recorded at Golden Beach. Using this approach, records at Golden Beach can be extrapolated to describe recreational activity in the entire impact zone. Results for the months of April through September are presented in Tables 3A through 3F of Appendix II.

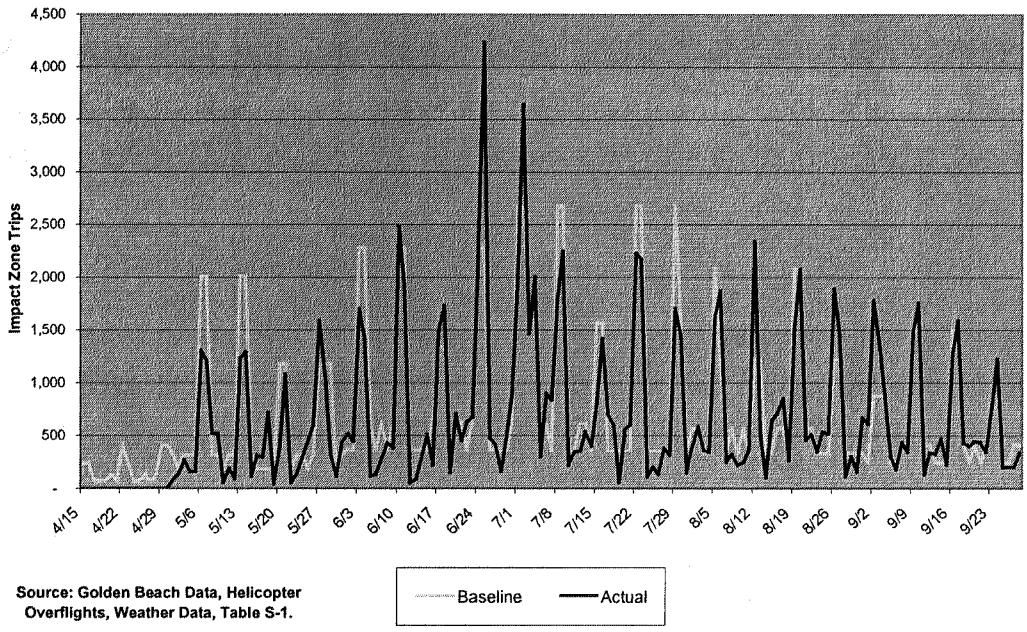
The Total Value of Lost Trips

The 1999 recreational use figures were adjusted for differences in weather between 1999 and 2000. This weather-adjusted 1999 use was used as an estimate of the baseline level of use in 2000. The difference between baseline and actual use represents lost trips due to the oil spill. Lost trips were then multiplied by a value per trip to arrive at the value of lost trips.

The average value of a recreational trip on the Patuxent River was estimated to be $27. This figure is based on the benefit-transfer method, whereby an appropriate value is selected from previous economic studies valuing similar recreational resources. Refer to Appendix IV for details of this analysis.

To determine the appropriate weather adjustment, meteorological data for the Patuxent River area were collected for 1999 and 2000 from the National Climatic Data Center and regressed against the Golden Beach index. According to the results, foul weather in 2000 led to a decline in activity compared to 1999 for the months of April, May, June and August. Thus somewhat less activity would be expected for most of the 2000 summer season even without the effects of the spill. Comparatively good weather in July 2000 led to an increase in projected baseline activity, however. Details of the weather adjustments are presented in Appendix III.

Figure I-4
Total Impact Zone Baseline and Actual Trips
2000



Source: Golden Beach Data, Helicopter Overflights, Weather Data, Table S-1.

Figure I-4 shows both the 2000 weather-adjusted baseline and estimated actual 2000 recreational activity. It is assumed that any divergence between these is due to the spill. As illustrated by the divergence of the two plotted lines, a decline in activity due to the

spill was generally observed from mid-April through early August. Following August 5, baseline and actual use fluctuate up and down but are roughly similar. August 5 was used as the end date for lost trips due to the spill. The difference between baseline and actual figures for 2000 amounted to 12,704 trips. Multiplied by the value of each trip, the total damages from lost trips amounts to $343,010.

The Diminished Value of Actual Trips

Based on responses to the on-site survey, experience with other damage assessments, and existing economics literature, it was determined that some recreational trips taken to the impact zone were diminished in value due to the spill. Survey respondents indicated that their knowledge of the spill detracted from their enjoyment of the visit. For example, some parents did not let their children swim in the water, though the family participated in other shoreline activities. Effects such as these appeared to decrease throughout the summer, with most people interviewed in late August saying their use had returned to normal by that time. The diminished value of actual trips occurs in addition to losses from trips that were not taken because of the spill.

To calculate this component of recreational damages, the loss per trip was estimated for each day based on an assumed exponential decline throughout the 2000 season. Losses were assumed to begin May 1, when Golden Beach reopened after the spill, and to continue through September. Losses in August and September were assumed to be small, based on the limited effects still present at the time of the surveys. For each day, the loss per trip was multiplied by the number of trips taken. The loss per trip was estimated to be 20 percent of the full value of a trip starting May 1. This figure is based on a previous study assessing losses due to diminished trips following the American Trader oil spill (Hanemann, 1997). Based on several site visits throughout the summer and a reasonable interpretation of the on-site survey, the loss per trip is set to decline to 5 percent of full value by June 15. The exponential expression Ae^{-bt} determines, for each day t, the values for loss per trip throughout the season.[1]

[1] This calculation requires solving two equations with two unknowns: $\$27 \times 0.2 = Ae^{-(b \times 0)}$ and

The daily calculation of losses is presented in Tables 3A through 3F of Appendix II. The loss per trip declines from $5.40 at the beginning of May to $1.35 in mid-June and to $0.06 by the end of September. The total diminished value by the end of September equals $110,489.

The Damage Model Presented in Equations

Variable Definitions

Q = Total quantity of trips in a given season

N = Total lost recreational trips for the 2000 season

V = Value of a recreational trip

T = Trips per peak user observed

A = Average length of a trip

H = Hours of recreation per peak user observed

M = Multiplier based on helicopter overflights, relating Golden Beach activity to trips throughout the spill impact zone

C_t = Count of recreational users throughout the spill impact zone on a given day *t* (observed by helicopter overflight)

L_t = Level-of-Use Index for Golden Beach for day *t*

U_{hs} = Use at Golden Beach for a given hour *h* at a given site *s*. U_{hs} is normalized by the daily level-of-use index L_t, so that U_{hs} represents a measure of hourly use relative to use throughout the day, consistent across all days.

$U_h = \sum_s U_{hs}$ = Use at all five Golden Beach sites combined for hour *h*

$U_{peak} = \sum_h U_h / 7$ for h = 11a.m. to 5 p.m., the seven hourly periods of peak use at Golden beach

X_{sht} = Count of cars parked at Golden Beach for site *s*, hour *h* and day *t*

$\$27 \times 0.05 = Ae^{-(b \times 45)}$, where 45 is the number of days from May 1 to June 15. The results are A = $5.40 and b = 0.03, so that the loss per trip at any given time is $5.4e^{-(0.03t)}$.

$I_{(X>0)}$ = An indicator variable that equals one if a count X_{sht} was performed for site s and hour h on day t, otherwise zero

Total Damages

The total number of lost trips N is multiplied by the value per trip V to calculate total damages. The value per trip is discussed in Appendix IV.

Total Damages = NV

Total Lost Trips

The total number of lost trips N is the difference between the expected number of trips in 2000 that would have occurred absent the oil spill and the actual number of trips taken in 2000. The number of trips in 2000 absent the oil spill is estimated based on the level of recreational activity in 1999 adjusted for differences in weather between 1999 and 2000. The details of the weather adjustment are given in Appendix III.

$N = Q_{1999\ \text{Weather Adjusted}} - Q_{2000\ \text{Actual}}$

Total Trips

The quantity of trips Q throughout the impact zone for the entire 2000 season is estimated using the level-of-use index L and a multiplier M that relates the index to total trips throughout the impact zone.

$Q = \sum_t L_t M$

The Golden Beach Level-of-Use Index

The level-of-use index L is constructed from the car counts X_{sht} at Golden Beach. By taking the average of the available car counts at a given site throughout the day and summing across sites, the total average use throughout the day is calculated.

$L_t = \sum_s (\sum_h X_{sht} / \sum_h I_{(X>0)})$

The Helicopter Multiplier

The multiplier *M* is the average number of trips per index unit *L* for the five days when helicopter overflights were conducted. The number of trips is estimated using the count of peak users *C* multiplied by the estimated number of trips per peak user *T*.

$M = \sum_t (C_t T / L_t) / 5$, for the five days *t* when overflights were conducted

Trips Per Peak User

The number of trips *T* per peak user is estimated based on the typical pattern of use represented in the Golden Beach data. First, the number of hours *H* per peak user is calculated. It is the sum of relative (normalized) use *U* throughout the day divided by the average normalized peak use.

$H = \sum_h U_h / U_{peak}$

The discussion of the calculation of *U* is postponed for the moment. To see that the above equation is true, it helps to realize that U_{peak} / U_{peak} is one, corresponding to one person observed during a given peak hour, which in turn represents one hour of recreational use. The sum of U_h / U_{peak} for all *h* during the seven peak hours represents seven hours of recreational use, and so on. If 100 people were observed during a given peak hour, on average one would expect that 100 people were present for the entire span of seven peak hours, representing 700 hours of recreational use. Adding up U_h / U_{peak} for all 15 hours contained in the daily Golden Beach data results in 12 hours of use for each peak user observed.

To find the number of trips *T* per peak user, we need the average number of hours *A* per trip, calculated using on-site surveys.

$T = H / A$,

which gives us trips per peak user.

