Supporting Information

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SI Text

Environmental Data for Oxygen Isotope Calibrations. The oyster population at Wreck Shoal in the James River, VA (Fig. 1 and Fig. S1, 37.06 N, −76.57 W), ~34 km southeast of Jamestown, was sampled as part of ongoing Virginia Institute of Marine Science (VIMS) monitoring studies at least every 3 months from October to May and weekly from May to October during 2002–2006. Water temperature (T, °C) and salinity (S, psu) were recorded 0.5 m from the bottom during each sampling trip. VIMS maintains a hydrographic monitoring station that records bottom T and S with 15-min resolution at Gloucester Point on the York River (37.2475 N, −76.4994 W). York and James River T are temporally equivalent (1), so York River T data were used as a surrogate for Wreck Shoal T when the latter were unavailable. Bottom T and S data from 2002 to 2006 at Old Point Comfort (Fig. 1, 36.00 N, −76.31 W; http://www.chesapeakebay.net/data_waterquality.aspx) are used to describe annual T and S conditions at a higher-salinity location. Water samples for oxygen isotope ($\delta^{18}O_{water}$) analyses collected from Wreck Shoal (August 2006 to September 2007) and Middle Ground (December 2006 to August 2007) (Fig. 1) provide a dataset from which modern James River $\delta^{18}O_{calcite}$ values are predicted.

Oyster Measurements and Morphology. Oysters do not grow symmetrically and are plastic with regard to morphological form. Shell length (SL) and shell width (SW) were measured (mm) for each left valve. SL, the longest dimension from the hinge to the shell growth margin is correctly termed shell height but is commonly described as SL in most literature. We adopt the common convention and refer to SL in the subsequent text. SW is the maximum dimension perpendicular to SL. Ratios of SL to SW can be used to characterize oyster morphological forms (2). Harding et al. (3) considered only WS and Jamestown oysters (from the same well examined by this study) with SL to SW ratios less than 1.9 to ensure that only similar growth forms were being compared. The SL to SW ratios of the WS shells examined here are also less than 1.9 (Table 1) and can be compared with these data (3). The SL to SW ratios for Z and P layer shells, like those of the modern WS shells, are less than 1.9 (Table 1).

Oyster Age-at-Length Determinations from Oxygen Isotope Data. The isotope profiles in Figs. 4 and 5 record oyster growth from the outer (oldest) edge of the shell cross-section just above the resilium to the inner (most recent, 0 value) edge. For example, the first year of the life of WS 8 extends from ~21 through ~11.5 mm (Fig. 4*F*), with year 2 from ~11.5 to ~5.5 mm, year 3 from ~5.5 to ~2.5 mm, and year 4 from ~2.5–0 mm. Thus, WS 8 was in its fourth year of growth when it was collected in November 2006 (Table 1), and we assign it an age of 4 based on the number of oxygen maxima (winter values) observed in the isotope record. Enumeration of the observed oxygen maxima for WS 2, 9, and 16 yield age (yr) estimates of 4, 3, and 4, respectively (Table 1). Adjustment of the age estimates for collection date (November), assuming a birth date of July 1 (1, 3), adds 0.33 to each age. Oxygen isotope derived age-length relationships from these four WS oysters are in agreement with those previously described for WS oysters using cohort analyses (3) (Fig. S2).

As with the WS shells, enumeration of $\delta^{18}O$ maxima (winter values) in the Jamestown shells provides an estimate of age (yr) at the time of collection. Examination of the Z1.2 isotope profile shows the first year of growth from ~19–14 mm, year 2 from ~14 to ~4 mm, and the final year from ~4–0 mm (Fig. 4 *A*–*D*). Age estimates (yr) for these shells are 2.5, 3, 3, and 2 for Z1.2, Z2.1, P14.1, and P5.4, respectively (Table 1). Age (yr) estimates for historic shells have also been adjusted for the collection season assuming a July 1 birth date (1, 3) (Table 1) by adding 0.5, 0.75, and 0.83 to Z, U, and P layer age estimates, respectively. The resulting isotopic age-at-length descriptions for Z and P oysters are in agreement with those previously described for historic oysters (3) (Fig. S2).

