Harris Creek Seafloor Survey, March 2010

Summary

Acoustic surveys of Harris Creek were conducted to identify seafloor bottom types. The seafloor surface sediments tend to be muddy within the main channel, sandier toward the shore and numerous surface shell deposits scattered throughout the creek. Of the approximately 4,380 acres surveyed, the following bottom deposits were identified: 568 acres of oyster bars or surface shell deposit; 856 acres of sediment potentially covering shell deposits; 753 acres of hard bottom suitable for artificial reef material. Oyster bars, shell deposits and hard bottom tend to be concentrated along the channel edges or within the narrowest, deepest channels.

Geologic Setting

Harris Creek occupies a drowned drainage basin developed in the Kent Island Formation, the primary source for sediment filling the creek. The Kent Island Formation consists of layered silt, sand and clay, often rich in organic material. It is interpreted as ancestral Chesapeake Bay estuarine sediments. These fine-grained sediments are eroded and redeposit in the channel, accounting in part for the abundance of muddy sediment on the Harris Creek seafloor.

Numerous small paleochannels, generally associated with Harris Creek tributaries, dissect the subsurface. The paleochannels are often filled with highly organic sediments which produce methane gas. The gas creates a characteristic dark, featureless echo in the seismic record. Gassy sediments can pose a risk to benthic organisms because anoxic conditions can rapidly develop at the sediment surface. Also, these sediments tend to be soft mud, a poor substrate for reef material placement.

The deepest channels in the creek occur where opposing shorelines are close together and constrict channel flow. The deep, narrow channels often contain shell deposits and oyster bars. Figure 1 shows the acoustic survey boundary for Harris Creek.

Methodology

Acoustic surveys were performed on January 28 and February 1, 2010 onboard the DNR R/V Kerhin. Primary instrumentation included:

- Side scan sonar - EdgeTech 4200 FS @ 120 and 410 kHz
- Seismic profiler – EdgeTech SB 424 @ 4 – 24 kHz, 10ms
- Seabed Classification System - QuesterTangent QTC 5.5 VIEW @ 200 kHz

Survey parameters were:

- Vessel speed – 5-6 knots
- Track line spacing – 100 meters

- Side scan sonar range – 75 meters
- Side scan fish depth – 1.5 meters
- Seismic profiler fish depth – 2 meters
- Seismic profiler depth range – 25 meters

Side scan sonar data were collected with EdgeTech Discover software and analyzed with Chesapeake Technologies SonarWiz.Map 4 software. Seismic data were collected and analyzed with EdgeTech Discover software. Seabed classification data was processed with QuesterTangent QTC IMPACT 3.4 software.

GIS data was compiled with ESRI ArcGIS Desktop 9.3.1. In ArcGIS, side scan sonar mosaic images were overlaid with a contour data set developed from NOS bathymetric data for the Harris Creek area. The seabed classification data were layered over the mosaics and bathymetry. These data sets were used to correlate side scan reflectivity with acoustic seabed classes and detect any influences that sudden changes in seafloor slope may have on the acoustic data. Steep slopes tend to scatter the acoustic signals and produce anomalous data.

The seismic profiles give an indication of subsurface structures, and where these structures meet the surface. Seismic data is useful in determining where the seafloor is firm or soft, where subsurface gas may be released to the water column, and where buried shell may be located. The profiles are correlated with the side scan mosaic to provide a 3-dimensional model of the seafloor.

Acoustic Survey Data Analysis

Seabed classification data indicated the presence of 6 acoustically distinct seafloor bottom types. These bottom types are highly variable and only 3 types are particularly distinct: mud, shell and sand. The 3 less distinct types are probably gradational sediments containing varying amounts of mud, sand and shell.

The overall low acoustic reflectivity in the side scan mosaic and variable seabed class distribution suggests the Harris Creek bottom is mostly muddy with intermixed, patchy sand and shell deposits scattered across the channel. In the side scan mosaic, lighter shades represent softer mud, and darker colors indicate sand and harder bottom. The darkest shades are oyster bars, and surface shell deposits.

Oyster bars are readily visible on sonar imagery. Their geometry takes several distinct forms. The most prominent form is an oval, “racetrack”, or semi-circular dark patch. The shape is produced by oyster shell planting methods and, if the bar is dredged, the dredging method. A number of these oyster beds are visible in the side scan image in Figure 3, particularly in the southern region. Older bars which are no longer planted or worked have a similar shape but appear less distinct and partially sedimented over, producing a lighter, less pronounced shape.

