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ORIGINAL RESEARCH

Distribution, Morphometry, and Land Use of Delmarva Bays

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Abstract Delmarva Bays are depressional wetlands that are elliptical in shape with sandy rims, and occur mainly in the central portion of the Delmarva Peninsula within the Mid-Atlantic United States. Situated in a region with abundant agriculture, Delmarva Bays and other wetlands may enhance water quality by reducing nutrient and sediment levels in local waters. A significant portion have been drained and converted from forested wetlands to agriculture. Using LiDAR to locate Bays, we estimate that there are 17,000 Bays on the Delmarva Peninsula, which is an order of magnitude greater than earlier estimates. Using a stratified sampling scheme based on Bay density, morphometric parameters of 1494 Bays were measured from the LiDAR data and their land use was assessed using aerial photography. Eighty percent of the Bays range in size from 0.46 to 5.68 ha, have a relief ranging between 0.55 and 2.02 m, and have a major to minor axis ratio between 1.08 and 1.65. Forty-one percent of the Bays sampled have been converted to agriculture and another 29 % have been partially converted, while 29 % retain natural vegetative cover. Improved understanding of the geomorphology, abundance and land cover of Delmarva Bays should lead to better management and conservation efforts.

Keywords Carolina Bay · Prior converted · Depressional Wetlands · LiDAR · Delmarva Bay · GIS · Land use

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Introduction

Carolina Bays are unique geomorphic formations that occur along the Atlantic Coastal Plain from Florida to New Jersey, although the most notable and highly studied Carolina Bays are situated in North and South Carolina. They are characterized geomorphologically by their overall elliptical shape that is often oriented northwest to southeast along the major axis (Sharitz and Gibbons 1982; Stolt and Rabenhorst 1987b; Bruland et al. 2003). Carolina Bays commonly have a sandy rim, usually in the southeast end of each Bay (Prouty 1952; Thom 1970; Stolt and Rabenhorst 1987a; Tiner 2003). In areas where they are readily found they can cover as much as 50 % of the land area (Prouty 1952), and can sometimes be superimposed on each other (Prouty 1952; Sharitz and Gibbons 1982).

There are many theories on the origin of Carolina Bays, a few of which include meteor impacts, solution, submarine formation of eddies, and shoals of fish or whales (giving rise to the term "whale wallow"). However, the most supported theory is that they began as wind blowouts during the Pleistocene that became locations where the water table was above the surface. It is postulated that the blowouts became elongated due to wind driven currents in the ponded water, moving sands to form the characteristic elliptical shape and sandy rim (Prouty 1952; Savage 1982; Stolt and Rabenhorst 1987b; French and Demitroff 2001).

Depressional features similar to Carolina Bays found on the Delmarva Peninsula are known as Delmarva Bays and are referred to locally as "whale wallows" or "potholes". In this region, they occur primarily near the Maryland and Delaware state border, between the Sassafras and Nanticoke Rivers (Stolt and Rabenhorst 1987b; Tiner 2003). Since the Bays are depressional geomorphological features theorized to have formed partially due to the presence of surface water, many of these features contain wetlands within their interior or basin, and would often be considered a geographically isolated wetland (Tiner 2003), if they were undisturbed. However, this region has been extensively ditched, and groundwater levels have been drawn down through the use of wells and irrigation (Soeder et al. 2007). Therefore, while it is possible that all of the Bays originally contained wetlands, a substantial number of Bays currently do not.

Delmarva Bays are situated in a region with abundant agriculture which often results in higher levels of nutrients and sediments in local waters. Delmarva Bays and other wetlands may enhance water quality by reducing nutrient and sediment levels in local waters, such as the Chesapeake Bay (Phillips et al. 1993). These features generally contain wetlands that interact with surficial groundwater and can act as both a recharge wetland during the late summer months and a discharge wetland during the winter and spring months (Phillips and Shedlock 1993). It has been suggested that depressional wetlands are likely to be up gradient of agricultural areas, and thus less likely to intercept nitrate from agricultural sources (Ator et al. 2013). However, they are a source of low nitrate water that can dilute higher nitrate agricultural waters. A significant portion of these features have been subject to agricultural drainage and have been converted from forested wetlands, or less commonly from emergent wetlands, to agricultural lands. A study conducted in Delaware by the Nature Conservancy (Zankel and Olivero 1999) noted that only 13 % of the Delmarva Bay wetlands in the state of Delaware appeared to be located within protected lands. Wetlands within Delmarva Bays provide habitat to many rare and endangered species, particularly amphibians, since they tend to be seasonally inundated and geographically isolated, which inhibits colonization by predatory fish (Sharitz and Gibbons 1982), and as such they play a critical role in the conservation of the region's natural heritage. Forty-two percent of the total occurrences of rare species in Delaware were reported to occur within only 11 % of Delmarva Bays, which were primarily situated in regions with low densities of Delmarva Bays, and generally within five miles of the coastline (Zankel and Olivero 1999). Therefore, more thorough documentation of the distribution, characteristics and land use within Delmarva Bays could prove valuable in conservation efforts.