1. Mann R, Southworth MJ, Harding JM, Wesson JA (2009) Population studies of the native oyster, *Crassostrea virginica* (Gmelin, 1791), in the James River, Virginia, USA. *J Shellfish Res* 28:193–220.
2. Harding JM, Mann R (2006) Age and growth of wild suminoe (*Crassostrea ariakensis*, Fugita 1913) and Pacific (*C. gigas*, Thunberg 1793) oysters from Laizhou Bay, China. *J Shellfish Res* 25:73–82.
3. Harding JM, Mann R, Southworth MJ (2008) Shell length-at-age relationships in James River oysters (*Crassostrea virginica*) collected four centuries apart. *J Shellfish Res* 27: 1109–1115.

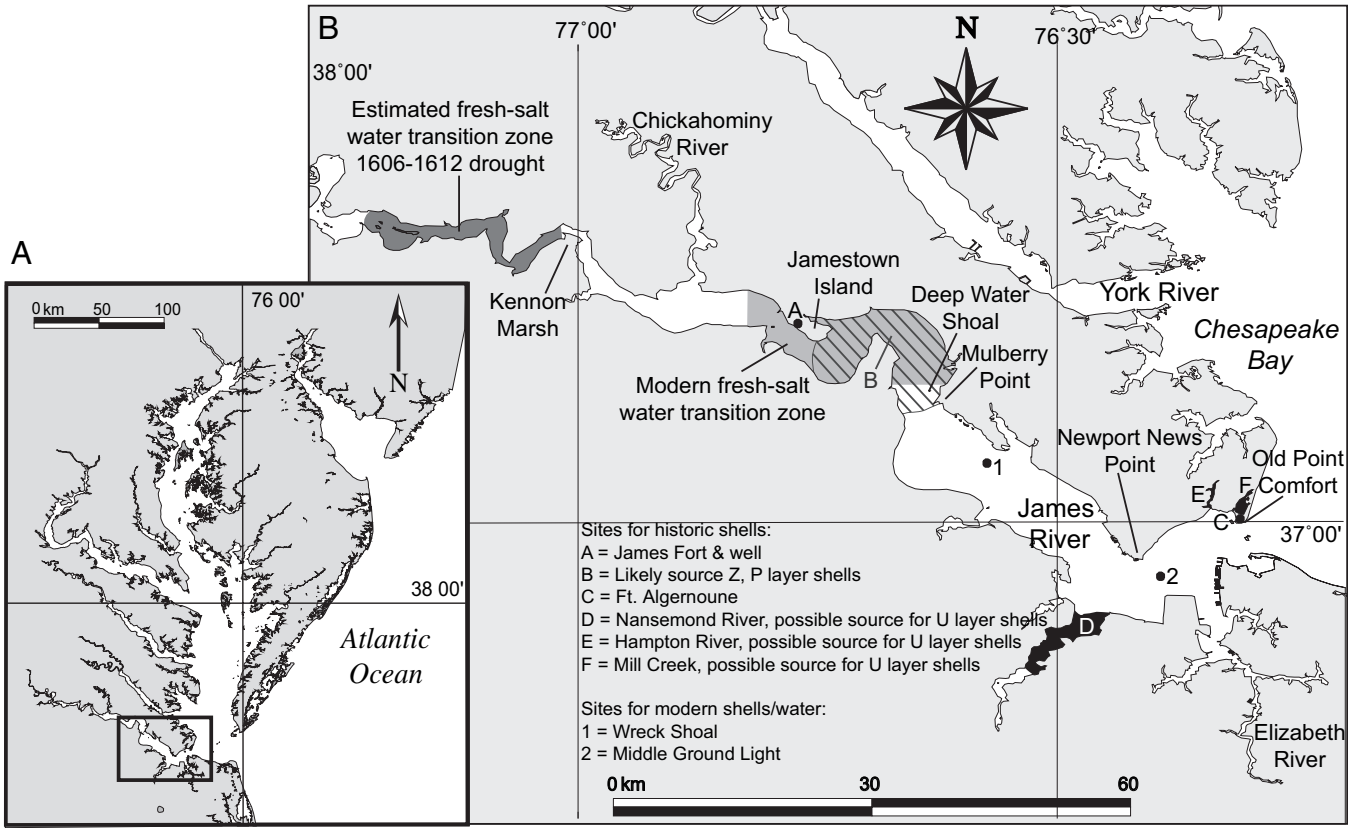

Fig. S1. High resolution map of the Chesapeake Bay (*A*) showing the James River, Virginia, USA (*B*) including collection locations for historic and modern oyster shells, modern water samples for isotope analyses and modern water temperature and salinity monitoring stations.