Normalized Hourly Use at Golden Beach

The normalized use U_{hs} for a given hour at a given site is based on the car counts X_{sht} divided by the level-of-use index L_t, averaged across all days for which a car count was available at that hour and site. The average is weighted by the level-of-use index, so that days of heavier use count more in establishing the typical relative use.

$$U_{hs} = \{[\ \Sigma_t\ [L_t\ (X_{sht}/L_t\ )\ I_{(X>0)}\ ]\} \ /\ \Sigma_t\ (L_t\ I_{(X>0)}) = \Sigma_t\ (X_{sht}\ ) \ /\ \Sigma_t\ (L_t\ I_{(X>0)})$$

Summary

Following the calculations from the data to the results, we know the average trip length A from the on-site surveys, we know the helicopter counts C from the overflights, and we know X from the data collected at Golden Beach. From X we know L and U. From U we know H, and therefore T. From C, T and L we know M. From M and L we know Q, the total quantity of trips. We know lost trips N by comparing baseline and actual Q for 2000 as described above. Total trips multiplied by the value of a trip gives total damages.

Appendix II: Spreadsheet Calculations

Tables 1 – 6: Damage Model Tables
Tables S-1 to S-2: Supporting Tables to Text

Table 1
SUMMARY OF RESULTS

(1)	**Value of Lost Trips**		
	Total Impact Zone User Trips Lost (2000)		
	April		2,832
	May		4,503
	June		897
	July		3,888
	August		584
	September		0
	Total		12,704
	Value of Lost Trips		
	April	$	76,458
	May	$	121,574
	June	$	24,231
	July	$	104,983
	August	$	15,764
	September	$	0
	Total	**$**	**343,010**

(2)	**Lost Value of Actual Trips**		
	Total Impact Zone Actual Trips Taken		
	April		0
	May		15,196
	June		25,644
	July		30,598
	August		22,493
	September		18,427
	Total		112,359
	Reduction in Value of Actual Trips		
	April	$	0
	May	$	51,909
	June	$	34,182
	July	$	18,138
	August	$	4,635
	September	$	1,625
	Total	**$**	**110,489**

(3) **Total Lost Recreational Use** **$ 453,499**

Notes

(1) This category of damages represents losses from a decline in recreational activity due to the spill.
(2) This category of damages represents the reduction in value of trips taken to the spill impact zone in the months following the spill.
(3) This is the estimate of total lost-use damages, calculated as the sum of damages in (1) and (2).

Table 2
TABLE OF VARIABLE INPUTS

Variable Description		Data Input
(1) The Value of a Recreational Trip		$27
(2) Diminished Value of Trips Taken After the Spill		
Start of Season	5/1/00	20.0%
Mid-June	6/15/00	5.0%
Change Over Time		Exponential Decay

Notes

(1) This is the value of a trip to the Patuxent River, including the range of activities observed in the spill impact zone: fishing, swimming, backyard use, etc. Based on the benefit-transfer method. See Appendix 4.
(2) Trips taken to the impact zone were diminished in value due to the spill. The amount of lost value per actual trip was 20 percent of the full value of a trip on 5/1/00, and so on. For details, see the explanation of damage assessment methods in the text of this appendix.

Table 3A
DAMAGE ASSESSMENT MODEL: APRIL 2000

	1999			2000				
Date	Golden Beach Index	Impact Zone Trips	Weather Adjusted Index	Baseline Trips	Golden Beach Index	Actual Trips	Loss Per Trip	Diminished Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4/1	na	na	na	na	na	na	na	na
4/2	na	na	na	na	na	na	na	na
4/3	na	na	na	na	na	na	na	na
4/4	na	na	na	na	na	na	na	na
4/5	na	na	na	na	na	na	na	na
4/6	na	na	na	na	na	na	na	na
4/7	na	na	na	na	na	na	na	na
4/8	na	na	na	na	na	na	na	na
4/9	na	na	na	na	na	na	na	na
4/10	na	na	na	na	na	na	na	na
4/11	na	na	na	na	na	na	na	na
4/12	na	na	na	na	na	na	na	na
4/13	na	na	na	na	na	na	na	na
4/14	na	na	na	na	na	na	na	na
4/15	3.91	521	1.79	239	0.0	0.0	0.0	0.0
4/16	3.50	467	1.79	239	0.0	0.0	0.0	0.0
4/17	0.88	117	0.55	74	0.0	0.0	0.0	0.0
4/18	0.50	67	0.55	74	0.0	0.0	0.0	0.0
4/19	0.50	67	0.55	74	0.0	0.0	0.0	0.0
4/20	1.13	150	0.94	126	0.0	0.0	0.0	0.0
4/21	0.89	119	0.55	74	0.0	0.0	0.0	0.0
4/22	1.00	133	3.05	407	0.0	0.0	0.0	0.0
4/23	1.82	243	1.79	239	0.0	0.0	0.0	0.0
4/24	1.33	178	0.55	74	0.0	0.0	0.0	0.0
4/25	1.13	150	0.55	74	0.0	0.0	0.0	0.0
4/26	0.10	13	0.94	126	0.0	0.0	0.0	0.0
4/27	0.83	111	0.55	74	0.0	0.0	0.0	0.0
4/28	0.20	27	0.94	126	0.0	0.0	0.0	0.0
4/29	2.00	267	3.05	407	0.0	0.0	0.0	0.0
4/30	2.31	308	3.05	407	0.0	0.0	0.0	0.0
Total		2,937		2,832		0.0		0.0

Calculation of Damages

(1) Lost Trips		2,832
(2) Value of Each Trip Lost	$	27
(3) Total Value of Lost Trips	$	76,458
(4) Reduction in Value of Actual Trips	$	0
(5) Total Damages	$	76,458

Table 3A
DAMAGE ASSESSMENT MODEL: APRIL 2000

Notes (Columns)

(1) Dates refer specifically to 2000 figures. Figures for 1999 are shifted by two days so that weekends and weekdays match with 2000. Thus the first line contains figures for April 17, 1999 and April 15, 2000. The pupose of presenting 1999 figures is solely to construct baseline estimates of use for 2000.
(2) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland. Records for Row 4/19 were missing in 1999. The figure from Row 4/18 is substituted.
(3) Column (2) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(4) Data for 1999 is adjusted for differences in weather to create a prediction of 2000 baseline use. Details of the weather adjustment are presented in Appendix III.
(5) Column (4) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(6) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland.
(7) Column (6) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(8) The loss per trip is determined according to specifications in Table 2.
(9) Column (7) x Column (8)

Notes (Calculation of Damages)

(1) The total in Column (5) minus the total in Column (7).
(2) This figure is based on data from the relevant economics literature. See Appendix IV.
(3) Row (1) x Row (2)
(4) Total diminished value of actual trips, from the total in Column (9).
(5) Row (3) + Row (4)

Table 3B
DAMAGE ASSESSMENT MODEL: MAY 2000

	1999			2000				
Date	Golden Beach Index	Impact Zone Trips	Weather Adjusted Index	Baseline Trips	Golden Beach Index	Actual Trips	Loss Per Trip	Diminished Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5/1	1.5	200	2.4	317	0.6	80	$5.40	$432
5/2	1.5	200	1.4	185	1.0	133	$5.24	$698
5/3	1.4	193	2.4	317	2.0	267	$5.08	$1,354
5/4	0.9	119	2.4	317	1.2	160	$4.92	$788
5/5	0.9	119	2.4	317	1.2	160	$4.77	$764
5/6	4.8	643	15.0	2,007	9.8	1,303	$4.63	$6,031
5/7	11.5	1,534	15.0	2,007	9.1	1,215	$4.49	$5,453
5/8	2.1	279	2.4	317	3.9	519	$4.35	$2,260
5/9	2.0	267	2.4	317	3.9	519	$4.22	$2,191
5/10	2.6	347	1.4	185	0.4	57	$4.09	$234
5/11	0.1	13	2.4	317	1.4	187	$3.97	$741
5/12	0.1	13	2.4	317	0.7	89	$3.85	$342
5/13	3.1	420	15.0	2,007	9.3	1,234	$3.73	$4,604
5/14	8.4	1,125	15.0	2,007	9.7	1,287	$3.62	$4,657
5/15	1.8	241	2.38	317	0.9	114	$3.51	$401
5/16	2.8	375	1.39	185	2.3	311	$3.40	$1,059
5/17	2.7	357	1.39	185	2.2	293	$3.30	$968
5/18	5.3	708	1.39	185	5.4	715	$3.20	$2,286
5/19	2.7	360	1.39	185	0.3	44	$3.10	$138
5/20	12.7	1,690	8.82	1,177	2.9	383	$3.01	$1,153
5/21	14.4	1,914	8.82	1,177	8.1	1,082	$2.92	$3,154
5/22	0.5	67	1.39	185	0.4	53	$2.83	$151
5/23	0.3	44	2.38	317	1.0	133	$2.74	$366
5/24	1.7	227	2.38	317	2.2	293	$2.66	$780
5/25	1.8	241	1.39	185	3.3	445	$2.58	$1,146
5/26	3.1	413	2.38	317	4.5	603	$2.50	$1,506
5/27	19.3	2,571	8.82	1,177	11.9	1,582	$2.42	$3,834
5/28	22.3	2,975	8.82	1,177	8.0	1,067	$2.35	$2,508
5/29	20.3	2,703	8.82	1,177	2.4	317	$2.28	$722
5/30	2.4	316	1.39	185	0.9	117	$2.21	$258
5/31	2.2	291	2.38	317	3.3	434	$2.14	$929
Total		20,964		19,699		15,196		$51,909

Calculation of Damages

(1) Lost Trips	4,503
(2) Value of Each Trip Lost	$ 27
(3) Total Value of Lost Trips	$ 121,574
(4) Reduction in Value of Actual Trips	$ 51,909
(5) Total Damages	$ 173,483