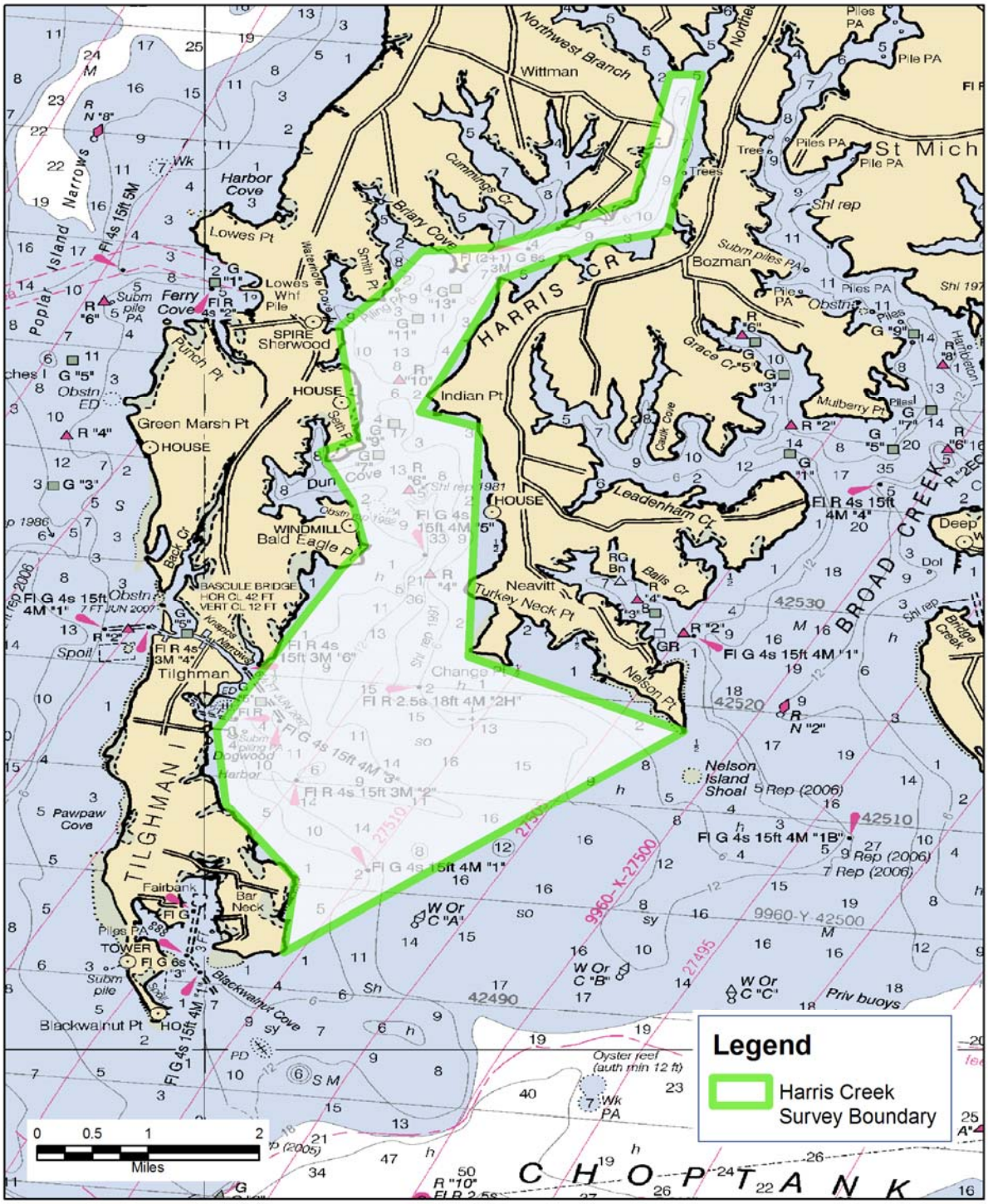

Figure 1: Harris Creek survey boundary

Another distinct bar geometry is the triangular or wedge-shaped bar often found near the shoreline or in shallow water. These bars developed on what were once points of land jutting out into the ancestral waterway, but have become submerged as sea level rose after the last ice age. Other bar shapes include irregular, oval mounds, and linear, "zebra-striped" patches. Figure 2 displays sonar imagery of these diverse bar forms. Figure 3 is the complete side scan sonar image mosaic for the Harris Creek survey.

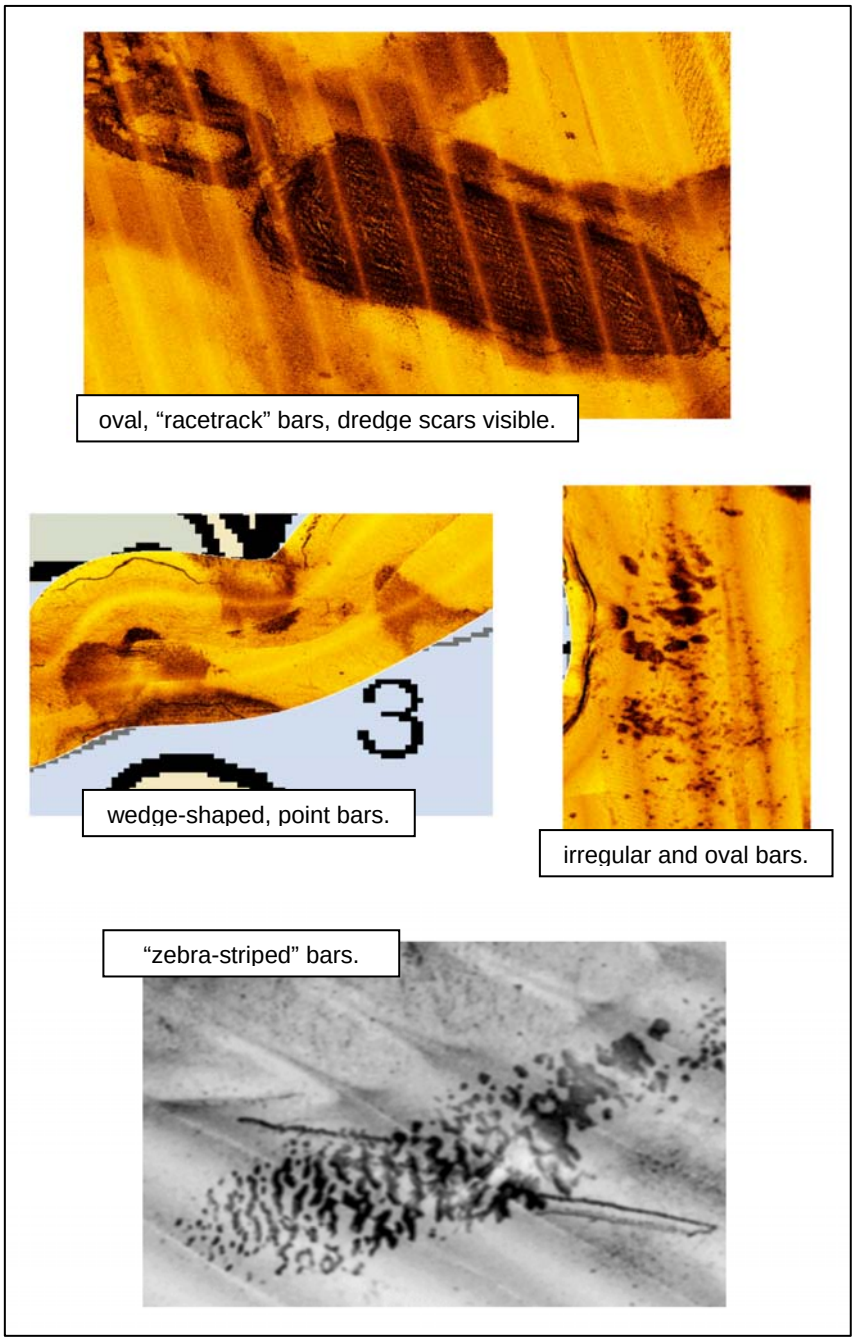

Figure 2: Sonar images of oyster bar forms.