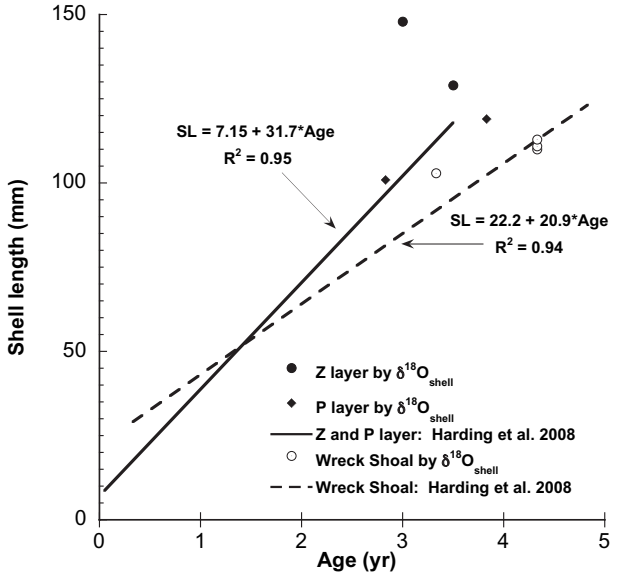

Fig. S2. Age-at-length estimates (individual data points, Table 1) for Wreck Shoal and Jamestown oyster shells from oxygen isotope data in relation to age-at-length relationships (fitted lines) from cohort analyses by Harding et al. (3) of the source populations i.e., modern Wreck Shoal oyster populations and James Fort Z and P layers.

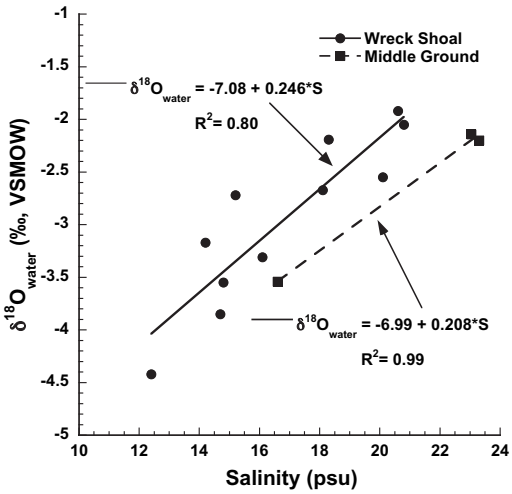

Fig. S3. Relationship between salinity (psu) and oxygen isotope values in seawater for Wreck Shoal (medium salinity) and Middle Ground (higher salinity) in the James River, VA.

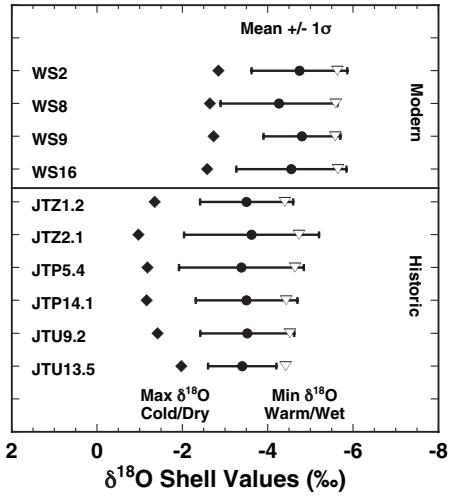

Fig. S4. Comparison of average (standard deviation), minimum range (◆),and maximum range (▽) $\delta^{18}O$ values from historic (Jamestown, 1609–1612) and modern (Wreck Shoal, 2002–2006) oyster shells.