Table 3B
DAMAGE ASSESSMENT MODEL: MAY 2000

Notes (Columns)

(1) Dates refer specifically to 2000 figures. Figures for 1999 are shifted by two days so that weekends and weekdays match with 2000. Thus the first line contains figures for May 3, 1999 and May 1, 2000. The pupose of presenting 1999 figures is solely to construct baseline estimates of use for 2000.
(2) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland. Records for Row 5/1 were missing in 1999. The figure from Row 5/2 is substituted. Likewise for 1999, 5/5 replaces 5/4 and 5/12 replaces 5/11. For 2000, 5/5 replaces 5/4 and 5/9 replaces 5/8.
(3) Column (2) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(4) Data for 1999 is adjusted for differences in weather to create a prediction of 2000 baseline use. Details of the weather adjustment are presented in Appendix III.
(5) Column (4) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(6) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland.
(7) Column (6) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(8) The loss per trip is determined according to specifications in Table 2.
(9) Column (7) x Column (8)

Notes (Calculation of Damages)

(1) The total in Column (5) minus the total in Column (7).
(2) This figure is based on data from the relevant economics literature. See Appendix IV.
(3) Row (1) x Row (2)
(4) Total diminished value of actual trips, from the total in Column (9).
(5) Row (3) + Row (4)

Table 3C
DAMAGE ASSESSMENT MODEL: JUNE 2000

	1999			2000				
Date	Golden Beach Index	Impact Zone Trips	Weather Adjusted Index	Baseline Trips	Golden Beach Index	Actual Trips	Loss Per Trip	Diminished Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
6/1	3.3	445	2.8	368	3.9	517	$2.08	$1,074
6/2	1.4	187	2.8	368	3.3	445	$2.01	$896
6/3	12.3	1,646	17.1	2,277	12.7	1,700	$1.95	$3,321
6/4	16.7	2,223	17.1	2,277	10.6	1,420	$1.89	$2,690
6/5	5.5	734	4.7	632	0.9	114	$1.84	$210
6/6	3.1	411	2.8	368	1.0	133	$1.78	$238
6/7	4.1	551	4.7	632	2.1	286	$1.73	$494
6/8	2.8	373	2.8	368	3.2	427	$1.67	$715
6/9	5.6	752	4.7	632	2.9	385	$1.62	$626
6/10	13.1	1,751	17.1	2,277	18.6	2,475	$1.57	$3,898
6/11	11.8	1,577	17.1	2,277	14.3	1,909	$1.53	$2,915
6/12	3.2	427	2.8	368	0.4	50	$1.48	$74
6/13	5.3	710	2.8	368	0.7	89	$1.44	$128
6/14	2.9	387	2.8	368	2.1	286	$1.39	$398
6/15	2.0	267	2.76	368	3.8	511	$1.35	$690
6/16	3.0	400	4.74	632	1.6	217	$1.31	$284
6/17	11.2	1,498	10.01	1,335	11.2	1,497	$1.27	$1,900
6/18	11.2	1,498	10.01	1,335	12.9	1,727	$1.23	$2,125
6/19	1.1	152	2.76	368	1.1	152	$1.19	$182
6/20	4.2	554	4.74	632	5.3	705	$1.16	$816
6/21	5.2	697	4.74	632	3.4	450	$1.12	$505
6/22	6.5	873	2.76	368	4.7	629	$1.09	$684
6/23	4.9	655	4.74	632	5.0	672	$1.06	$709
6/24	15.7	2,090	17.1	2,277	16.4	2,184	$1.02	$2,235
6/25	23.3	3,104	17.1	2,277	31.7	4,233	$0.99	$4,199
6/26	2.6	350	2.76	368	3.6	476	$0.96	$458
6/27	2.0	273	2.76	368	3.1	417	$0.93	$389
6/28	3.3	440	2.76	368	1.2	160	$0.90	$145
6/29	4.4	587	2.76	368	3.7	490	$0.88	$430
6/30	7.8	1,043	4.74	632	6.7	889	$0.85	$756
Total		26,653		26,542		25,644		$34,182

Calculation of Damages

(1) Lost Trips		897
(2) Value of Each Trip Lost	$	27
(3) Total Value of Lost Trips	$	24,231
(4) Reduction in Value of Actual Trips	$	34,182
(5) Total Damages	$	58,413

Table 3C
DAMAGE ASSESSMENT MODEL: JUNE 2000

Notes (Columns)

(1) Dates refer specifically to 2000 figures. Figures for 1999 are shifted by two days so that weekends and weekdays match with 2000. Thus the first line contains figures for June 3, 1999 and June 1, 2000. The pupose of presenting 1999 figures is solely to construct baseline estimates of use for 2000.
(2) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland. Records for Row 6/18 were missing in 1999. The figure from Row 6/17 is substituted.
(3) Column (2) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(4) Data for 1999 is adjusted for differences in weather to create a prediction of 2000 baseline use. Details of the weather adjustment are presented in Appendix III.
(5) Column (4) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(6) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland.
(7) Column (6) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(8) The loss per trip is determined according to specifications in Table 2.
(9) Column (7) x Column (8)

Notes (Calculation of Damages)

(1) The total in Column (5) minus the total in Column (7). The result is negative 531, so there were no lost trips in June.
(2) This figure is based on data from the relevant economics literature. See Appendix IV.
(3) Row (1) x Row (2)
(4) Total diminished value of actual trips, from the total in Column (9).
(5) Row (3) + Row (4)

Table 3D
DAMAGE ASSESSMENT MODEL: JULY 2000

	1999			2000				
Date	Golden Beach Index	Impact Zone Trips	Weather Adjusted Index	Baseline Trips	Golden Beach Index	Actual Trips	Loss Per Trip	Diminished Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
7/1	24.1	3,210	20.1	2,677	15.0	2,001	$0.82	$1,650
7/2	20.2	2,691	20.1	2,677	27.3	3,639	$0.80	$2,910
7/3	10.4	1,389	12.3	1,645	11.0	1,467	$0.78	$1,138
7/4	2.4	325	11.8	1,570	15.0	2,001	$0.75	$1,504
7/5	5.7	762	4.6	613	2.3	300	$0.73	$219
7/6	4.0	530	4.6	613	6.7	896	$0.71	$633
7/7	4.0	530	2.7	358	6.3	838	$0.69	$575
7/8	12.4	1,653	20.1	2,677	13.5	1,803	$0.66	$1,198
7/9	21.7	2,896	20.1	2,677	16.8	2,245	$0.64	$1,447
7/10	3.0	400	2.7	358	1.6	217	$0.62	$135
7/11	2.8	371	2.7	358	2.6	343	$0.61	$208
7/12	2.0	267	4.6	613	2.6	350	$0.59	$206
7/13	6.2	830	4.6	613	4.0	534	$0.57	$304
7/14	4.3	570	2.7	358	3.0	400	$0.55	$221
7/15	15.4	2,053	11.77	1,570	6.1	810	$0.54	$434
7/16	16.1	2,144	11.77	1,570	10.6	1,418	$0.52	$737
7/17	3.2	427	2.68	358	5.3	700	$0.50	$353
7/18	4.5	594	2.68	358	4.5	600	$0.49	$293
7/19	1.7	222	2.68	358	0.4	57	$0.47	$27
7/20	2.9	387	2.68	358	4.2	556	$0.46	$255
7/21	3.5	467	2.68	358	4.5	600	$0.45	$267
7/22	11.3	1,503	20.07	2,677	16.7	2,223	$0.43	$960
7/23	19.5	2,599	20.07	2,677	16.2	2,167	$0.42	$907
7/24	3.6	480	2.68	358	0.8	111	$0.41	$45
7/25	1.2	160	2.68	358	1.5	200	$0.39	$79
7/26	3.3	440	2.68	358	1.0	133	$0.38	$51
7/27	4.7	622	2.68	358	2.8	378	$0.37	$140
7/28	5.9	785	2.68	358	2.4	317	$0.36	$114
7/29	15.7	2,092	20.07	2,677	12.8	1,701	$0.35	$592
7/30	11.3	1,502	11.77	1,570	10.8	1,441	$0.34	$486
7/31	4.0	534	2.68	358	1.1	152	$0.33	$50
Total		33,435		34,487		30,598		$18,138

Calculation of Damages

(1) Lost Trips	3,888
(2) Value of Each Trip Lost	$ 27
(3) Total Value of Lost Trips	$ 104,983
(4) Reduction in Value of Actual Trips	$ 18,138
(5) Total Damages	$ 123,121

Table 3D
DAMAGE ASSESSMENT MODEL: JULY 2000

Notes (Columns)

(1) Dates refer specifically to 2000 figures. Figures for 1999 are shifted by two days so that weekends and weekdays match with 2000. Thus the first line contains figures for July 3, 1999 and July 1, 2000. The pupose of presenting 1999 figures is solely to construct baseline estimates of use for 2000. Note that July 3, 2000 was a Monday, but was part of a holiday weekend. It was therefore treated as a combination of a weekend and weekday, with the baseline calculated as an average of the weekend and weekday baselines.
(2) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland. Records for Row 7/7 were missing in 1999. The figure from Row 7/6 is substituted.
(3) Column (2) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(4) Data for 1999 is adjusted for differences in weather to predict 2000 baseline use. Details of the weather adjustment are presented in Appendix III.
(5) Column (4) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(6) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland.
(7) Column (6) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(8) The loss per trip is determined according to specifications in Table 2.
(9) Column (7) x Column (8)

Notes (Calculation of Damages)

(1) The total in Column (5) minus the total in Column (7).
(2) This figure is based on data from the relevant economics literature. See Appendix IV.
(3) Row (1) x Row (2)
(4) Total diminished value of actual trips, from the total in Column (9).
(5) Row (3) + Row (4)