Although numerous efforts have focused on Carolina Bays further to the south (Ross 1987), relatively few have studied Delmarva Bays, and these studies have not addressed geomorphology and spatial characteristics of these landforms. Rather, more detailed examinations were made of relatively small numbers of Delmarva Bays (Stolt and Rabenhorst 1987b), and it has been noted that Delmarva Bays are smaller and less elliptical than the highly studied Carolina Bays in North and South Carolina. However, very little detail on the larger population of Delmarva Bays is available. Therefore it is important to explore the origins and relatedness of Delmarva Bays to Carolina Bays and to gain better estimates of the amount of wetlands and ecosystem services lost due to land use change, especially considering that these landforms provide critical habitat for rare and endangered species in this region. Information obtained regarding their distribution, morphometery, and land use should be useful in developing strategies for conservation efforts. The objectives of this study were to: 1) estimate the number Delmarva Bays on the Delmarva Peninsula; 2) document their typical morphometric characteristics (comparing them with Carolina Bays); and 3) examine the current land uses associated with these landforms.

Materials and Methods

Light Detection and Ranging (LiDAR) derived digital elevation models (DEMs) were used to manually identify and locate Delmarva Bay landforms using ArcGIS 9.2 (Environmental Systems Research Institute, Redlands, CA). The DEMs used in this study originated from two sources. One dataset obtained from the Maryland Department of Natural Resources was collected during the spring of 2003 and spring of 2006. This dataset has a vertical resolution of 18 cm root mean square error, but only covered the central core of the Delmarva Peninsula in Maryland. The remainder of the data, which covered most of the remaining portions of the Delmarva Peninsula, was the USGS 1/9 arc-second National Elevation Dataset, which has a spatial resolution of approximately 3 m and is primarily obtained from LiDAR. This data set was accessed via the Geospatial Data Gateway (USDA-NRCS 2013).

Delmarva Bay landforms were identified as a circular area of low elevation (the basin) surrounded by an area of higher elevation (the rim), generally with a relief greater than half a meter. The rim may not have been continuous if the landform was dissected by a ditch. Some Bays overlap each other, which causes the rim to appear like the outermost line of a Venn diagram; these overlapped features may not have a continuous basin. Those in which the basin was continuous were identified as a single feature. Where the rims of overlapped features were sufficiently distinct to preclude a single continuous basin they were recognized and counted as separate features. Man-made depressions, such as ponds or reservoirs, which typically have a linear side for the earthen dam, were excluded from the study. To ensure consistency, the identification of Bays was conducted by a single individual. The Bays were reviewed for consistent identification several weeks after initial identification.

LiDAR data were not available for some parts of the study area (Fig. 1). The density of Delmarva Bays in areas with missing LIDAR data was estimated and assumed to be similar to that of bays in the immediately adjacent and surrounding areas. Estuarine water bodies were excluded from the assessment.

After each of the Bays was manually identified and located, a grid of 1.875-min quadrants was created by dividing quarter-