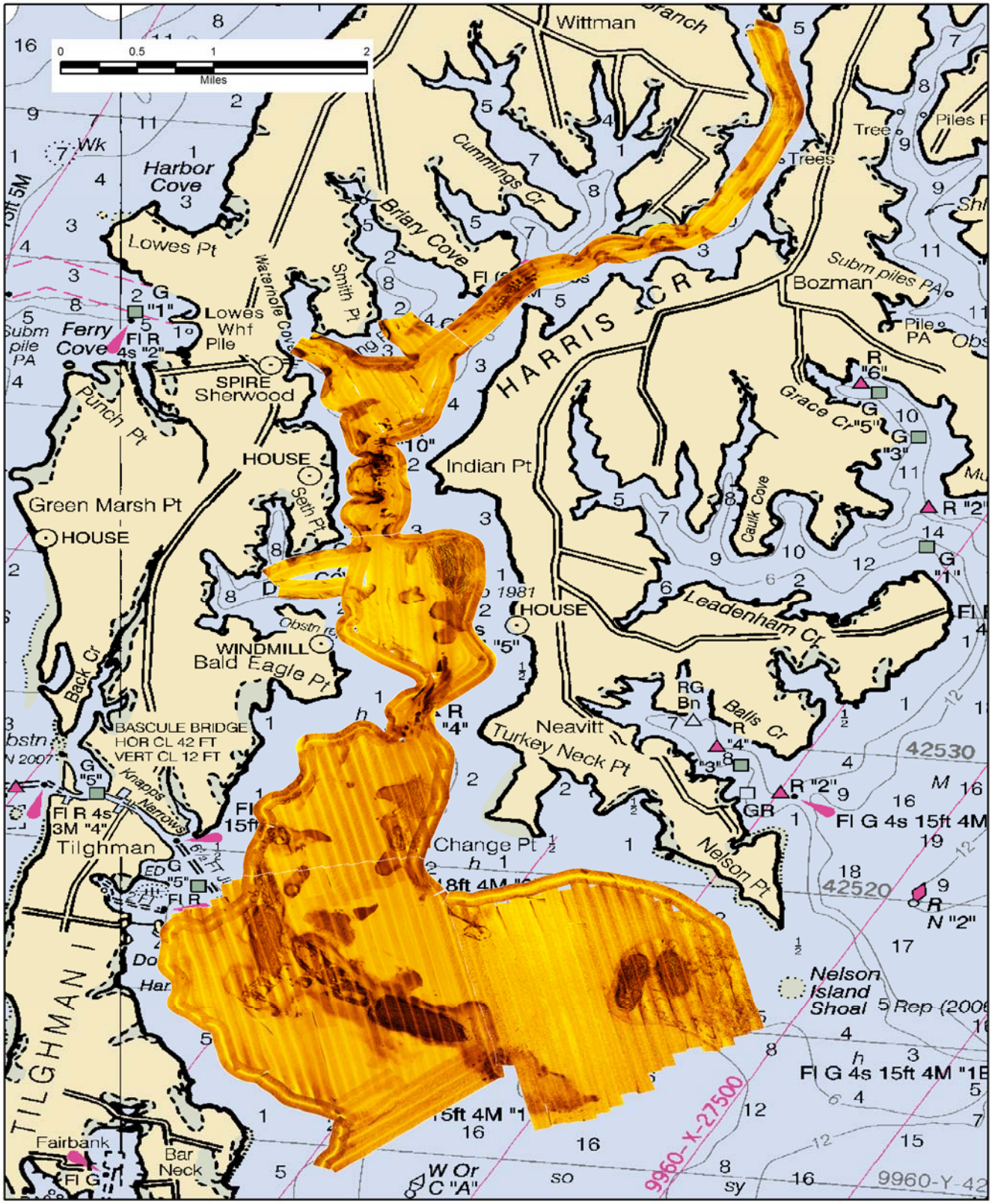

Figure 3: Side scan sonar mosaic of Harris Creek

The relationship between side scan imagery and seismic imagery is shown in Figure 4. This diagram is a close-up view of the two bars seen in the lower right corner of Figure 3. These bars have been artificially planted with oyster shell and spat, and have been power dredged. The bars developed on a drowned point of land that was exposed during low sea level stand. The grayscale seismic profile overlaid on the sonar image represents a cross section of the bar along the purple line drawn on the sonar image.

The center of the seismic profile shows the submerged land emerging from the mud-filled, gassy paleochannels on the left and right (north and south, respectively). The surface shell is perched on top of this hard-bottom platform. The platform rises steeply up from the southern channel. The northern edge gradually slopes below the muddy bottom and eventually dips into the northern paleochannel. At the point where the surface shell ends, there is a stretch of about 150 meters of buried hard bottom that potentially could contain buried shell within 1 meter of the seafloor. Figure 4 is an example of how acoustic data is used to locate potential buried shell deposits.

Results

The following bottom types were mapped based on acoustic data analysis.

- Surface shell
- Buried shell
- Hard bottom
- Unclassified

Surface shell is defined as whole shell, shell fragments and shell hash with a sufficient surface density to produce a distinct acoustic signal. The nature of the shell is not necessarily determined. Some areas are clearly oyster bars, either currently harvested or relict. Because a comprehensive bottom sampling program was not included in this project, existing surface data from the Bay Bottom Survey [1] , DNR's Patent Tong Survey, and acoustic seabed classification data were used to estimate the presence of shell on the surface. Surface shell can be mixed with sand, mud or a range of sediment, referred to as "cultch" in the Bay Bottom Survey database.

The buried shell bottom type is defined to be areas where shell-bearing sediments may occur within 1 meter below the seafloor. This definition takes into account the limited dredging depth available to watermen participating in the shell reclamation program.

Hard bottom refers to areas which appear acoustically dense, but are not definitively shell-bearing. Hard sand, clay outcrops, and gravel beds will appear as hard bottom in acoustic signals. While this bottom type may be well-suited for reef materials, there was no definitive evidence that shell was present in this bottom type.

Unclassified bottom in Harris Creek is assumed to be muddy bottom. Most of the creek seafloor appears to be acoustically translucent, producing an overall lightly shaded side scan image. This is indicative of soft, muddy sediment.

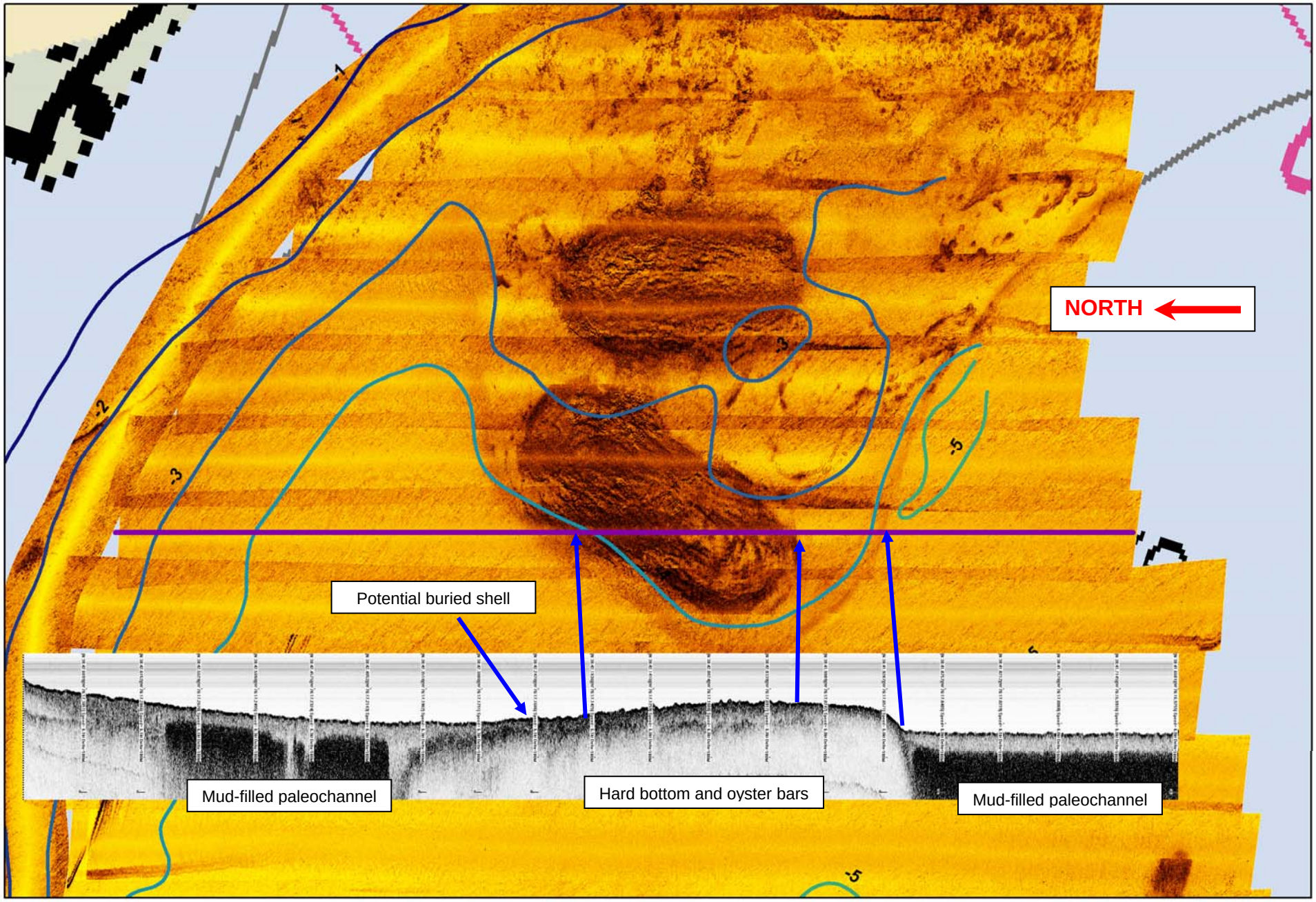

Figure 4: Seismic profile through an oyster bar

The following figures show outlines of surface and buried shell regions superimposed on side scan imagery.