Table 3E
DAMAGE ASSESSMENT MODEL: AUGUST 2000

	1999			2000				
Date	Golden Beach Index	Impact Zone Trips	Weather Adjusted Index	Baseline Trips	Golden Beach Index	Actual Trips	Loss Per Trip	Diminished Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
8/1	5.4	718	4.3	569	3.0	400	$0.32	$127
8/2	2.7	366	4.3	569	4.4	581	$0.31	$179
8/3	4.4	587	2.5	332	2.7	356	$0.30	$106
8/4	4.5	606	2.5	332	2.6	343	$0.29	$99
8/5	15.6	2,084	15.6	2,084	12.2	1,623	$0.28	$455
8/6	10.9	1,449	9.2	1,222	14.0	1,867	$0.27	$508
8/7	4.7	625	2.5	332	1.9	248	$0.26	$65
8/8	2.9	382	4.3	569	2.4	320	$0.26	$82
8/9	3.8	509	2.5	332	1.7	222	$0.25	$55
8/10	5.1	684	4.3	569	1.8	240	$0.24	$58
8/11	2.3	307	2.5	332	2.7	362	$0.23	$84
8/12	8.4	1,119	9.2	1,222	17.5	2,334	$0.23	$528
8/13	14.1	1,875	9.2	1,222	3.8	507	$0.22	$111
8/14	3.8	511	2.5	332	0.8	107	$0.21	$23
8/15	3.3	436	2.5	332	4.8	640	$0.21	$132
8/16	1.9	252	4.3	569	5.3	711	$0.20	$142
8/17	4.8	637	4.3	569	6.3	845	$0.19	$164
8/18	4.9	654	2.5	332	2.0	267	$0.19	$50
8/19	8.5	1,128	15.6	2,084	11.3	1,512	$0.18	$276
8/20	17.8	2,380	15.6	2,084	15.6	2,075	$0.18	$367
8/21	2.1	280	4.3	569	3.4	457	$0.17	$78
8/22	4.0	534	4.3	569	3.8	507	$0.17	$84
8/23	0.8	100	2.5	332	2.6	347	$0.16	$56
8/24	2.3	311	2.5	332	4.0	534	$0.16	$83
8/25	4.5	600	2.5	332	3.9	514	$0.15	$78
8/26	17.2	2,288	9.2	1,222	14.1	1,886	$0.15	$277
8/27	17.4	2,318	9.2	1,222	10.9	1,451	$0.14	$207
8/28	0.5	67	2.5	332	0.9	114	$0.14	$16
8/29	1.3	176	2.5	332	2.3	300	$0.13	$40
8/30	1.9	253	2.5	332	1.2	156	$0.13	$20
8/31	2.1	286	2.5	332	5.0	667	$0.13	$84
Total		24,524		21,897		22,493		$4,635

Calculation of Damages

(1) Lost Trips		584
(2) Value of Each Trip Lost	$	27
(3) Total Value of Lost Trips	$	15,764
(4) Reduction in Value of Actual Trips	$	4,635
(5) Total Damages	$	20,399

Table 3E
DAMAGE ASSESSMENT MODEL: AUGUST 2000

Notes (Columns)

(1) Dates refer specifically to 2000 figures. Figures for 1999 are shifted by two days so that weekends and weekdays match with 2000. Thus the first line contains figures for August 3, 1999 and August 1, 2000. The pupose of presenting 1999 figures is solely to construct baseline estimates of use for 2000.
(2) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland.
(3) Column (2) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(4) Data for 1999 is adjusted for differences in weather to create a prediction of 2000 baseline use. Details of the weather adjustment are presented in Appendix III.
(5) Column (4) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(6) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland.
(7) Column (6) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(8) The loss per trip is determined according to specifications in Table 2.
(9) Column (7) x Column (8)

Notes (Calculation of Damages)

(1) The total through August 5 in Column (5) minus the same total in Column (7). As described in the report, damages from lost trips are determined to end August 5.
(2) This figure is based on data from the relevant economics literature. See Appendix IV.
(3) Row (1) x Row (2)
(4) Total diminished value of actual trips, from the total in Column (9).
(5) Row (3) + Row (4)

Table 3F
DAMAGE ASSESSMENT MODEL: SEPTEMBER 2000

	1999			2000				
Date	Golden Beach Index	Impact Zone Trips	Weather Adjusted Index	Baseline Trips	Golden Beach Index	Actual Trips	Loss Per Trip	Diminished Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9/1	3.4	454	1.8	241	4.6	610	$0.12	$74
9/2	7.5	1,000	6.6	874	13.3	1,778	$0.12	$211
9/3	4.3	578	6.6	874	10.3	1,378	$0.11	$158
9/4	7.0	934	6.6	874	6.6	880	$0.11	$98
9/5	2.9	381	1.8	241	2.3	300	$0.11	$32
9/6	2.4	320	1.8	241	1.3	178	$0.10	$19
9/7	1.5	205	3.1	412	3.3	434	$0.10	$44
9/8	2.6	347	3.1	412	2.6	343	$0.10	$34
9/9	10.8	1,443	11.2	1,491	11.1	1,486	$0.10	$142
9/10	13.2	1,761	11.2	1,491	13.1	1,751	$0.09	$162
9/11	3.1	417	3.1	412	1.0	133	$0.09	$12
9/12	3.3	436	3.1	412	2.5	333	$0.09	$29
9/13	1.5	200	1.8	241	2.4	324	$0.08	$27
9/14	0.5	67	1.8	241	3.5	467	$0.08	$38
9/15	0.5	67	1.8	241	1.7	222	$0.08	$18
9/16	8.7	1,163	11.2	1,491	9.5	1,270	$0.08	$98
9/17	11.8	1,575	11.2	1,491	11.9	1,585	$0.07	$118
9/18	3.6	480	3.1	412	3.2	427	$0.07	$31
9/19	0.7	89	1.8	241	3.0	400	$0.07	$28
9/20	0.5	67	3.1	412	3.3	438	$0.07	$30
9/21	4.3	569	1.8	241	3.3	434	$0.07	$29
9/22	5.1	680	3.1	412	2.6	343	$0.06	$22
9/23	10.5	1,396	6.6	874	5.7	756	$0.06	$47
9/24	8.3	1,100	6.6	874	9.2	1,223	$0.06	$74
9/25	1.8	245	1.8	241	1.5	200	$0.06	$12
9/26	0.7	98	1.8	241	1.5	200	$0.06	$11
9/27	0.2	27	3.1	412	1.5	200	$0.05	$11
9/28	1.5	200	3.1	412	2.5	333	$0.05	$18
Total		16,297		16,450		18,427		$1,625

Calculation of Damages

(1) Lost Trips		0
(2) Value of Each Trip Lost	$	27
(3) Total Value of Lost Trips	$	0
(4) Reduction in Value of Actual Trips	$	1,625
(5) Total Damages	$	1,625

Table 3F
DAMAGE ASSESSMENT MODEL: SEPTEMBER 2000

Notes (Columns)

(1) Dates refer specifically to 2000 figures. Figures for 1999 are shifted by two days so that weekends and weekdays match with 2000. Thus the first line contains figures for September 3, 1999 and September 1, 2000. The pupose of presenting 1999 figures is solely to construct baseline estimates of use for 2000.
(2) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland. Records for Row 9/14 were missing in 1999. The figure from Row 9/15 is substituted. Likewise for 2000, 9/25 and 9/26 were both missing, and were replaced with the figure for 9/27.
(3) Column (2) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(4) Data for 1999 is adjusted for differences in weather to create a prediction of 2000 baseline use. Details of the weather adjustment are presented in Appendix III.
(5) Column (4) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(6) The Golden Beach index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in Golden Beach, Maryland.
(7) Column (6) multiplied by the 133, the impact zone multiplier (see Table 6). On average, there were 133 recreational trips per Golden Beach index unit.
(8) The loss per trip is determined according to specifications in Table 2.
(9) Column (7) x Column (8)

Notes (Calculation of Damages)

(1) Damages due to lost trips were determined to end in August, so no lost trips are calculated for September.
(2) This figure is based on data from the relevant economics literature. See Appendix IV.
(3) Row (1) x Row (2)
(4) Total diminished value of actual trips, from the total in Column (9).
(5) Row (3) + Row (4)

Table 4
TRIPS PER PEAK USER OBSERVED

Time	Normalized Hourly Level Of Use	Average Peak Use	Use As % Of Peak
(1)	(2)	(3)	(4)
6:00 AM	0.32		26.1%
7:00 AM	0.64		51.9%
8:00 AM	0.73		59.0%
9:00 AM	0.83		66.6%
10:00 AM	0.98		78.8%
11:00 AM	1.38	1.24	100.0%
12:00 PM	1.17	1.24	100.0%
1:00 PM	1.10	1.24	100.0%
2:00 PM	1.47	1.24	100.0%
3:00 PM	1.14	1.24	100.0%
4:00 PM	1.12	1.24	100.0%
5:00 PM	1.30	1.24	100.0%
6:00 PM	1.16		93.2%
7:00 PM	0.91		73.5%
8:00 PM	0.58		46.9%

(1) Total Person-Hours	12.0
(2) Average Trip Length	4.6
(3) Trips Per Peak User Observed Peak	2.61

Notes (Columns)

(1) The row "6:00 AM" refers to the time period 6 a.m. to 7 a.m., and so on. Records prior to 6 a.m. and after 9 p.m. were only sporadically maintained and were therefore not includd in this analysis.
(2) These unitless figures represent the relative intensity of use throughout the day based on data from Golden Beach.
(3) Hours of peak use are judged to be 11 a.m. to 5 p.m., based on visual inspection of the numbers in Column (1) and Figure 2 entitled "Normalized Hourly Level Of Use At Five Golden Beach Sites." The average of the peak-use figures in Column (1) is calculated to be 1.24.
(4) The intensity of use for a given time period is represented as a percentage of peak use.

