Scaling the Washington Creek Restoration Project to the Chalk Point Oil Spill Diamondback Terrapin Injury

By Heath Byrd, Eric English, Norman Meade and Ted Tomasi[1]

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The injury to Diamondback Terrapins resulting from the Chalk Point oil spill was presented in *Estimate of Total Injury to Diamondback Terrapins from the Chalk Point Oil Spill* (Byrd et. al., 2002). The loss was estimated to be 5,244.6 discounted terrapin-years.

This document presents a description of the methodology and results of an analysis of the proposed Washington Creek Restoration Project (WCRP), with reference to scaling compensatory restoration for the estimated terrapin injury. The WCRP and the project site are summarized, followed by a description of the scaling calculations. The project, as proposed, is more than sufficient to compensate for the terrapin injury resulting from the Chalk Point oil spill.

Project / Site Description

The proposed WCRP will convert 5.6 acres of agricultural land at the northeast corner of the mouth of Washington Creek to functioning intertidal marsh. The site will be excavated to an appropriate elevation and planted with marsh vegetation. Two breakwaters will be installed to protect the site from wave energy. The sand that is excavated from the site will be used to augment a nearby eroding beach, which will improve the quality of diamondback terrapin nesting habitat on the beach.

Diamondback Terrapins in the Patuxent River nest, primarily, on narrow (< 10 m wide) sandy beaches and upland areas with sparse vegetation some 0 .5 to 1.0 m above the mean high-tide waterline (Roosenburg, 1994). The beach at the northeast corner of Washington Creek is quite narrow because of erosion. As the beach has eroded over time, the bank has been undercut by wave action, leaving an obstruction between the beach and some portions of the upland area on top of the bank. This obstruction and the dense vegetation in the upland impede terrapins from utilizing the upland area for nesting. Overall, the beach is relatively poor nesting habitat. Moreover, there is a possibility that the beach is completely inundated at high tide, in which case the beach itself is not suitable terrapin nesting habitat.

Sand to be excavated as part of the WCRP will be deposited on this beach, resulting in a wider beach with a gentle slope from the beach to the area of dense vegetation. Sparse vegetation will be planted on the slope to mitigate its erosion. The two breakwaters will be constructed to help reduce future erosion of the beach. The restoration project will increase the suitability of terrapin nesting habitat available on this portion of the Patuxent River.

Discounted Terrapin-Years for the WCRP

The credit that will be produced by the restoration project was estimated by calculating the discounted terrapin-years the project area is expected to produce in its post-implementation condition versus its baseline condition. The estimation proceeded in four steps. First, appropriate terrapin nesting densities were estimated for the beach in its baseline and post-implementation conditions. Second, the number of hatchlings produced by the project was estimated over the

[1] Byrd and Tomasi: ENTRIX Inc.; English and Meade: NOAA

anticipated duration of the project. Third, the number of discounted terrapin-years per hatchling was applied to each hatchling produced, yielding the credit generated each year. Finally, these credits were discounted to the time of the injury, and summed to find the total discounted terrapin-years credit for the project.

Nesting Densities

Roosenburg (1994) reported that the range of nesting densities in the Patuxent River were 240 nests/ha to 1,125 nests/ha. As discussed above, the current condition of the beach render it to be poor quality nesting habitat. Therefore, 240 nests/ha is an appropriate baseline nest density for the beach.

Upon completion, the WCRP is expected to provide high quality terrapin nesting habitat. However, it is conservatively assumed that it will provide "average" quality nesting habitat when it reaches full project maturity (after five years). Therefore, the midpoint of the nest density range, 682.5 nests/ha, was used for the beach in its post-implementation, mature condition. Thus, the maximum nesting credit provided by the restoration project in any given year is estimated to be 682.5 – 240 = 442.5 nests/ha.

Hatchlings Produced over the Project Lifespan

The expected number of hatchlings produced in each year of the project lifespan was estimated by multiplying the hatchlings credited during a year of full project maturity ("full services") by the percent of full services the project is expected to provide in that year. For example, if 1,000 hatchlings were produced in a year of full services, then 500 hatchlings would be produced in a year of 50% services. The number of hatchlings expected at full services was calculated based on parameter values found in Byrd, et al. (2002), which are summarized in Table 1:

Table 1: Diamondback Terrapin Parameters

Number of Eggs per Nest	13
Egg to Hatchling Survivorship	20%
Discounted Terrapin Years per Hatchling	2.095

The expected number of eggs produced in a year (at full services) is the nests/ha (442.5) multiplied by the number of eggs per nest (13), which equals 5,752.5. The expected number of hatchlings produced in a year is the number of eggs (5,752.5) multiplied by the probability that an egg will hatch (0.20), which equals 1,150.5. The expected total number of terrapin-years produced is the number of hatchlings (1,150.5) multiplied by the discounted terrapin years per hatchling (2.095), which equals 2,410.3.