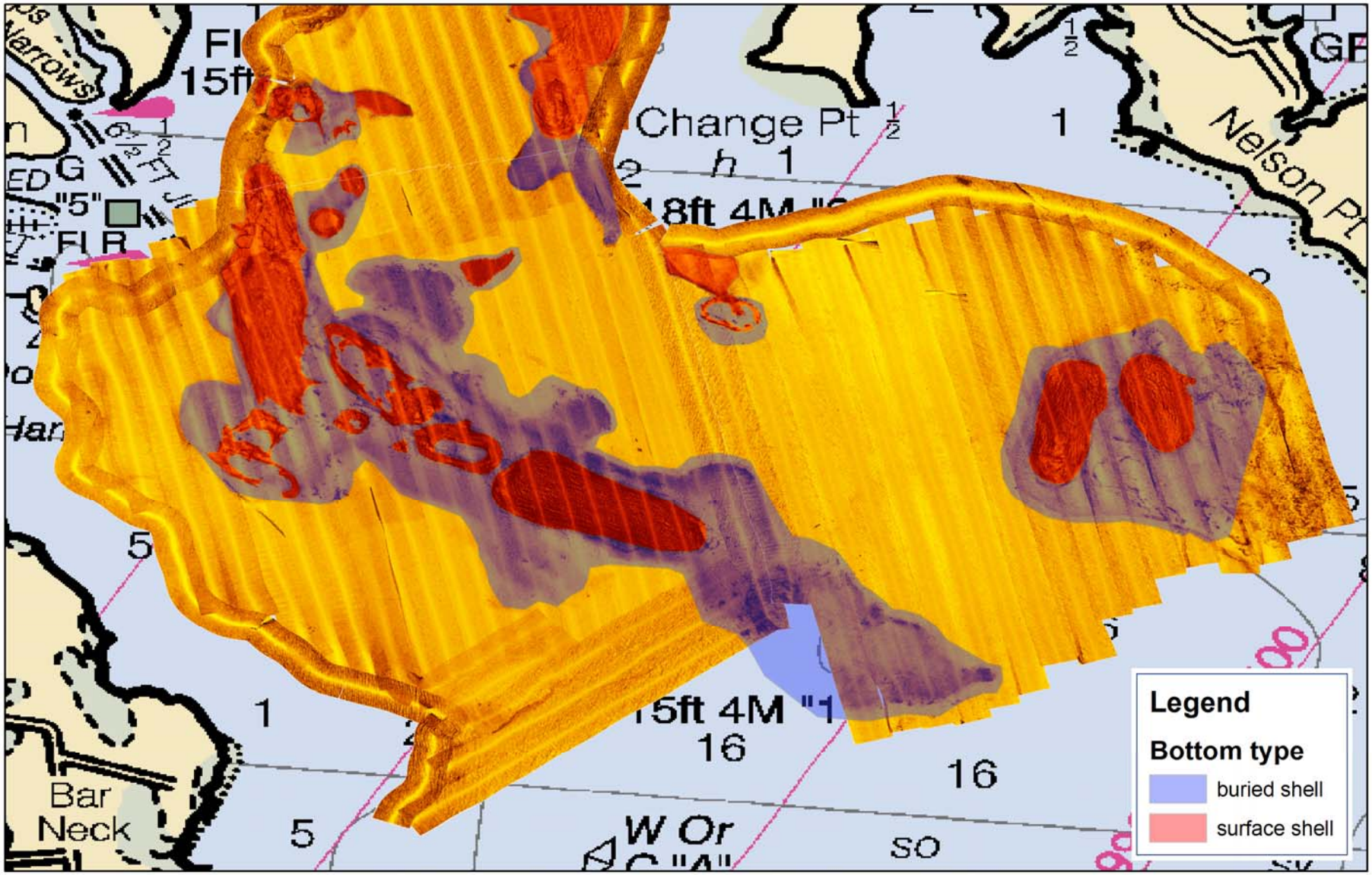

Figure 5: Lower Harris Creek bottom types

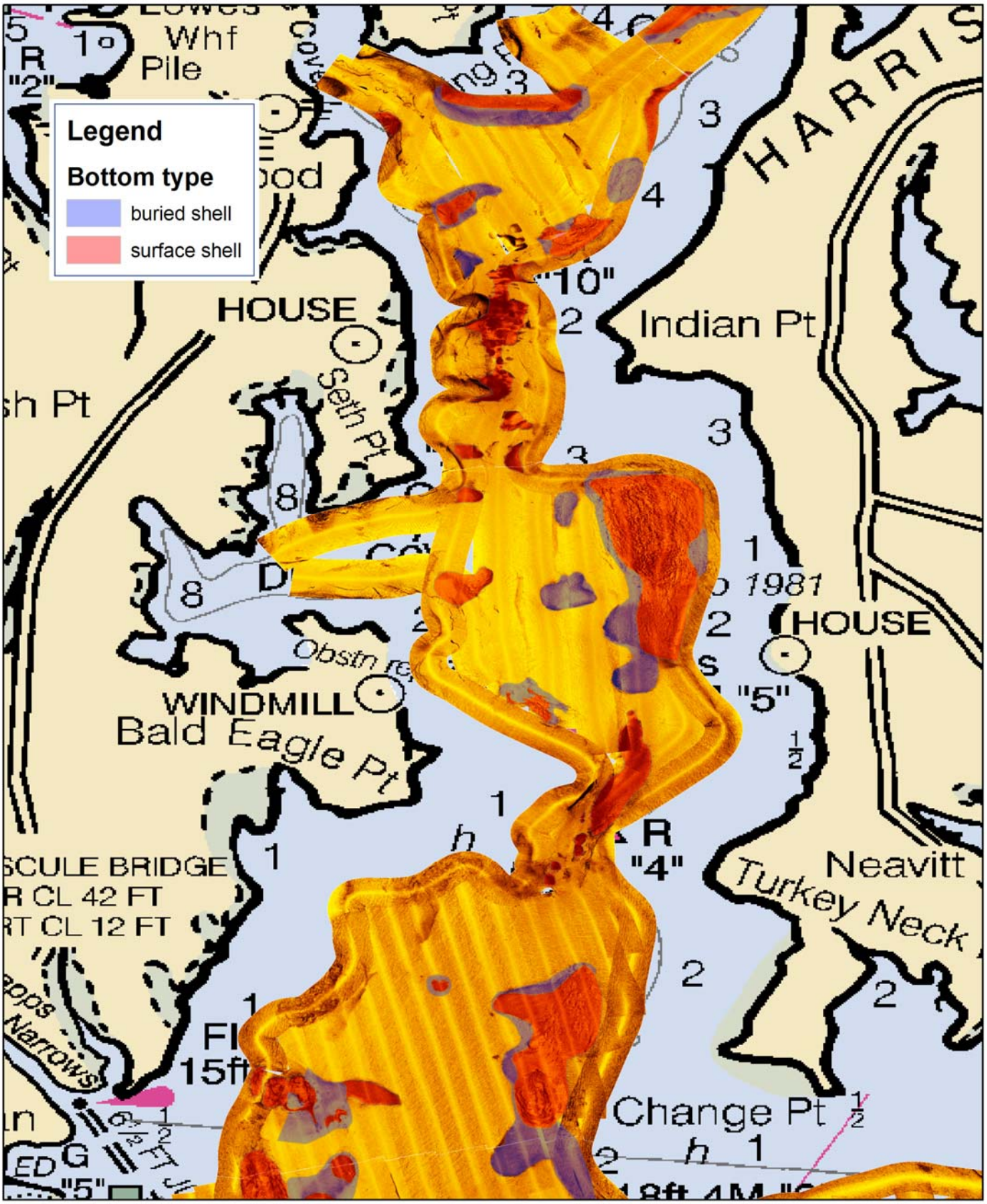

Figure 6: Middle Harris Creek bottom types

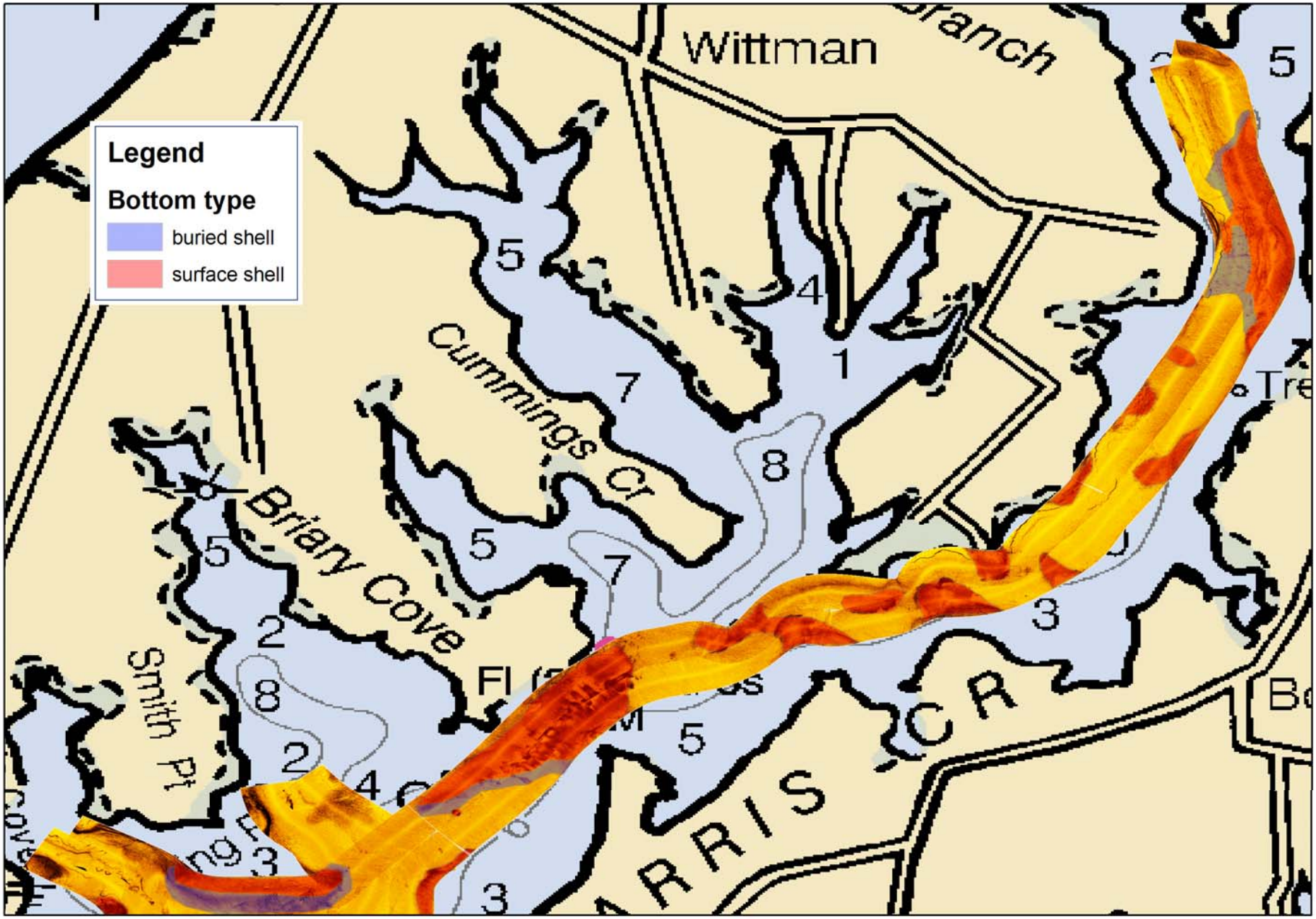

Figure 7: Upper Harris Creek bottom types

Figure 8 is a summary of Harris Creek bottom types, superimposed on a shaded bathymetric map. This figure suggests that oyster bars are often associated with either channel edges or deep, narrow channels. Most hard bottom tends to occur near the shoreline or on shallow platforms.