Notes (Rows)

(1) Given the pattern of use represented in Column (3), it can be estimated that there are typically 12 user-hours of recreational activity associated with each person observed during peak hours. This is simply the total of Column (3) expressed in units rather than percentages.
(2) See Table 7 entitled "The Length of a Recreational Trip."
(3) Calculation: Row (1) / Row (2)
Given the estimated hours of recreational use per peak user and the average hours per trip, recreational trips per peak user can be calculated.

Table 5
THE LENGTH OF A RECREATIONAL TRIP

Observation	Length Of Trip	Observation	Length Of Trip
1	4.5	27	3.5
2	5.0	28	4.5
3	2.0	29	na
4	1.5	30	1.5
5	4.3	31	4.5
6	6.0	32	1.3
7	5.0	33	1.8
8	6.0	34	3.2
9	6.0	35	4.2
10	3.0	36	6.0
11	3.0	37	7.0
12	2.5	38	5.0
13	na	39	3.0
14	4.5	40	6.5
15	na	41	3.5
16	na	42	2.8
17	5.0	43	5.0
18	na	44	6.0
19	8.0	45	1.0
20	2.5	46	5.0
21	6.5	47	na
22	7.5	48	na
23	4.5	49	12.5
24	5.5	50	3.5
25	7.0	51	7.5
26	5.0	52	3.0

Average	4.59
Median	4.50

Notes

Average and median trip length are calculated based on responses to 52 surveys administered throughout the impact zone in late August and early September, 2000.

Table 6
CALCULATION OF IMPACT ZONE MULTIPLIER
Based On Golden Beach Car Counts and Overflight Peak Recreation Counts

Date Of Overflight	Overflight Impact Zone Total Count	Estimated Trips Per Peak User Counted	Impact Zone Total Trips	Golden Beach Index Of Use	Impact Zone Multiplier: Trips/ Index Unit
(1)	(2)	(3)	(4)	(5)	(6)
08/12/00	816	2.61	2,128	17.5	122
08/19/00	682	2.61	1,777	11.3	157
09/09/00	561	2.61	1,462	11.1	131
09/10/00	675	2.61	1,759	13.1	134
09/13/00	108	2.61	282	2.4	116
Total	2,841	2.61	7,407	55.53	133

Notes:

(1) Overflights were conducted on four weekend days and one weekday.
(2) The total number of recreators were counted throughout the impact zone during hours of peak use.
(3) See Table 6 entitled "Trips Per Peak User Observed." This figure is based on the typical level of use throughout the day (using Golden Beach data) and the typical length of a recreational trip (using surveys conducted throughout the impact zone). Given a snapshot of recreational use recorded sometime during peak hours (11 a.m. to 5 p.m.), an estimated 2.66 recreational trips occurred for each peak user observed.
(4) Calculation: Row (2) x Row (3)
(5) See Table 5 entitled "Summary of Damage Assessment: June - September 2000."
(6) Calculation: Row (4) / Row (5).

Table S-1
ADDITIONAL SUPPORTING DATA
LEVEL-OF-USE INDEX AND LOSS PER TRIP, SEVEN-DAY MOVING AVERAGE, 1999-2000

	Estimated Recreational Activity						2000 Season Reduction In Value Of Trips Taken		
	1999			2000					
Date	Golden Beach Index	Impact Zone Trips	Index: 7-Day Moving Average	Golden Beach Index	Impact Zone Trips	Index: 7-Day Moving Average	Loss Per Trip	Daily Total Lost Value	Lost-Value 7-Day Moving Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
4/15	3.9	521	1.6	-	0	0	$0.00	$0	$0
4/16	3.5	467	1.2	-	0	0	$0.00	$0	$0
4/17	0.9	117	1.0	-	0	0	$0.00	$0	$0
4/18	0.5	67	1.0	-	0	0	$0.00	$0	$0
4/19	0.5	67	1.1	-	0	0	$0.00	$0	$0
4/20	1.1	150	1.1	-	0	0	$0.00	$0	$0
4/21	0.9	119	1.0	-	0	0	$0.00	$0	$0
4/22	1.0	133	0.9	-	0	0	$0.00	$0	$0
4/23	1.8	243	1.1	-	0	0	$0.00	$0	$0
4/24	1.3	178	1.1	-	0	0	$0.00	$0	$0
4/25	1.1	150	1.2	-	0	0	$0.00	$0	$0
4/26	0.1	13	1.2	-	0	0	$0.00	$0	$0
4/27	0.8	111	1.4	-	0	0	$0.00	$0	$0
4/28	0.2	27	1.4	-	0	0	$0.00	$0	$0
4/29	2.0	267	1.5	-	0	0	$0.00	$0	$0
4/30	2.3	308	1.9	-	0	0	$0.00	$0	$0
5/1	1.5	200	3.2	0.6	80	3.6	$5.40	$432	$2,217
5/2	1.5	200	3.3	1.0	133	4.0	$5.24	$698	$2,478
5/3	1.4	193	3.4	2.0	267	4.4	$5.08	$1,354	$2,692
5/4	0.9	119	3.5	1.2	160	4.2	$4.92	$788	$2,532
5/5	0.9	119	3.4	1.2	160	4.2	$4.77	$764	$2,525
5/6	4.8	643	3.3	9.8	1,303	4.2	$4.63	$6,031	$2,465
5/7	11.5	1,534	3.1	9.1	1,215	4.1	$4.49	$5,453	$2,261
5/8	2.1	279	2.6	3.9	519	4.2	$4.35	$2,260	$2,147
5/9	2.0	267	2.6	3.9	519	3.7	$4.22	$2,191	$1,881
5/10	2.6	347	2.7	0.4	57	3.5	$4.09	$234	$1,720
5/11	0.1	13	2.7	1.4	187	3.8	$3.97	$741	$1,825
5/12	0.1	13	3.5	0.7	89	4.3	$3.85	$342	$2,045
5/13	3.1	420	3.8	9.3	1,234	4.3	$3.73	$4,604	$2,016
5/14	8.4	1,125	5.2	9.7	1,287	3.4	$3.62	$4,657	$1,523
5/15	1.8	241	6.0	0.9	114	3.2	$3.51	$401	$1,308
5/16	2.8	375	5.9	2.3	311	3.1	$3.40	$1,059	$1,273
5/17	2.7	357	5.5	2.2	293	2.9	$3.30	$968	$1,174
5/18	5.3	708	5.4	5.4	715	2.9	$3.20	$2,286	$1,147
5/19	2.7	360	4.9	0.3	44	2.6	$3.10	$138	$984
5/20	12.7	1,690	4.9	2.9	383	3.2	$3.01	$1,153	$1,180
5/21	14.4	1,914	5.9	8.1	1,082	4.5	$2.92	$3,154	$1,563
5/22	0.5	67	7.0	0.4	53	4.5	$2.83	$151	$1,470
5/23	0.3	44	9.8	1.0	133	4.8	$2.74	$366	$1,552
5/24	1.7	227	10.1	2.2	293	4.7	$2.66	$780	$1,536
5/25	1.8	241	10.2	3.3	445	4.9	$2.58	$1,146	$1,558
5/26	3.1	413	10.4	4.5	603	5.0	$2.50	$1,506	$1,547
5/27	19.3	2,571	10.2	11.9	1,582	4.8	$2.42	$3,834	$1,460
5/28	22.3	2,975	9.2	8.0	1,067	4.9	$2.35	$2,508	$1,387
5/29	20.3	2,703	8.4	2.4	317	5.3	$2.28	$722	$1,413
5/30	2.4	316	6.3	0.9	117	5.1	$2.21	$258	$1,340
5/31	2.2	291	6.4	3.3	434	5.1	$2.14	$929	$1,337
6/1	3.3	445	6.6	3.9	517	4.9	$2.08	$1,074	$1,275
6/2	1.4	187	6.6	3.3	445	4.8	$2.01	$896	$1,223
6/3	12.3	1,646	7.2	12.7	1,700	4.8	$1.95	$3,321	$1,185
6/4	16.7	2,223	7.3	10.6	1,420	5.6	$1.89	$2,690	$1,267
6/5	5.5	734	6.6	0.9	114	6.1	$1.84	$210	$1,299
6/6	3.1	411	6.3	1.0	133	6.1	$1.78	$238	$1,280
6/7	4.1	551	6.6	2.1	286	6.0	$1.73	$494	$1,264
6/8	2.8	373	6.4	3.2	427	6.0	$1.67	$715	$1,250
6/9	5.6	752	6.3	2.9	385	6.1	$1.62	$626	$1,247
6/10	13.1	1,751	5.9	18.6	2,475	5.9	$1.57	$3,898	$1,198
6/11	11.8	1,577	5.6	14.3	1,909	4.9	$1.53	$2,915	$913