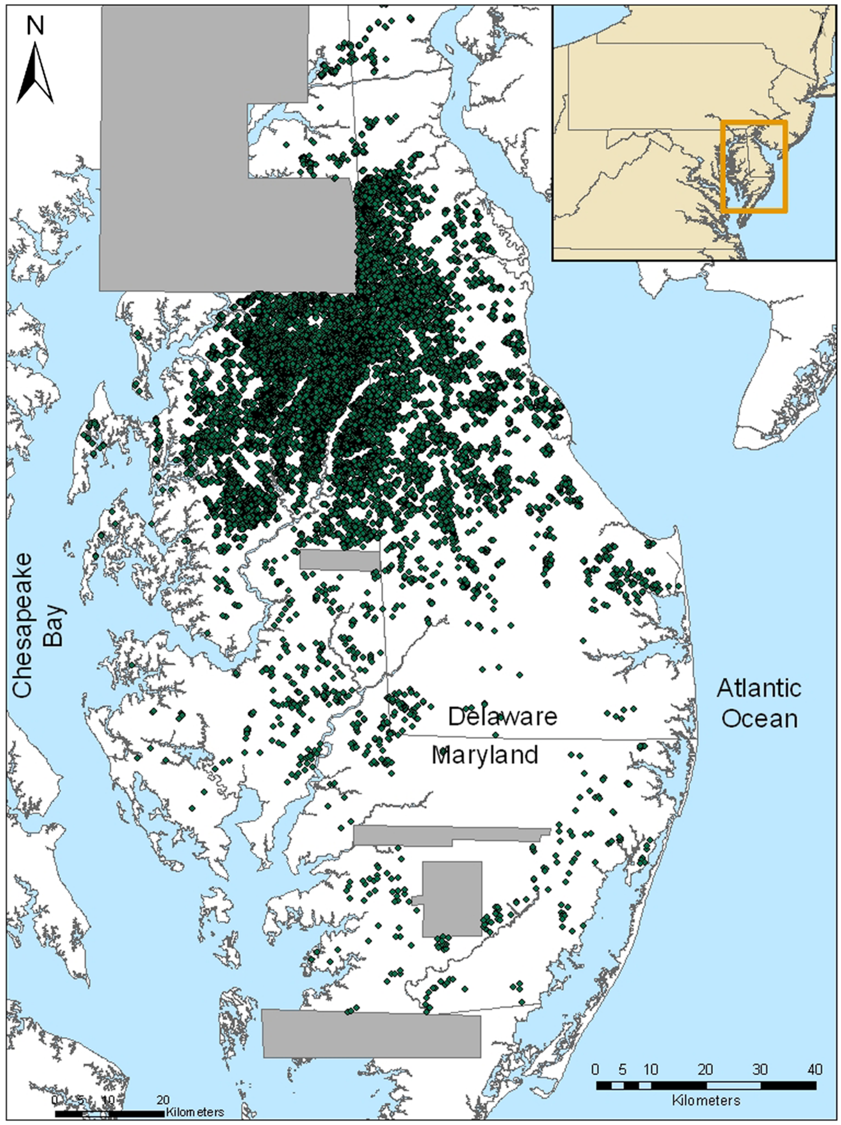

Fig. 1 Map showing the Delmarva peninsula, in Maryland and Delaware, including individual Delmarva Bays that were identified using LiDAR imagery, n=14,969. *Gray* areas represent zones where LiDAR data were not available

topo quads into quarters (sixteenth quads, hereafter called quads), each of which covered an area of 9.42 km^2. Forty of these quads were randomly selected (Fig. 2) for more detailed analysis using four strata based upon the density of Bays (Table 1). The four density strata were 1–20, 21–50, 51–100, and >100 Bays per quad, which corresponds to approximately 0–2, 2–5, 5–10, and >10 Bays km^{-2}. Quads that contained no Bays were excluded from the landform analysis. The number of quads sampled at each density stratum was approximately proportional to the number observed within each density stratum (Table 1). In each sampled quad, Bays that touched the upper and right quad boundaries were included, along with the portions of these bays that extended outside of the quad, while those that touched the left and lower boundaries were completely excluded. A total of 1,494 Delmarva Bays were examined (8.8 % of the estimated population). Each identified Delmarva Bay was manually outlined by drawing a polygon around the rim of the bay, following the highest elevation surrounding the basin, as one would do when delineating a watershed. In order to make comparisons with the larger Carolina Bays, the morphometric parameters of major axis, minor axis, and orientation were collected using the *zonal geometry* tool in ArcGIS, while vector data for area and perimeter were obtained using the *calculate geometry* tool. To ensure that the elevation of ditches was not included in the calculation of the basin elevation, the relief for each Bay was determined manually by comparing the average elevations of three randomly selected points from the basin, with the average elevation of three randomly selected points on the rim. The selected points were visually examined to ensure that they did not include gross anomalies such as drainage ditches. Based on the morphometric analyses, frequency distributions were created for major characteristics of Delmarva Bays. Land cover was documented using false-color near infrared aerial photography (acquisition dates 1992–95; leaf-off; 1 m resolution) by estimating percentages of natural, agricultural,

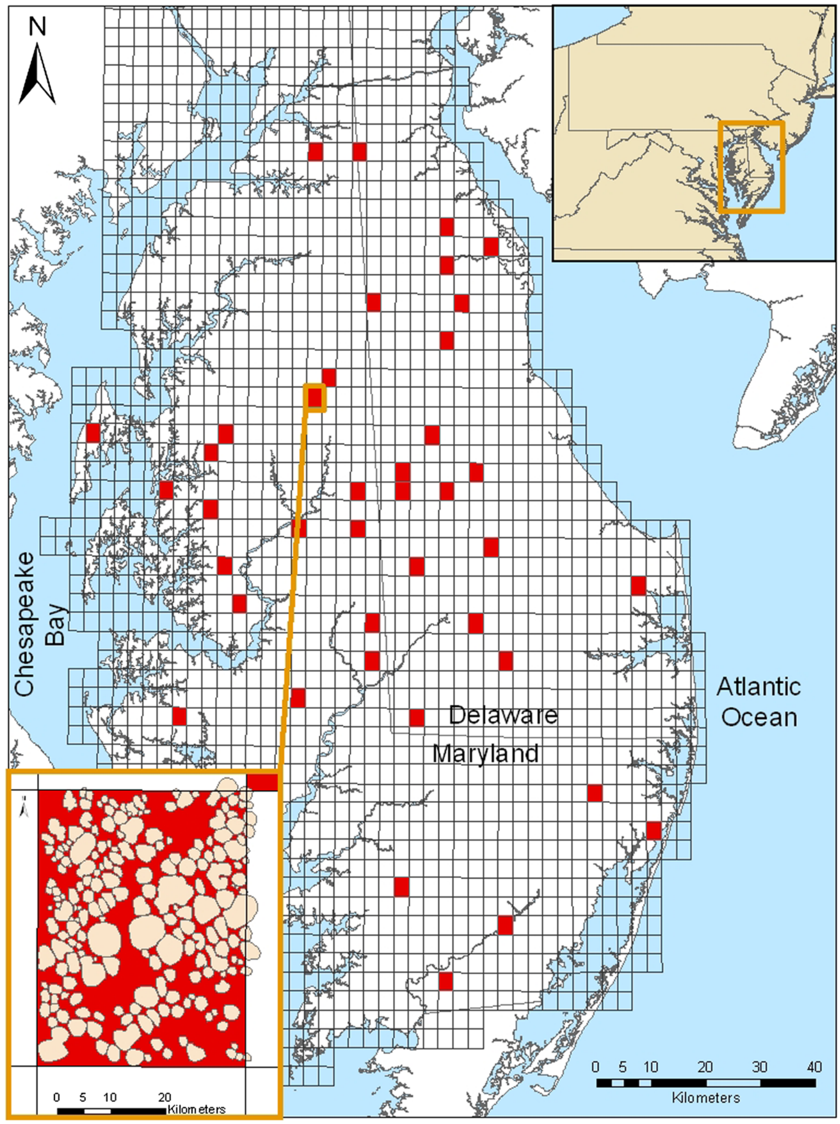

Fig. 2 Map showing 40 randomly selected quads; inset map shows an example of individual Bays that were measured within a sampled quad