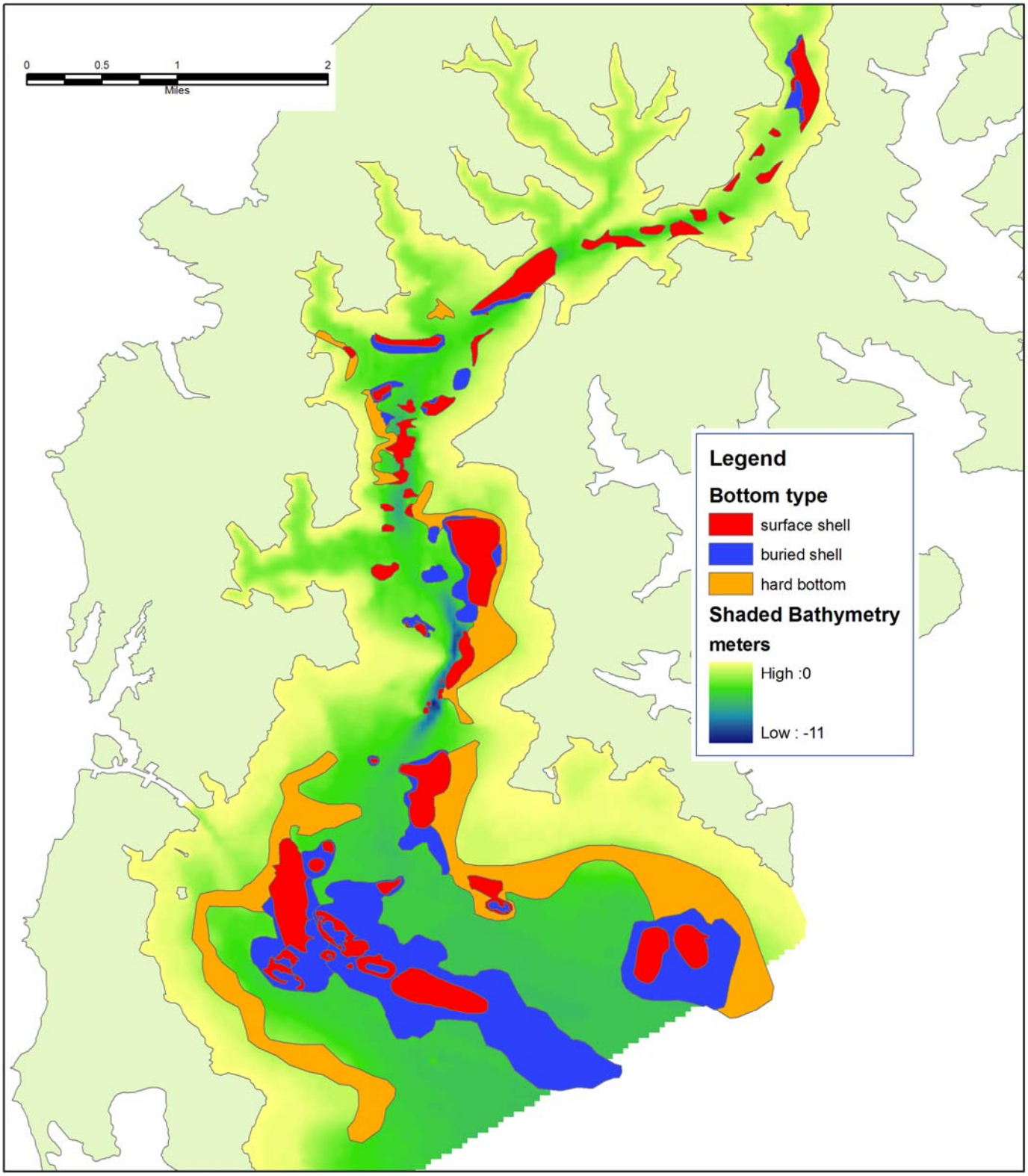

Figure 8: Summary of Harris Creek bottom types superimposed on a shaded bathymetric map.

Conclusion

Acoustic surveys of Harris Creek indicate significant surface and buried shell deposits. Active oyster bars were located and mapped. Approximately 4,380 acres were surveyed. The following bottom deposits were identified:

- 568 acres of oyster bars or surface shell deposit
- 856 acres of potential buried shell deposits
- 753 acres of hard bottom suitable for artificial reef material.

Oyster bars tend to be distributed along channel edges and in deep, narrow channels. Many bars and shell deposits are located on submerged land areas which were once points of land along the ancestral watershed.

GIS data for this project are available from Maryland Geological Survey.

APPENDIX

Table 1: Bottom type areas associated with historic Yates Bars

Surface type	Associated Yates Bar	Area (sq meters)
buried shell	Change	131715.0653
buried shell	Eagle point	19219.42341
buried shell	Green Marsh	577093.5482
buried shell	Lodges	8724.715273
buried shell	Lodges	19138.63342
buried shell	Mill Point	13048.42978
buried shell	Mill Point	88800.10327
buried shell	Mill Point	30514.12925
buried shell	Mill Point	12984.64753
buried shell	Smith Point	25723.4324
buried shell	Tilghman Wharf	282416.1835
buried shell	Tilghman Wharf	8991.180686
buried shell	Tilghman Wharf	54193.13181
buried shell	Tilghman Wharf	3577.162574
buried shell	Tilghman Wharf	52593.81562
buried shell	Tilghman Wharf	29924.73779
buried shell	Turnrow	25129.55808
buried shell	Turnrow	12322.78323
buried shell	Upper Harris Creek	32167.69196
buried shell	Upper Harris Creek	13442.65215
buried shell	Walnut	2592.885909
buried shell	Walnut	2981.179291
buried shell	Walnut	52083.56785
buried shell	Walnut	25523.19338
buried shell	Wild Cherry Tree	1888200.165
buried shell	Wild Cherry Tree	12886.65102
buried shell	Wild Cherry Tree	1136.540442
buried shell	Wild Cherry Tree	30063.7861
buried shell	[none]	5521.610438
surface shell	Change	189419.5849
surface shell	Change	2763.405732
surface shell	Change	1756.011841
surface shell	Eagle point	11175.41044
surface shell	Green Marsh	124956.6371
surface shell	Green Marsh	99871.13661
surface shell	Hunts	6919.570823
surface shell	Hunts	7038.831888
surface shell	Hunts	6965.174294
surface shell	Hunts	29287.6804
surface shell	Little Neck	160220.8412
surface shell	Lodges	14969.21094
surface shell	Mill Point	259640.3201
surface shell	Rabbit Island	47229.60744
surface shell	Rabbit Island	16134.44818
surface shell	Seths Point	8658.088599
surface shell	Seths Point - Lodges	76021.03684
surface shell	Tilghman Wharf	274405.5444
surface shell	Tilghman Wharf	49813.68982
surface shell	Tilghman Wharf	15808.35583
surface shell	Tilghman Wharf	10340.49825
surface shell	Tilghman Wharf	3834.854822

surface shell	Tilghman Wharf	28105.96009
surface shell	Tilghman Wharf	6599.550147
surface shell	Tilghman Wharf	18902.7348
surface shell	Turkey Neck	4309.431585
surface shell	Turkey Neck	779.711615
surface shell	Turkey Neck	65992.71464
surface shell	Turnrow	62185.70196
surface shell	Upper Harris Creek	29732.92125
surface shell	Upper Harris Creek	14546.77585
surface shell	Upper Harris Creek	9151.952991
surface shell	Upper Harris Creek	9636.200519
surface shell	Upper Harris Creek	18370.99638
surface shell	Upper Harris Creek	8909.618089
surface shell	Upper Harris Creek	5862.505753
surface shell	Upper Harris Creek	112838.2078
surface shell	Walnut	7690.436587
surface shell	Walnut	32554.96437
surface shell	Walnut	41692.67709
surface shell	Walnut	774.319313
surface shell	Walnut	17999.29368
surface shell	Wild Cherry Tree	222744.0299
surface shell	Wild Cherry Tree	46659.22009
surface shell	Wild Cherry Tree	10990.93418
surface shell	Wild Cherry Tree	2852.299931
surface shell	Wild Cherry Tree	78603.32894
surface shell	Wild Cherry Tree	18479.25761
surface shell	[none]	3246.608628

Bottom Type	**total sq. meters**	**total sq. km**	**total acres**
surface shell	2297442.3	2.3	567.7
buried shell	3462710.6	3.5	855.7
hard bottom	3045102.0	3.0	753.0
surveyed area	17724411.0	17.7	4380.0