Table S-1
ADDITIONAL SUPPORTING DATA
LEVEL-OF-USE INDEX AND LOSS PER TRIP, SEVEN-DAY MOVING AVERAGE, 1999-2000

	Estimated Recreational Activity						2000 Season Reduction In Value Of Trips Taken		
	1999			2000					
Date	Golden Beach Index	Impact Zone Trips	Index: 7-Day Moving Average	Golden Beach Index	Impact Zone Trips	Index: 7-Day Moving Average	Loss Per Trip	Daily Total Lost Value	Lost-Value 7-Day Moving Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
6/12	3.2	427	5.6	0.4	50	4.7	$1.48	$74	$800
6/13	5.3	710	5.3	0.7	89	4.8	$1.44	$128	$815
6/14	2.9	387	5.1	2.1	286	5.5	$1.39	$398	$914
6/15	2.0	267	5.4	3.8	511	5.6	$1.35	$690	$929
6/16	3.0	400	6.1	1.6	217	5.8	$1.31	$284	$928
6/17	11.2	1,498	6.3	11.2	1,497	6.2	$1.27	$1,900	$989
6/18	11.2	1,498	7.0	12.9	1,727	7.0	$1.23	$2,125	$1,037
6/19	1.1	152	8.7	1.1	152	9.7	$1.19	$182	$1,333
6/20	4.2	554	8.9	5.3	705	10.0	$1.16	$816	$1,372
6/21	5.2	697	8.6	3.4	450	9.7	$1.12	$505	$1,311
6/22	6.5	873	8.3	4.7	629	9.4	$1.09	$684	$1,260
6/23	4.9	655	8.0	5.0	672	9.2	$1.06	$709	$1,223
6/24	15.7	2,090	8.4	16.4	2,184	9.5	$1.02	$2,235	$1,230
6/25	23.3	3,104	9.6	31.7	4,233	9.3	$0.99	$4,199	$1,147
6/26	2.6	350	9.2	3.6	476	8.6	$0.96	$458	$962
6/27	2.0	273	10.3	3.1	417	9.7	$0.93	$389	$1,060
6/28	3.3	440	10.4	1.2	160	11.4	$0.90	$145	$1,219
6/29	4.4	587	10.7	3.7	490	11.6	$0.88	$430	$1,229
6/30	7.8	1,043	10.7	6.7	889	12.0	$0.85	$756	$1,259
7/1	24.1	3,210	10.1	15.0	2,001	11.9	$0.82	$1,650	$1,233
7/2	20.2	2,691	8.4	27.3	3,639	11.7	$0.80	$2,910	$1,168
7/3	10.4	1,389	8.7	11.0	1,467	10.2	$0.78	$1,138	$959
7/4	2.4	325	7.6	15.0	2,001	8.9	$0.75	$1,504	$816
7/5	5.7	762	7.6	2.3	300	7.1	$0.73	$219	$631
7/6	4.0	530	7.1	6.7	896	7.2	$0.71	$633	$629
7/7	4.0	530	7.4	6.3	838	6.8	$0.69	$575	$582
7/8	12.4	1,653	7.5	13.5	1,803	6.3	$0.66	$1,198	$531
7/9	21.7	2,896	7.9	16.8	2,245	5.2	$0.64	$1,447	$422
7/10	3.0	400	7.1	1.6	217	4.4	$0.62	$135	$321
7/11	2.8	371	7.1	2.6	343	4.9	$0.61	$208	$352
7/12	2.0	267	7.4	2.6	350	5.2	$0.59	$206	$364
7/13	6.2	830	7.3	4.0	534	4.8	$0.57	$304	$338
7/14	4.3	570	6.9	3.0	400	4.9	$0.55	$221	$331
7/15	15.4	2,053	6.7	6.1	810	5.1	$0.54	$434	$338
7/16	16.1	2,144	6.2	10.6	1,418	6.6	$0.52	$737	$413
7/17	3.2	427	6.6	5.3	700	7.4	$0.50	$353	$438
7/18	4.5	594	6.7	4.5	600	6.8	$0.49	$293	$394
7/19	1.7	222	6.2	0.4	57	6.3	$0.47	$27	$363
7/20	2.9	387	6.5	4.2	556	6.4	$0.46	$255	$366
7/21	3.5	467	6.7	4.5	600	6.2	$0.45	$267	$350
7/22	11.3	1,503	7.1	16.7	2,223	5.9	$0.43	$960	$328
7/23	19.5	2,599	7.7	16.2	2,167	5.4	$0.42	$907	$275
7/24	3.6	480	6.5	0.8	111	4.6	$0.41	$45	$215
7/25	1.2	160	6.6	1.5	200	4.6	$0.39	$79	$216
7/26	3.3	440	7.2	1.0	133	4.8	$0.38	$51	$223
7/27	4.7	622	7.1	2.8	378	5.3	$0.37	$140	$241
7/28	5.9	785	7.1	2.4	317	5.3	$0.36	$114	$236
7/29	15.7	2,092	6.9	12.8	1,701	5.3	$0.35	$592	$234
7/30	11.3	1,502	6.9	10.8	1,441	5.2	$0.34	$486	$215
7/31	4.0	534	6.8	1.1	152	5.7	$0.33	$50	$218
8/1	5.4	718	6.9	3.0	400	5.8	$0.32	$127	$220
8/2	2.7	366	6.5	4.4	581	5.7	$0.31	$179	$214
8/3	4.4	587	6.7	2.7	356	5.3	$0.30	$106	$196
8/4	4.5	606	6.8	2.6	343	5.2	$0.29	$99	$189
8/5	15.6	2,084	6.5	12.2	1,623	5.2	$0.28	$455	$187
8/6	10.9	1,449	5.4	14.0	1,867	6.0	$0.27	$508	$197
8/7	4.7	625	5.9	1.9	248	4.5	$0.26	$65	$140
8/8	2.9	382	5.8	2.4	320	4.4	$0.26	$82	$134

Table S-1
ADDITIONAL SUPPORTING DATA
LEVEL-OF-USE INDEX AND LOSS PER TRIP, SEVEN-DAY MOVING AVERAGE, 1999-2000

	Estimated Recreational Activity						2000 Season Reduction In Value Of Trips Taken		
	1999			2000					
Date	Golden Beach Index	Impact Zone Trips	Index: 7-Day Moving Average	Golden Beach Index	Impact Zone Trips	Index: 7-Day Moving Average	Loss Per Trip	Daily Total Lost Value	Lost-Value 7-Day Moving Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8/9	3.8	509	5.8	1.7	222	4.7	$0.25	$55	$142
8/10	5.1	684	5.6	1.8	240	5.2	$0.24	$58	$154
8/11	2.3	307	5.5	2.7	362	5.9	$0.23	$84	$169
8/12	8.4	1,119	5.9	17.5	2,334	5.8	$0.23	$528	$164
8/13	14.1	1,875	5.9	3.8	507	4.9	$0.22	$111	$128
8/14	3.8	511	6.4	0.8	107	6.6	$0.21	$23	$165
8/15	3.3	436	6.2	4.8	640	7.0	$0.21	$132	$173
8/16	1.9	252	6.3	5.3	711	6.8	$0.20	$142	$166
8/17	4.8	637	6.1	6.3	845	6.4	$0.19	$164	$154
8/18	4.9	654	5.8	2.0	267	6.1	$0.19	$50	$142
8/19	8.5	1,128	5.7	11.3	1,512	6.4	$0.18	$276	$146
8/20	17.8	2,380	7.0	15.6	2,075	6.8	$0.18	$367	$146
8/21	2.1	280	6.9	3.4	457	6.1	$0.17	$78	$123
8/22	4.0	534	6.7	3.8	507	5.7	$0.17	$84	$114
8/23	0.8	100	6.3	2.6	347	5.5	$0.16	$56	$108
8/24	2.3	311	6.4	4.0	534	5.3	$0.16	$83	$103
8/25	4.5	600	6.4	3.9	514	5.4	$0.15	$78	$103
8/26	17.2	2,288	6.3	14.1	1,886	5.6	$0.15	$277	$103
8/27	17.4	2,318	4.9	10.9	1,451	5.4	$0.14	$207	$93
8/28	0.5	67	3.0	0.9	114	5.4	$0.14	$16	$86
8/29	1.3	176	3.9	2.3	300	6.2	$0.13	$40	$98
8/30	1.9	253	4.2	1.2	156	6.2	$0.13	$20	$97
8/31	2.1	286	4.2	5.0	667	6.2	$0.13	$84	$97
9/1	3.4	454	4.1	4.6	610	6.0	$0.12	$74	$91
9/2	7.5	1,000	4.0	13.3	1,778	5.7	$0.12	$211	$85
9/3	4.3	578	4.5	10.3	1,378	5.4	$0.11	$158	$75
9/4	7.0	934	5.8	6.6	880	5.8	$0.11	$98	$76
9/5	2.9	381	5.2	2.3	300	5.0	$0.11	$32	$64
9/6	2.4	320	5.3	1.3	178	5.0	$0.10	$19	$63
9/7	1.5	205	5.1	3.3	434	5.1	$0.10	$44	$64
9/8	2.6	347	5.0	2.6	343	5.2	$0.10	$34	$63
9/9	10.8	1,443	4.7	11.1	1,486	5.1	$0.10	$142	$61
9/10	13.2	1,761	4.4	13.1	1,751	4.8	$0.09	$162	$55
9/11	3.1	417	4.2	1.0	133	4.6	$0.09	$12	$49
9/12	3.3	436	4.3	2.5	333	5.0	$0.09	$29	$51
9/13	1.5	200	3.9	2.4	324	5.0	$0.08	$27	$51
9/14	0.5	67	3.8	3.5	467	5.2	$0.08	$38	$51
9/15	0.5	67	4.3	1.7	222	5.1	$0.08	$18	$50
9/16	8.7	1,163	5.0	9.5	1,270	5.2	$0.08	$98	$51
9/17	11.8	1,575	5.2	11.9	1,585	4.7	$0.07	$118	$43
9/18	3.6	480	4.7	3.2	427	4.3	$0.07	$31	$37
9/19	0.7	89	4.4	3.0	400	4.1	$0.07	$28	$34
9/20	0.5	67	4.5	3.3	438	3.8	$0.07	$30	$32
9/21	4.3	569	4.4	3.3	434	3.6	$0.07	$29	$29
9/22	5.1	680	4.0	2.6	343	3.5	$0.06	$22	$28
9/23	10.5	1,396	3.8	5.7	756	3.6	$0.06	$47	$29
9/24	8.3	1,100	2.5	9.2	1,223	3.2	$0.06	$74	$25
9/25	1.8	245	1.1	1.5	200	1.8	$0.06	$12	$13
9/26	0.7	98	0.8	1.5	200	1.8	$0.06	$11	$13
9/27	0.2	27	0.9	1.5	200	2.0	$0.05	$11	$14
9/28	1.5	200	1.5	2.5	333	2.5	$0.05	$18	$18
Total	935.7	124,810		842.4	112,359			$ 110,489	