The service levels provided each year were estimated based on the following assumptions. The lifetime of the project is expected to be 25 years. It will be completed by the end of 2002, but credit will not begin to accrue until 2003. The service level will increase 20% per year over five years, reaching 100% services (full project maturity) at the end of 2007. Full services will then be provided for 20 years, through the year 2027. For purposes of these calculations, it is assumed there are no services provided after year 2027.

Credit Produced Each Year

Table 2 summarizes the estimation of discounted terrapin years produced on each hectare of the shoreline improved by the WCRP. The average service level provided each year of the project is contained in column (3). The hatchlings/ha per year in column (4) are the multiplication of the services in column (3) by the expected number of hatchlings at the full service level, 1,150.5. Column (5), the discounted terrapin years provided each year, is column (4) multiplied by 2.095, the discounted terrapin-years per hatchling from the injury assessment. Column (6) contains the discount factor, used to express the value of the discounted terrapin years provided each year in terms of 2000, the year of the injury. The standard discount rate for performing Natural Resource Damage Assessments, 3.0%, was used for these calculations. Column (7) contains the terrapin years each year discounted to 2000, and is the multiplication of columns (5) and (6). The total credit that is provided by one hectare of the restoration project is the sum of column (7), which equals 34,233.4 discounted terrapin-years.

Table 2: Discounted Terrapin-Years Produced per Hectare

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Year	**Service Level (End of Year)**	**Service Level (Average for Year)**	**Hatchlings per ha per Year**	**DTYs per Year**	**Discount Factor (end 2000)**	**Discounted Terrapin Years per ha**
2002	0%	0%				
2003	20%	10%	115.05	241.010	0.915	220.558
2004	40%	30%	345.15	723.031	0.888	642.403
2005	60%	50%	575.25	1205.051	0.863	1039.488
2006	80%	70%	805.35	1687.071	0.837	1412.896
2007	100%	90%	1035.45	2169.092	0.813	1763.670
2008	100%	100%	1150.5	2410.102	0.789	1902.557
2009	100%	100%	1150.5	2410.102	0.766	1847.143
2010	100%	100%	1150.5	2410.102	0.744	1793.342
2011	100%	100%	1150.5	2410.102	0.722	1741.109
2012	100%	100%	1150.5	2410.102	0.701	1690.397
2013	100%	100%	1150.5	2410.102	0.681	1641.162
2014	100%	100%	1150.5	2410.102	0.661	1593.361
2015	100%	100%	1150.5	2410.102	0.642	1546.953
2016	100%	100%	1150.5	2410.102	0.623	1501.896
2017	100%	100%	1150.5	2410.102	0.605	1458.151
2018	100%	100%	1150.5	2410.102	0.587	1415.681
2019	100%	100%	1150.5	2410.102	0.570	1374.448
2020	100%	100%	1150.5	2410.102	0.554	1334.415
2021	100%	100%	1150.5	2410.102	0.538	1295.549
2022	100%	100%	1150.5	2410.102	0.522	1257.814
2023	100%	100%	1150.5	2410.102	0.507	1221.179
2024	100%	100%	1150.5	2410.102	0.492	1185.611
2025	100%	100%	1150.5	2410.102	0.478	1151.078
2026	100%	100%	1150.5	2410.102	0.464	1117.552
2027	100%	100%	1150.5	2410.102	0.450	1085.002
sum						**34233.415**

Area of Beach Required to Fully Compensate for Terrapin Injury

The terrapin injury was estimated to be 5,244.6 discounted terrapin years. It is estimated that the WCRP will produce 34,233.4 discounted terrapin years/hectare. Therefore, the area of terrapin nesting habitat needed to fully compensate for the terrapin injury is 5,244.6 / 34,233.4 = 0.1532 ha, or 1532 m^2. Assuming the nesting area will be 10 meters wide, 153.2 meters along the shoreline would be necessary for compensation. The actual length of shoreline that will be improved is approximately 600 meters (the exact length of the beach is dependent on the configuration of the breakwaters, which has not been finalized to date). Thus, the WCRP, under conservative assumptions, more than compensates for the diamondback terrapin injury.

References Cited

Byrd, et al. 2002. Estimate of Total Injury to Diamondback Terrapins from the Chalk Point Oil Spill.

Roosenburg, W.M. 1994. "Nesting Habitat Requirements of the Diamondback Terrapin: A Geographic Comparison". *Wetland Journal* 6(2).