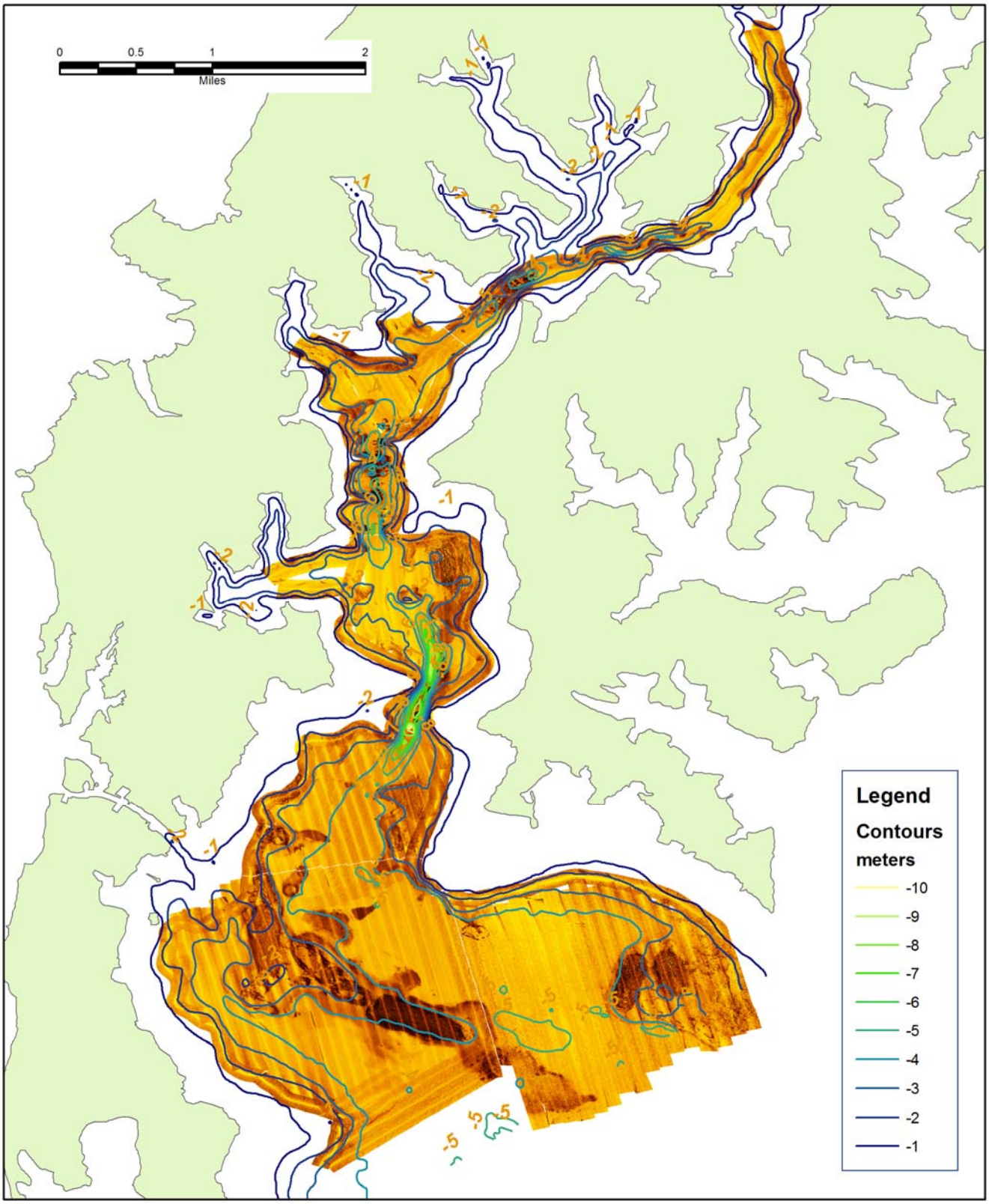

Figure 9: Bathymetric contours over side scan mosaic. (1 meter interval)