Table S-1
ADDITIONAL SUPPORTING DATA
LEVEL-OF-USE INDEX AND LOSS PER TRIP, SEVEN-DAY MOVING AVERAGE, 1999-2000

	Estimated Recreational Activity						2000 Season Reduction In Value Of Trips Taken		
	1999			2000					
Date	Golden Beach Index	Impact Zone Trips	Index: 7-Day Moving Average	Golden Beach Index	Impact Zone Trips	Index: 7-Day Moving Average	Loss Per Trip	Daily Total Lost Value	Lost-Value 7-Day Moving Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

Notes (Columns)

(1) The dates in Column (1) refer specifically to the 2000 figures. In order to compare 1999 with 2000 using matching weekends and weekdays, figures for 2000 are pushed forward by two days. That is, 4/15 refers to April 15 figures in 2000 and April 17 figures in 1999.
(2) The index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in the Golden Beach community.
(3) Calculation: Column (2) x Impact Zone Multiplier (see Table 6 entitled "Calculation of Impact Zone Multiplier"). This extrapolation from recreational activity at Golden Beach to total activity in the impact zone is based on overflight data.
(4) The 7-day moving average is based on figures for the given date and the six days following it.
(5) The index of recreational use is the average number of cars throughout the day (6 a.m. to 9 p.m.) at five recreational sites in the Golden Beach community.
(6) Calculation: Column (5) x Impact Zone Multiplier (see Table 6 entitled "Calculation of Impact Zone Multiplier"). This extrapolation from recreational activity at Golden Beach to total activity in the impact zone is based on overflight data.
(7) The 7-day moving average is based on figures for the given date and the six days following it.
(8) The loss per trip is determined according to specifications described in the text of this appendix.
(9) Calculation: Column (6) x Column (8).
(10) The 7-day moving average is based on figures for the given date and the six days following it.

Table S-2
ADDITIONAL SUPPORTING DATA
NORMALIZED HOURLY LEVEL OF USE AT FIVE GOLDEN BEACH SITES

	Time Period														
Location	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM
Benson's	0.15	0.30	0.32	0.37	0.45	0.38	0.43	0.39	0.48	0.44	0.42	0.52	0.46	0.41	0.27
Long Point	0.13	0.29	0.31	0.35	0.39	0.86	0.63	0.58	0.84	0.55	0.50	0.60	0.53	0.32	0.20
Small Beach	0.02	0.03	0.05	0.06	0.08	0.08	0.03	0.04	0.06	0.06	0.07	0.06	0.03	0.08	0.06
Trent Hall	0.01	0.02	0.03	0.03	0.04	0.03	0.03	0.02	0.02	0.02	0.03	0.04	0.04	0.03	0.01
Main Beach	0.01	0.00	0.02	0.01	0.02	0.03	0.04	0.06	0.07	0.07	0.10	0.08	0.10	0.08	0.04
Total	0.32	0.64	0.73	0.83	0.98	1.38	1.17	1.10	1.47	1.14	1.12	1.30	1.16	0.91	0.58

Notes:

The figures above represent the average normalized hourly levels of use at sites in Golden Beach during 1999, from April 15 through September 30. They are calculated as follows: The number of cars observed at a given site during a given time period is normalized by dividing by the average number of cars observed at all sites over all time periods for that day. In this way the data show relative use over the course of the day and are comparable across days of varying use intensity. Data for each site and time period are averaged across all days from April 15 to September 30. The average is weighted according to the level of use for a given day, so that days of heavy use count more than days of light use.

Appendix III: Meteorological Data and Adjustments for Weather

Appendix III: Meteorological Data and Adjustments for Weather

A basic assumption of the human use damage assessment was that the level of use at Golden Beach during 1999 would be the same as use during 2000 but for two influences: the oil spill and differences in weather between the two years. To isolate the effect of the spill, an adjustment was made to 1999 use data to account for weather differences between 1999 and 2000. This "weather adjusted" 1999 use served as the baseline use in 2000 but for the spill. This appendix describes the weather adjustment procedures.

Meteorological data were collected from the National Climatic Data Center. The data included hourly measurements of wind speed and hourly observations of the following weather conditions: clear, rain, drizzle, fog, or hazy. Observations from 6:00 AM to 9:00 PM were included, corresponding to the observation periods of the Golden Beach visitation data. Wind speed was averaged over the observation period each day. The weather conditions were converted into percentages of each weather category that occurred during a given day. Through this transformation, the weather on any given day was characterized by average wind speed and the proportion of the day that was clear, rainy, foggy, etc.

To determine the influence of different weather conditions on recreational use in the area, daily recreational use in 1999 was modeled as a function of weekend or weekday days (holidays were considered weekend days), and whether the day was a "foul-weather day". A "foul-weather day" was defined as a day on which any of the following occurred: 1) average wind speed was greater than 12 knots; 2) rain was recorded for greater than 5% of the day; or, 3) fog was recorded for greater than 20% of the day. These thresholds used in defining foul-weather days were determined through graphical inspection of the weather variables and recreational use data. The graphs were examined to find levels of different weather conditions for which recreational activity was significantly reduced.

After defining a foul-weather day, the following model was estimated using linear regression analysis:

1999 Golden Beach Index = $\beta_0 + \beta_1$*Weekend + β_2*Foul Weekend + β_3*Foul Weekday

The variables on the right-hand side are all binary dummy variables identifying the type of day. The results are summarized in the table below.

Weather Regression Results

N = 169		Mean of 1999 Golden Beach Index = 5.48		
Parameter	OLS Estimate	S.E.	t-ratio	p-value
Constant	3.48	0.43	8.18	0.00
Weekend	10.66	0.73	14.56	0.00
Foul Weekend	-5.85	0.97	-6.05	0.00
Foul Weekday	-1.45	0.61	-2.38	0.02
F = 103.15		Adjusted R^2 = 0.65		
p = 0.00				

Using this model, the estimated average effect of foul weather on recreational use at Golden Beach from April 15 to September 30 1999 can be calculated for weekdays and weekend days. The Golden Beach index on a non-foul weekday is β_0, which is estimated to be 3.48. The index on a foul-weather weekday = $\beta_0+\beta_3$ = 3.48+(-1.45) = 2.03. Thus, the model predicts use on a foul-weather weekday that is 58.33% of a non-foul weekday during the 1999 season. Similarly, the index on a non-foul weekend day = $\beta_0+\beta_1$ = 3.48+10.66 = 14.14. The Golden Beach index on a foul-weather weekend day =

$(\beta_0+\beta_1)+\beta_2$= 3.48+10.66+(-5.85) = 8.29. The model predicts use on a foul-weather weekend day that is 58.67% of use on a non-foul weekend day during the 1999 season.

The above effects of weather on recreational activity were used to project the weather-adjusted baseline for the 2000 season. First, the average daily 1999 Golden Beach index was calculated for weekend days and weekdays, respectively, in each month, April through September. Calculating separate averages for non-foul and foul-weather days required solving the equations below. Separate equations were solved for weekdays and weekend days in each month.

Average 1999 weekday Golden Beach use =

$$\frac{\text{(Non-Foul Weekdays) (x) + Foul Weekdays (0.5833x)}}{\text{Total Weekdays}}$$

Average 1999 weekend Golden Beach use =

$$\frac{\text{(Non-Foul Weekend Days) (y) + Foul Weekend Days (0.5867y)}}{\text{Total Weekend Days}}$$

Solving for x and y gives the average monthly Golden Beach use in 1999 on non-foul weekdays and weekend days, respectively. Calculating 0.5833x and 0.5867y yields the average monthly Golden Beach use in 1999 on foul-weather weekdays and weekend days. Each day in the 2000 season was also designated as foul or non-foul based on the same criteria as were used for 1999, as described above. In each month, the 2000 weather-adjusted baseline on each non-foul day was projected as x for weekdays, and y for weekend days. The 2000 weather-adjusted baseline on each foul-weather day was

0.5833x for weekdays, and 0.5867y for weekend days. The calculated weather-adjusted baselines for each month are presented in Tables 3A through 3F in Appendix 1.

Appendix IV: Valuing Recreation and the Benefit Transfer Method

Appendix IV: Valuing Recreation and the Benefit-Transfer Method

Accepted economic theory holds that the value of recreational activity at a given site is measured by the recreator's consumer surplus. This is the additional amount a visitor to a site would be willing to pay for access to the site, beyond any actual costs such as boat launch fees or travel expenses. The value of recreation varies depending on the type of recreational activity involved, the type and quality of the facilities and resources, the availability of substitute sites with similar recreational opportunities, and the characteristics and preferences of the site visitors.

When valuing trips at a particular site, it is common for economists to rely on previous estimates of value for trips to similar recreational sites when a costly on-site study is unwarranted. The process of applying a value for a given site from within the range of value estimates available in the economics literature is called the benefit-transfer method. It is the purpose of this technical appendix to present evidence regarding the relevant types of recreational use and to explain the basis for the choice of the value of a typical Patuxent River trip used in this assessment.

The value ultimately used in this study represents a combination of the activities observed in the spill impact zone. As discussed previously, activities occurring in the spill impact zone include fishing, boating, backyard recreation and general public shoreline use such as sunbathing, swimming and picnicking. The length of the affected area, roughly from Eagle Harbor to Greenwell State Park, is about 17 miles. This includes an additional two miles beyond the actual April closure zone and is based on a reasonable upper-bound assessment of the extent of impact apparent in on-site surveys.