residential, and fallow land cover classes in each bay (USDA-NRCS 2013). Natural land cover had undisturbed (assessed from 1992 to 95 photography) vegetation, and generally included forested areas and herbaceous areas surrounded by forest. Agricultural land use had been cleared and tilled for row crop production. Residential included houses and lawns. Fallow areas had been cleared and formerly cultivated (probably within 20 years of when photographs were taken, or roughly within 40 years of present) and generally contained saplings and shrubby vegetation in the early successional stages of forest development. Land uses were compared in groupings of Dominant and Entire. Classification as the "dominant" group identifies the land uses that covered more than 50 % of individual Bays. Classification as the "entire" group identifies the land use that completely covered (100 % of a single land use) individual bays. The "mixed" class is used for any bays that did not have a dominant (>50 %) land use, or in the "entire" grouping, those Bays that did not have a single land use that covered 100 % of the Bay. Statistical comparison of relief between natural and agricultural bays was conducted using a *t*-test.

Table 1 Number and proportion of quads in each density stratum found on the Delmarva Peninsula and the number of quads from each density stratum which were sampled for inclusion in the morphometric analysis

	Total quads observed		Quads sampled	
Density stratum (Bays/quad)	Number	%	Number	%
1–20	472	69	24	60
21–50	119	18	8	20
51–100	67	10	5	12
>100	21	3	3	8
Total	679	100	40	100

Results and Discussion

By examining the LiDAR data sets, a total of 14,969 Delmarva Bays were identified (Fig. 1). By also including estimates of bay density in areas for which LiDAR data were lacking, we estimate that there are roughly 17,000 Delmarva Bays in Maryland and Delaware. This estimate is an order of magnitude greater than the Stolt and Rabenhorst (1987b) estimate of 1,500–2,500 Bays on the Delmarva Peninsula, and within the range of 10,000 to 20,000 that Richardson and Gibbons (1993) estimated for the entire Atlantic coast. Their estimates relied on aerial photography which is less effective than LiDAR for identifying these landforms, especially in forested environments where trees interfere with the observation of the ground. The ability to observe small changes in elevation using LiDAR data has greatly improved the ability to identify and quantify these landforms. As an example, Fig. 3a illustrates one test area, where 47 bays were initially identified using only aerial photography. Figure 3b shows that when LiDAR data were utilized, 169 bays could be recognized.

Mean values for the morphometric data from each sampled quad are presented in Table 2. Among sampled quads (Fig. 2), density of bays (median 2.02 bays km^{-2}) was as high as 27 bays km^{-2}. In the two quads with the highest densities, the proportion of land area covered by Delmarva Bay landforms was 52 and 54 %, which is comparable to that reported for Carolina Bays (Prouty 1952).