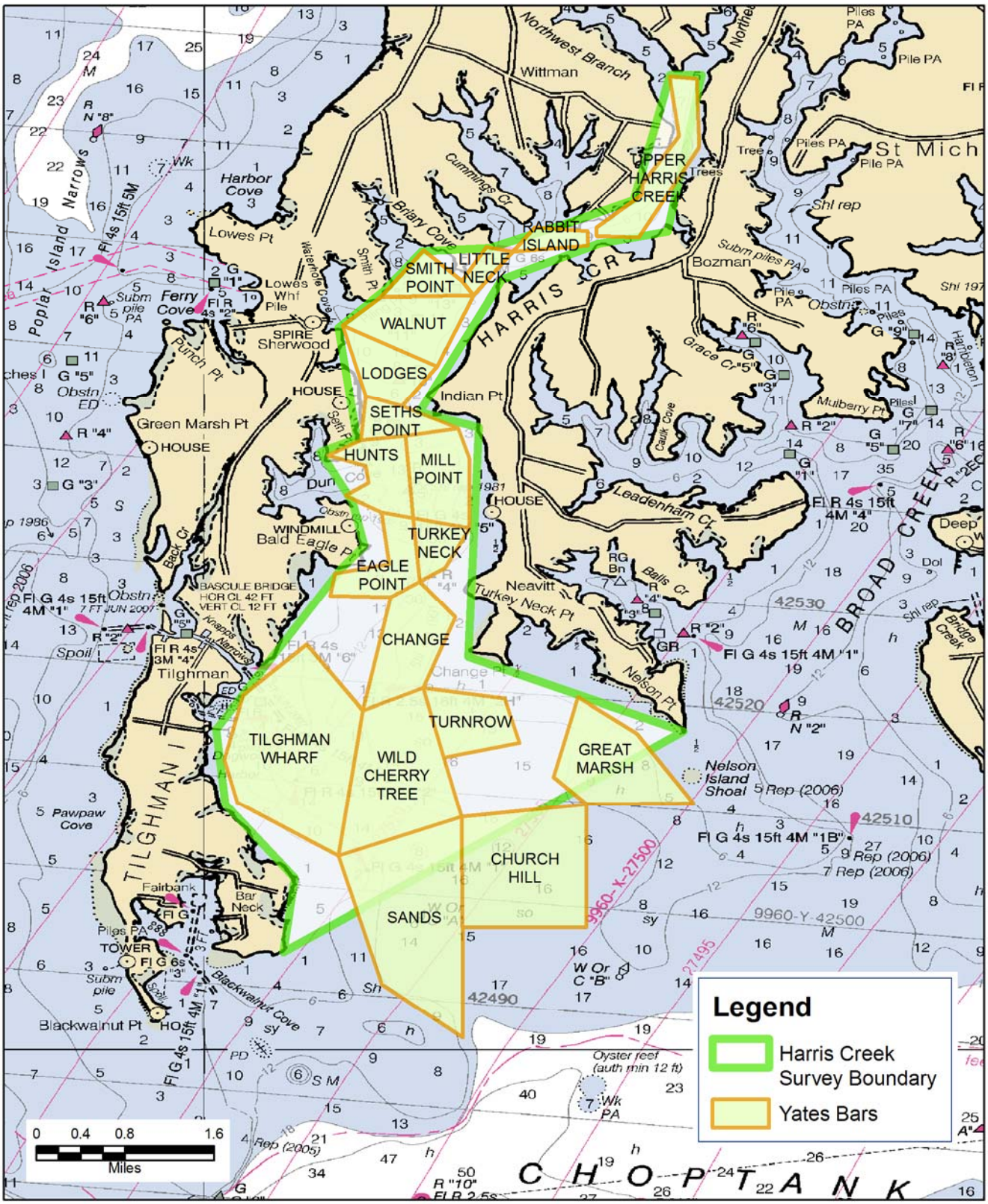

Figure 10: Location of historic Yates Bars in Harris Creek

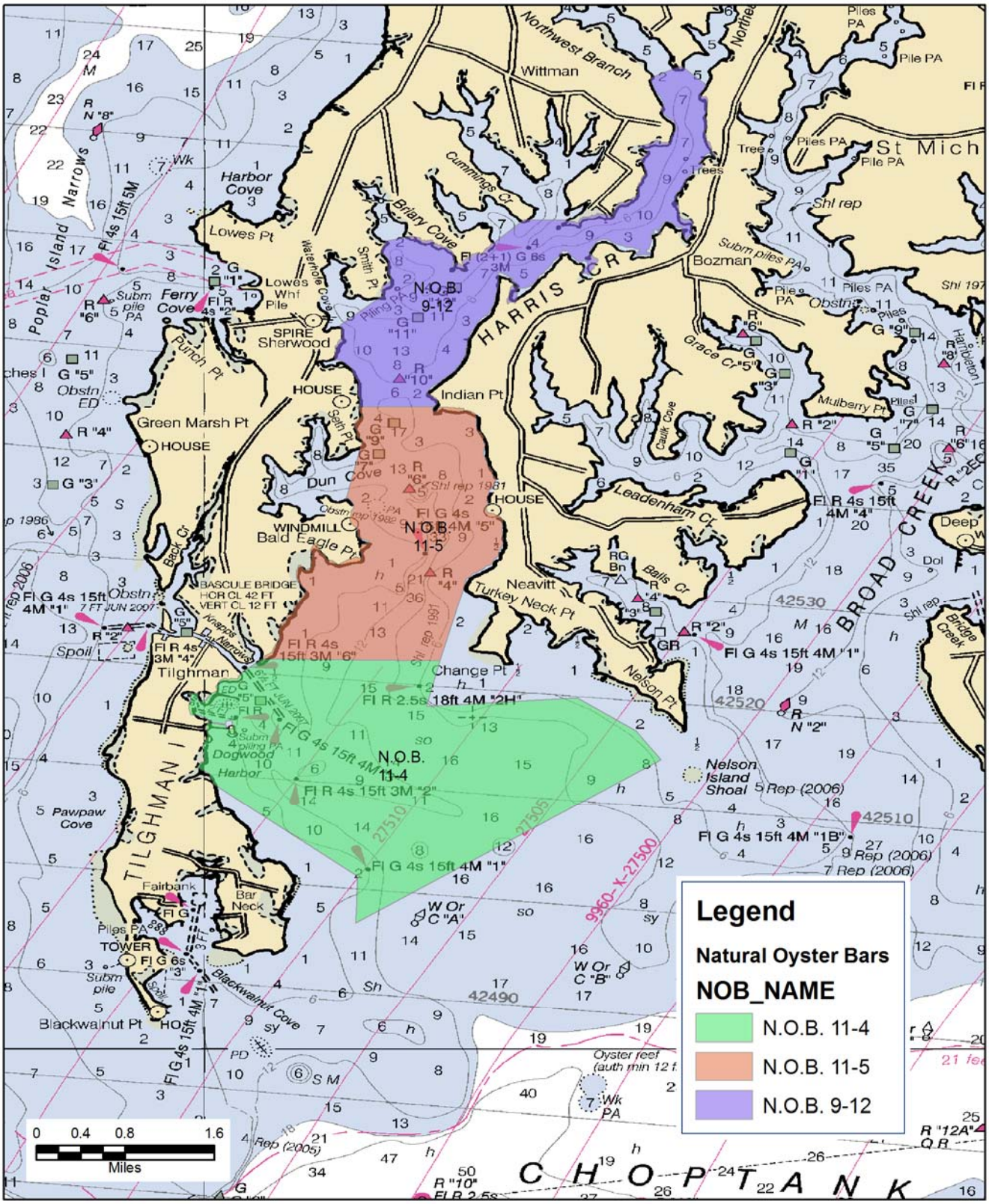

Figure 11: Natural Oyster Bars in Harris Creek

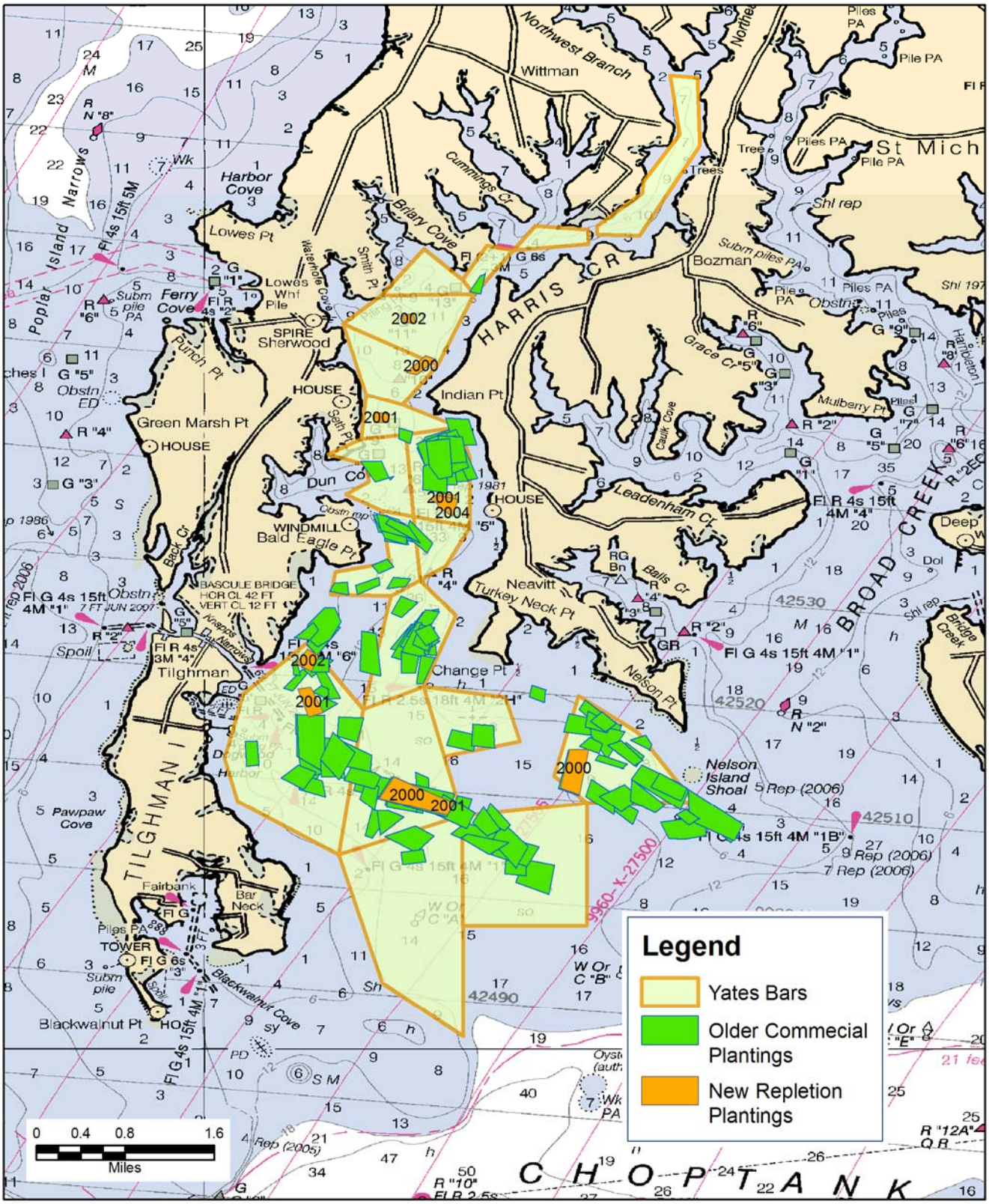

Figure 12: Oyster repletion plantings in Harris Creek

Reference

[1] Smith, G.F., K.N. Greenhawk, D.G. Bruce, E.B. Roach and S.J. Jordan. 2001 A digital presentation of the Maryland oyster habitat and associated bottom types in the Chesapeake Bay (1974-1983). Journal of Shellfish Research 20:197-206.

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