As noted previously, the majority of recreational use in the affected area is by local residents. In the survey, the average distance traveled to get to the site was about 25 miles. But some use was from within walking distance in one's own neighborhood. This has several implications. On the one hand, the local nature of recreational trips makes it less likely that trips not taken in the impact zone were instead taken to substitute sites

despite the limited geographic area affected. Moreover, trips involving backyard access or use of locally known sites may offer convenience and familiarity not matched by recreational sites farther down the river or on neighboring water bodies. On the other hand, more unique and infrequently enjoyed experiences tend to be more highly valued. Furthermore, recreators who drove some distance likely had substitute sites available. The exact mix of those with good and those with few substitute sites is unknown.

A discussion of relevant values for fishing, boating, backyard use and general shoreline use is presented below. Unless otherwise noted, all values are converted to CPI-adjusted current (2000) dollars. The studies and articles referenced are listed at the end of the appendix.

Recreational Fishing

The value of a fishing trip varies depending on the quality of the resource, the types of fish available and proximity of alternative sites. Identifying past studies that value a resource substantially similar to the Patuxent River would be difficult. Most studies examine either freshwater or saltwater fishing, or in the case of an estuary like Chesapeake Bay, studies typically focus on a particular targeted species. The Patuxent River is not readily comparable to freshwater or ocean fishing and the recreational anglers there do not appear to target any single species of fish. Furthermore, existing studies often involve recreational sites with different types of substitutes and distances to population centers, etc.

Accordingly, it makes sense in this case to consider a range of values that capture a general fishing experience. A comprehensive study of marine recreational fishing values (Freeman, 1993) examines previous studies and concludes that they range from $10 to $100 in 1991 dollars. Those values would be about 30 percent higher in today's dollars. That range includes a study of Chesapeake striped bass fishing (Norton, 1983) with a value of $87 per trip in current dollars. While striped bass fishing takes place on the Patuxent, it is not clear that the average fishing trip in our study area involves targeting of

this valued species. Another study with relevant geographic coverage is McConnell and Strand (1994) which arrives at a value of about $30 for a Maryland fishing trip.

A published paper by Walsh (Walsh et al. 1992) synthesized data from a variety of previous studies and determines average and median values for a selection of recreational activities. The values are reported on a per day basis, reflecting a variety of underlying calculations. Sometimes a value for a trip is divided by the number of days per trip, other times an annual value is divided by the number of days of participation per year. For our purposes, a day is equivalent to a trip since most of the trips to the spill impact zone were day trips. The Walsh study includes the fishing values shown in the table below.[1]

Fishing Activity	*Mean Value*	*Median Value*
Cold Water Fishing	$47.63	$44.31
Anadromous Fishing	$84.01	$71.92
Warm Water Fishing	$36.63	$35.00
Salt Water Fishing	$112.75	$82.98

The spill impact zone on the Patuxent River includes numerous individual fishing sites. Closing any one of the sites might result in a small loss per trip, but taken together, the sites comprise a more valuable composite resource. Opportunities to fish elsewhere in the region are available, but the extra travel time or a lack of familiarity with a new site might provide deterrence for some.

However, a figure at the high end of the range of estimates would probably overvalue a trip to the Patuxent River. The on-site survey performed for this assessment indicates that most use in the spill impact zone was local in nature. If people are not traveling great distances to reach these particular Patuxent River sites, then the resource is probably considered comparable to the rest of Chesapeake Bay. Therefore, those from outside the

[1] The distinction between cold water and warm water fishing is not clearly defined in the Walsh paper and the terms, though commonly used, are somewhat vague. In the Walsh analysis, cold water fishing includes angling for anadromous fish. Typically, cold water fishing includes trout, salmon and striped bass, among other species. Warm water fishing includes bass, panfish, catfish, pickerel and other species.

immediate region (for example those seeking the recreational experience valued at $87 in the Norton study) have numerous other alternative destinations. The appropriate figure for our purposes is probably lower.

Recreational Boating

Recreational boating is a broad use category encompassing a variety of specific activities including boat-based fishing, water skiing and general cruising. Boat-based fishing is usually valued more highly than shore-based fishing. For example, Freeman cites a study that finds per-trip values for boat-based fishing that are four times higher than values for shore-based fishing at the same location. (The range is $53 to $93 for fishing by private boat, as opposed to $13 to $21 for fishing from shore at sites in southern California.)

Generally, boat trips are valued more highly than other types of water-based recreation. This makes sense, since difficulties of travel and boating access limits the available substitutes compared to general shore use. However, those who trailer a boat do have available the option of driving to a boat-launch ramp outside the spill zone. The proportion of those boat trips taken on the Patuxent involving trailered boats versus those from private docks or marinas in the spill zone is not known. Note that the purchase price of the boat places a lower bound on the consumer surplus of recreational trips over time, since the purchaser expects to gain at least as much value from his trips as he lost in purchasing the boat.

The Walsh study finds that the average value per day for general motorized boating is $49.09 and the median value is $39.93. This is lower than many of the fishing-day values presented above, but considerably higher than figures for general shoreline recreation discussed below. The helicopter overflight counts of recreational activity performed for this damage assessment indicate that about half of the trips taken to the spill impact zone were for boat-based recreation.

General Shoreline Use

Many areas in the spill impact zone are frequented by visitors engaged in a variety of recreation activities, including sunbathing, swimming, wildlife viewing, etc. These types of general shoreline use were evaluated by the Department of the Interior in developing its regulations for Type A damage assessment (which includes the benefit transfer method). DOI examined seven valuation studies, and recommended that a generic day of beach recreation in the United States be valued at about $15 per trip.

The 1992 Walsh study also included results for three types of shoreline activity observed in the Patuxent River spill impact zone. These values are presented below.

Shoreline Activity	*Mean Value*	*Median Value*
Camping	$30.33	$30.98
Picnicking	$26.93	$19.94
Swimming	$35.73	$28.93

Residential Backyard Use

A significant portion of the activity observed during the helicopter overflights consisted of residential backyard use. These uses included cookouts, sunbathing, swimming and other activities, much like the general shoreline use category above. Backyard use may provide additional value compared to public recreation sites. The values obtained in studies of beach use and picnicking incorporate downward adjustments to the degree that substitute destinations are available. Familiarity and proximity are important attributes for a viable substitute site, and in this regard backyards are significantly more desirable than most available alternatives. Alternatively, backyard use tends to be frequent and non-unique compared to some of the experiences valued in the economics literature, which typically involve non-negligible travel away from home.

Additional Studies Considered

Many other studies were reviewed for this report and were rejected for a variety of reasons. Some studies that valued beach recreation, such as Bell and Leeworthy (1986) and Parsons et al. (1999), considered expansive coastal sites that were not comparable to the smaller local sites on the Patuxent. Several good studies of recreational fishing were not considered relevant because they either focused on a particular species, e.g. salmon in Morey et al. (1993). An alternative to the meta-analysis approach used in Walsh et al. for assessing generalized recreational values is presented in Bergstrom and Cordell (1991). This multi-site nationwide travel cost model has the advantage that a consistent methodology is used for all activities studied. The Walsh study, though, offers the benefits of diversification and incorporates a far greater sum total of research and analysis.

Conclusions

It is reasonable to choose $35 as a value for recreational fishing and boating in the spill impact zone. Given the comparable values and considerable overlap in fishing and boating activities, a combined figure makes sense for these uses. In Walsh et al. the median value for motorized boating is $40 per day, and the median value for cold water fishing is $44 per day. The former figure may be somewhat high due to the types of sites valued in the studies. And while the Patuxent is host to various anadromous fish, on-site observations indicated that most visitors were not targeting the highly valued species that are typically the focus of anadromous fishing studies, like striped bass. Thus the figure for general cold water fishing, which includes anadromous fishing along with other lower-valued river fishing, is probably most appropriate. Some fishing on the Patuxent likely is valued somewhat less than this. Choosing the median rather than average value and the lower of the boating and fishing figures results in a conservative $35 estimate.

A figure of $20 per trip was chosen for the value of general shoreline use, including backyard use. Again, the median values in Walsh et al. for camping, picnicking and swimming are $30, $20 and $29 per day, respectively. The DOI figure for general beach use is $15 per trip. While $20 is higher than the DOI value, it is the lowest of the three values reported in Walsh et al. Given the high proportion of backyard use and the difficulty inherent in defining substitutes for such use, this represents a reasonably conservative point estimate.

The figures for fishing/boating and general shoreline use should be combined at about 50 percent each, as indicated roughly by the helicopter counts. A resulting value of $27 represents a conservative, best estimate for an average recreational trip in the spill impact zone.

REFERENCES

Bell, F.W. and V.R. Leeworthy, *An Economic Analysis of the Importance of Saltwater Beaches in Florida*, 1986.

Freeman, A. M. *The Benefits of Water Quality Improvements for Marine Recreation:: A Review of the Empirical Evidence*, 1995.

Hanemann, M. *Final Conclusions of Professor Michael Hanemann Regarding Lost Recreational Damages Resulting From the American Trader Oil Spill,* 1997.

McConnell, K.E. and I.E. Strand, *The Economic Value of Mid and South Atlantic Sportfishing*, 1994.

Morey, E.R., R.D. Rowe and M. Watson, *A Repeated Nested-Logit Model of Atlantic Salmon Fishing*, 1993.

Parsons, G.R., D.M. Massey and T. Tomasi. *Familiar and Favorite sites in a Random Utility Model of Beach Recreation*, 1999.

Norton, V., T. Smith and I. E. Strand, eds. *Stripers, The Economic Value of the Atlantic Coast Commercial and Recreational Striped Bass Fisheries*, 1983.

Walsh, R. G., D. M. Johnson and J. R. McKean. *Benefit Transfer of Outdoor Recreation Demand Studies, 1968-1988*, 1992.