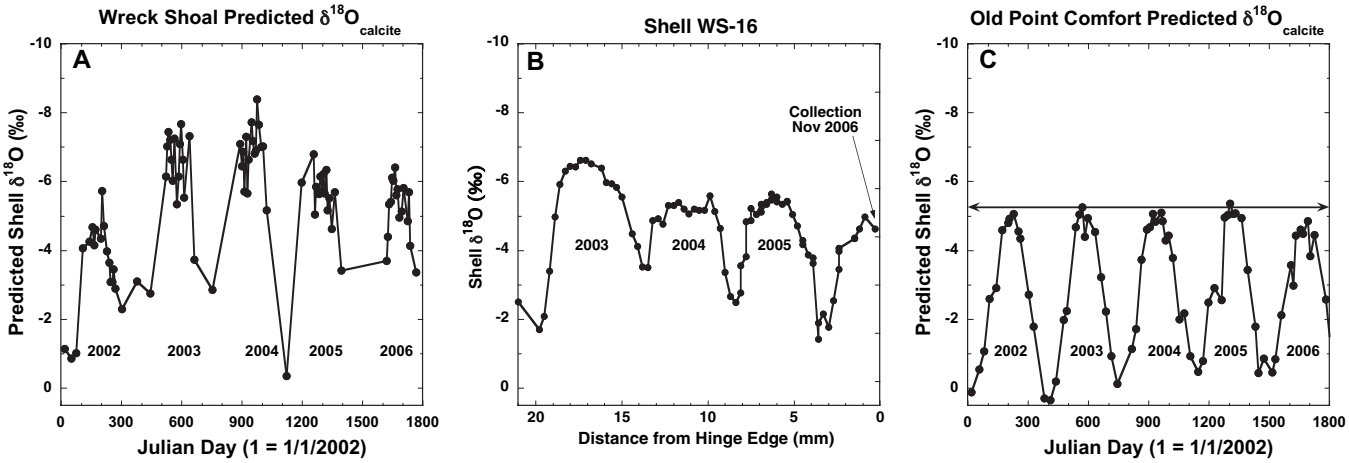

Fig. S5. Predicted $\delta^{18}O_{calcite}$ values for Wreck Shoal shells from 2002 through 2006 (*A*) with observed $\delta^{18}O$ values from modern shell WS16 (*B*) and predicted $\delta^{18}O_{calcite}$ values from the higher salinity Old Point Comfort region during 2002–2006 (*C*). Horizontal line with arrows (*C*) denotes the predicted summer minima at Old Point Comfort in contrast to the predicted minima at the lower salinity Wreck Shoal (*A*) during the same years.

Table S1. Final edge $\delta^{18}O$ values from Jamestown oyster shells sampled in this study

Shell ID	Final shell $\delta^{18}O$	Layer mean $\delta^{18}O \pm 1\sigma$
P12.2	−5.39	−3.77 ± 1.44
P14.2	−3.43	
P14.3	−3.74	
P6.3	−1.17	
P14.1*	−4.46	
P5.4*	−4.40	
U12.2	−4.90	−3.96 ± 1.20
U13.6	−5.65	
U8.2	−2.69	
U9.1	−4.37	
U9.2*	−2.88	
U13.5*	−3.24	
Z2.3	−1.32	−0.77 ± 0.94
Z3.2	−0.42	
Z2.1*	0.39	
Z1.2*	−1.72	

Letters in shell identification code (Shell ID) correspond to well layer (P, U, or Z; Fig. 2) from which oysters were collected. Final edge $\delta^{18}O$ values from Z layer are significantly more positive than values from U and P layers (ANOVA, $F = 9.24$, $P = 0.003$).

*Specimens with full hinge isotope records presented in body of text.