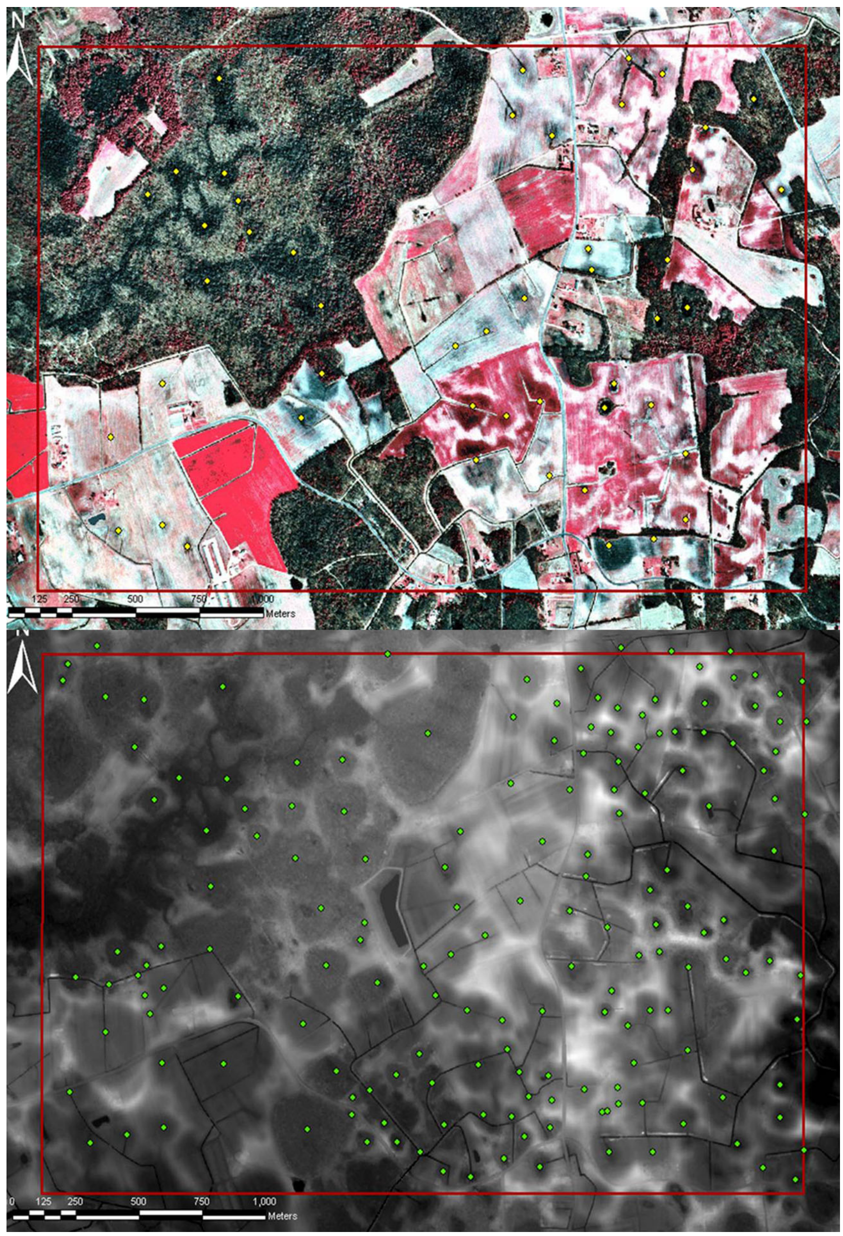

Fig. 3 Identification of Delmarva Bays in a test area using **a** aerial photography identifying 47 features and **b** using LiDAR elevation data identifying 169 features

Table 2 Morphometric parameters of Delmarva Bays (mean and standard error of the mean [SEM]) for each of the 40 randomly selected quads sampled for detailed analysis

Quad ID	# of Bays	Density (Bays km^{-2})	Bay Area (ha)		Major: Minor axis ratio		Orientation (circle deg.)		Relief (m)		Basin elevation (m)	
			Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
1141	259	27	1.91	0.15	1.32	0.02	102	3.0	1.37	0.03	18.3	0.05
649	204	21	2.51	0.19	1.35	0.02	108	2.8	1.54	0.04	17.0	0.06
1959	138	14	3.15	0.41	1.36	0.03	108	3.8	1.02	0.03	20.3	0.06
489	78	8.3	0.72	0.07	1.34	0.03	107	6.4	0.62	0.03	9.9	0.09
1847	77	8.2	1.89	0.22	1.32	0.03	112	5.0	0.80	0.05	14.9	0.12
1190	60	6.4	2.73	0.37	1.28	0.02	121	5.5	1.62	0.10	16.1	0.37
50	56	5.9	3.69	0.56	1.38	0.03	98	5.4	1.82	0.08	13.7	0.16
719	55	5.8	2.01	0.26	1.32	0.04	98	6.7	0.95	0.05	15.6	0.13
32	49	5.2	4.23	1.28	1.22	0.02	116	7.1	0.91	0.06	17.6	0.10
1095	49	5.2	1.75	0.22	1.34	0.04	106	5.3	1.18	0.08	2.7	0.10
1206	48	5.1	2.04	0.24	1.26	0.02	113	7.3	1.22	0.06	14.6	0.37
1260	44	4.7	2.14	0.16	1.40	0.03	110	7.1	1.53	0.09	16.2	0.22
1505	30	3.2	2.97	0.72	1.26	0.03	85	8.5	0.88	0.08	17.4	0.13
615	28	3	1.40	0.26	1.40	0.04	122	8.2	0.88	0.06	12.7	0.12
955	23	2.4	2.36	1.11	1.26	0.03	91	13.2	0.81	0.07	13.5	0.09
69	22	2.3	3.46	0.60	1.36	0.06	111	8.5	0.94	0.10	15.5	0.21
1081	20	2.1	3.43	0.65	1.26	0.05	95	9.1	1.72	0.23	4.0	0.36
16	19	2	2.27	0.55	1.37	0.07	99	10.0	1.03	0.12	14.2	0.31
516	19	2	3.87	0.94	1.37	0.08	97	13.0	0.85	0.05	14.0	0.11
560	19	2	2.73	0.58	1.30	0.07	81	10.5	1.15	0.11	15.5	0.24
606	19	2	2.93	0.56	1.32	0.05	104	3.4	1.27	0.08	2.2	0.17
12	18	1.9	2.07	0.36	1.43	0.06	120	8.4	1.05	0.10	6.2	0.51
1925	18	1.9	2.17	0.42	1.26	0.04	88	12.9	1.03	0.11	21.3	0.20
961	17	1.8	1.85	0.66	1.26	0.04	118	12.4	0.91	0.08	12.6	0.08
754	16	1.7	2.43	0.60	1.19	0.03	102	10.8	1.21	0.15	4.4	0.43
1948	15	1.6	4.07	0.88	1.22	0.03	89	12.8	1.01	0.11	7.3	0.31
1185	15	1.6	3.21	0.44	1.24	0.04	94	12.4	1.21	0.09	2.1	0.26
1072	15	1.6	1.75	0.29	1.35	0.06	126	9.9	0.88	0.09	13.7	0.11
237	10	1.1	9.50	7.75	1.23	0.04	101	18.4	1.23	0.10	18.9	0.33
990	10	1.1	4.28	1.34	1.22	0.05	97	18.3	1.35	0.15	11.4	0.56
1845	8	0.85	1.58	0.41	1.13	0.04	110	22.0	1.29	0.15	10.2	0.95
1377	8	0.85	12.7	3.44	1.34	0.07	119	15.5	0.69	0.08	5.4	0.09
1637	7	0.74	6.96	1.94	1.43	0.08	123	13.0	1.64	0.17	20.9	0.53
1230	6	0.64	52.0	20.0	1.40	0.08	125	26.0	0.67	0.08	5.0	0.11
1621	3	0.32	5.48	0.72	1.83	0.30	160	6.8	2.25	0.15	5.8	0.26
390	3	0.32	25.4	14.6	1.35	0.12	150	15.8	1.90	0.53	6.1	1.8
913	3	0.32	22.2	6.79	1.24	0.08	122	30.1	0.91	0.17	8.3	0.35
1672	3	0.32	4.62	1.88	1.35	0.12	149	12.8	0.86	0.03	2.1	0.31
227	2	0.21	2.39	0.34	1.15	0.01	113	12.0	1.66	0.26	2.3	0.31
807	1	0.11	0.09		1.45		94		0.38		1.0	
Overall	1494	3.97	2.83	0.16	1.32	0.01	106	1.2	1.21	0.02	14.9	0.13

Delmarva Bays had a mean area of 2.83 ha, (median 1.45 ha), with 80 % falling within the range of 0.46 to 5.68 ha (Table 2). This is much smaller than the highly studied Carolina Bays, which have a mean area of 46 ha (Bennett and Nelson 1991). Mean relief within Delmarva Bays was 1.21 m (median 1.11 m) with 80 % falling within the range of 0.55 to 2.02 m (Fig. 4) compared to 1.81 m for Carolina Bays (Prouty 1952; Thom 1970). The Delmarva Bays had an average major

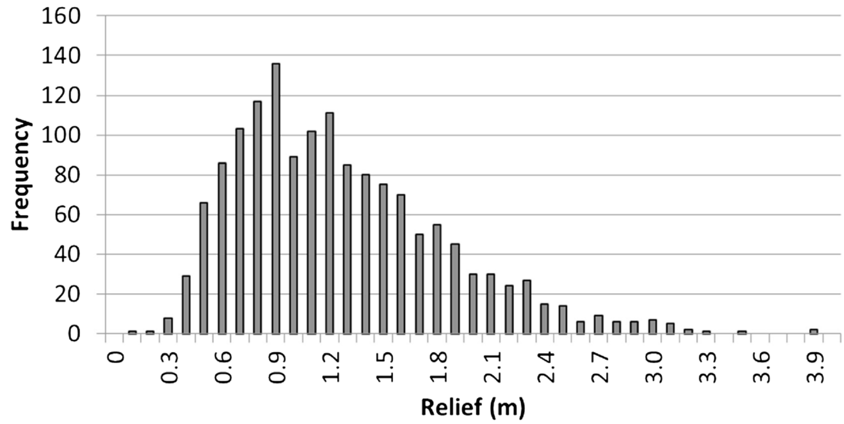

Fig. 4 Histogram showing relief for the Delmarva Bays examined in detail (n=1494)

to minor axis ratio of 1.32 (median 1.26), with 80 % falling within the range of 1.08 to 1.65; this is lower than the Carolina Bays, which had a mean ratio of 1.51 (Melton and Scriever 1933).

Since Delmarva and Carolina Bays are believed to have formed from similar processes (Prouty 1952; Savage 1982), it might be anticipated that they would be more similar in size and shape, but the Delmarva Bays are clearly much smaller

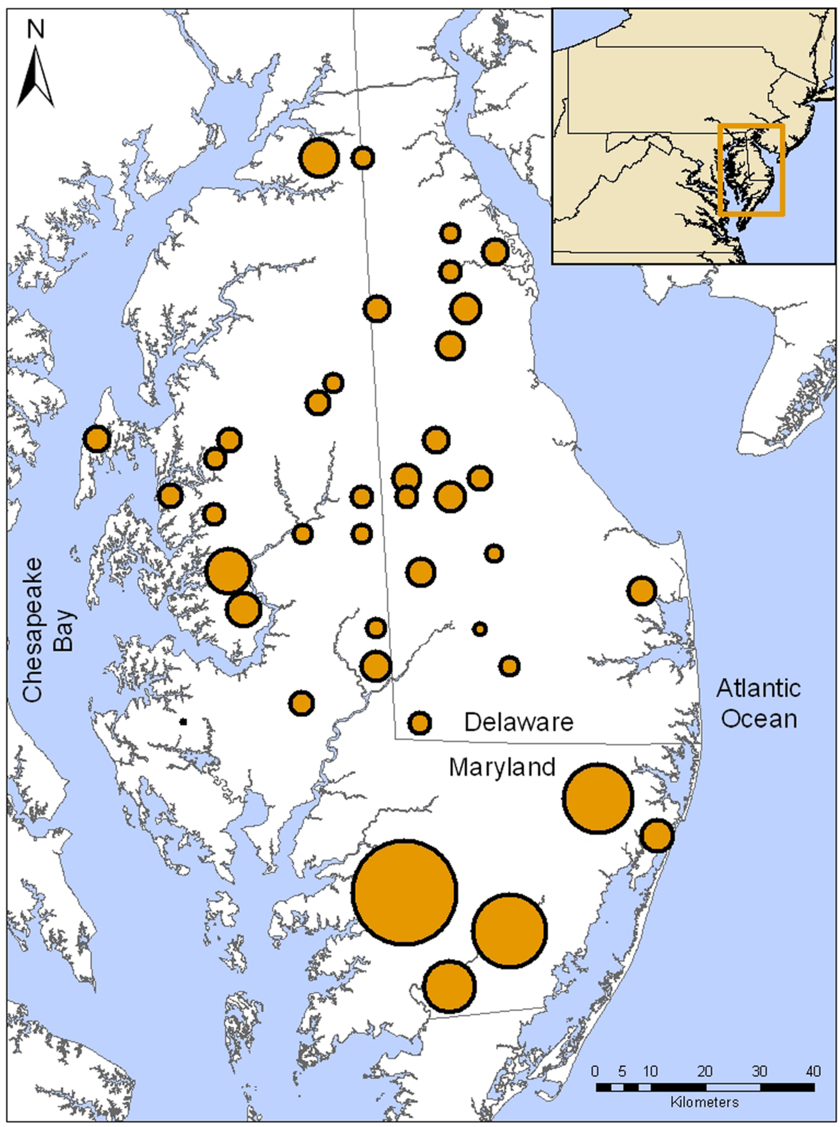

Fig. 5 Map showing 40 randomly selected quads which are represented by circles. The size of each circle is proportionally representative of the average bay area for that quad. Mean bay area among quads range from 0.1 to 52 ha

than the Carolina Bays. Although one might assume that the larger Bays would be older, or perhaps located at higher elevations, all sizes and shapes of Bays have been observed on coastal plain deposits of different ages and at different elevations (Prouty 1952; Thom 1970; Bliley and Pettry 1979; Stolt and Rabenhorst 1987b). The only observable trend regarding Bay size is that the southernmost cluster of Bays in North and South Carolina have nearly twice the area (46 ha) (Bennett and Nelson 1991) of those found in Virginia (approximately 25.2 ha as calculated from mean axis data and number of features reported) (Bliley and Pettry 1979), which are an order of magnitude greater in area than the average size of the Delmarva Bays in this study (2.83 ha).

One possible explanation for this difference is that the Delmarva Bays formed in a colder environment than the Carolina Bays. During the Pleistocene, when the features were formed, the Delmarva Peninsula was closer to the southern extent of the Laurentide Ice Sheet; therefore the periglacial climate in the Delmarva region would have resulted in longer durations of frozen surface water in blowout depressions. The frozen surface could have inhibited the further development of the Delmarva Bay landforms, which relied on erosional and shaping processes driven by wind blowing across the surface water. This would limit the size, relief, and elliptical shape of these features. Additional support for this theory can be observed in the morphological characteristics of the Delmarva Bays that are located on the southernmost part of the Delmarva Peninsula. Four of the five southernmost quads have the largest mean Bay area. These include quads 1,230, 390, 913, and 1,377, which had Bay areas of 52.0±21.9, 25.4 ±17.9, 22.2±8.32 and 12.7±3.68 ha, respectively (Table 2; Fig. 5). These values are in line with the findings of a study in the southernmost portion of the Delmarva Peninsula in Virginia (Bliley and Pettry 1979), just outside of our study area of Maryland and Delaware. The fifth southern quad (ID 1672) in our study had the eighth highest mean area (4.62 ha), which is still above the average for the entire data set. Also, the Delmarva Bays were noted to have a silty basin fill, believed to be a loessial deposit originating from the Susquahanna River and the Chesapeake Bay (Stolt and Rabenhorst 1987a, b). This silty basin fill is absent from the southern Carolina Bays which tend to have a sandy or clayey basin indicative of marine deposits (Prouty 1952; Thom 1970; Bliley and Pettry 1979; Bruland et al. 2003). The loessial deposits in the Delmarva could also have filled in the depressions created by blowouts, thereby reducing the amount of open water and inhibiting the development of the features.

The orientation of Carolina Bays has been reported to change systematically from approximately 55° east of south in the northern part of North Carolina to 15° east of south in the southern part of North Carolina (Prouty 1952). Our analysis shows Delmarva Bays to be less clearly oriented, but some orientation was evident. Many of the Delmarva Bays were equidimensional (more circular than elliptical). In order to better identify the orientation of elliptical bays, those with a major to minor axis ratio of less than or equal to 1.5 were removed from subsequent analysis of orientation, leaving 284 features (19 %) in the analysis (Fig. 6). This analysis showed that the middle 50 % of bays had an orientation between 5 and 55° east of south (95–145°), which is similar to the orientation of Carolina Bays (Prouty 1952). Some Delmarva Bays were found to be oriented west of south, which could weaken arguments that Carolina Bays and Delmarva Bays share a similar origin. Closer examination, however, demonstrated that many of these instances turned out to be pairs of overlapping bays that were analyzed as a single bay, resulting in the major axis providing a false direction of orientation.

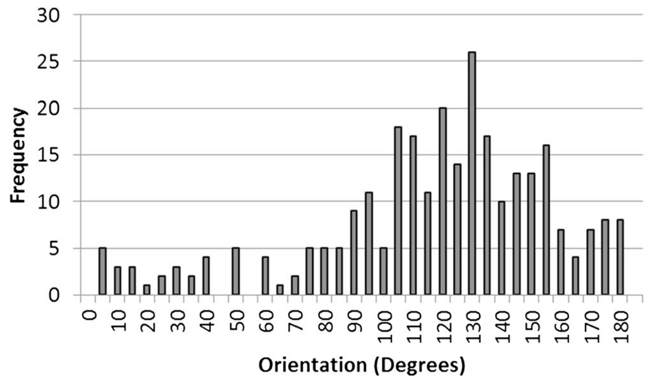

Fig. 6 Histogram showing the orientation of the subset of sampled Delmarva Bays having a major to minor axis ratio >1.5

The analysis of land cover/land use for Delmarva Bay landforms is presented in Fig. 7. More Bays have a dominantly agricultural land use than those with a dominantly natural land cover (mostly forested with some areas of emergent

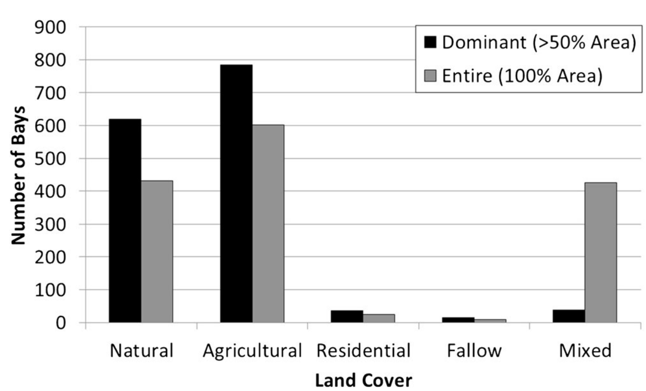

Fig. 7 Land use of the 1494 Delmarva Bays as classified according to their dominant and entire groupings. Any land use within a Bay that was greater than 50 % was considered to be dominant. Bays that had a single (100 %) land use were considered entire. Some Bays did not have a dominant (>50 %) land use and were classified as a "mixed". When considering the entire bay, any bays that did not have a single (100 %) land use were classified as mixed

vegetation). However, only 29 % of the Bays examined have entirely a natural land cover—the vast majority have been impacted in some way (mostly by agriculture). Even among the 29 % that appear to be natural, it is likely that many may in fact have undergone some hydrological disturbance. When examining the LiDAR images of these forested regions, remnants of man-made drainage features can be seen, often as a network extending throughout the forested areas. Although these drainage structures may not be currently maintained, they nevertheless would have resulted in some alteration of the hydrology in these "natural" Delmarva Bays. Therefore, it is likely that far fewer than 29 % of Delmarva Bays are unaltered. Ironically, these ditches may actually serve to help protect these wetlands from development as they often provide a surface water connection to other water bodies, perhaps bringing these wetlands within a regulatory framework (Lang et al. 2012).

When comparing Delmarva Bays that were entirely in natural land cover with Bays that were entirely in agriculture, natural Bays had significantly greater ($p<0.001$) relief (1.27 m) than those in agriculture (1.08 m). It is possible that erosion and sedimentation in the basins following tillage resulted in lower relief in agricultural bays. Alternatively, it is possible that those Bays selected for agriculture may have originally had lower topographic relief and possibly better natural drainage, making them more attractive for agriculture because they had shorter hydroperiods or were easier to drain. When comparing the average area of Bays that were entirely in natural land cover (2.03 ha) with those that were entirely in agriculture (1.97 ha), there was no significant difference ($p=0.31$). Also, there did not appear to be a significant relationship between relief and Bay area, either for the entire data set ($R^2=0.18$), nor when land use was evaluated independently (natural land cover $R^2=0.32$; agricultural land cover $R^2=0.17$).

Conclusions

Delmarva Bays are more abundant than previously thought, with the population in Maryland and Delaware now estimated to be approximately 17,000. This is an order of magnitude greater than previously reported. We believe that this refinement was mainly the result of improvement in the efficiency and accuracy of landform identification when using LiDAR derived DEMs. Eighty percent of Delmarva Bays have areas ranging from 0.46 to 5.68 ha, relief ranging from 0.55 to 2.02 m, and major to minor axis ratio ranging between 1.08 and 1.65. While smaller and less consistently elliptical than Carolina Bays, which are located further south, they have similar orientations, supporting the hypothesis that landforms in both areas were formed from similar processes. The smaller and less elliptical character of Delmarva Bays may be the result of a colder periglacial climate.

Understanding the geomorphology and abundance of Delmarva Bays, which provide vital habitat for many rare plant and animal species, can lead to improved management and conservation efforts. Since Bays with natural land cover typically contain wetlands, this information can assist in the prediction of wetland location. Also, it could be used to locate sites under agricultural land use that have the greatest potential for wetland restoration. In many cases, wetland hydrology can be regained by plugging drainage ditches. This information could also be coupled with other data to develop models regarding land use or climate change impacts, such as predicting the quantity of carbon that could be sequestered through ecosystem restoration efforts.

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