Supporting Information

Carstensen et al. 10.1073/pnas.1323156111

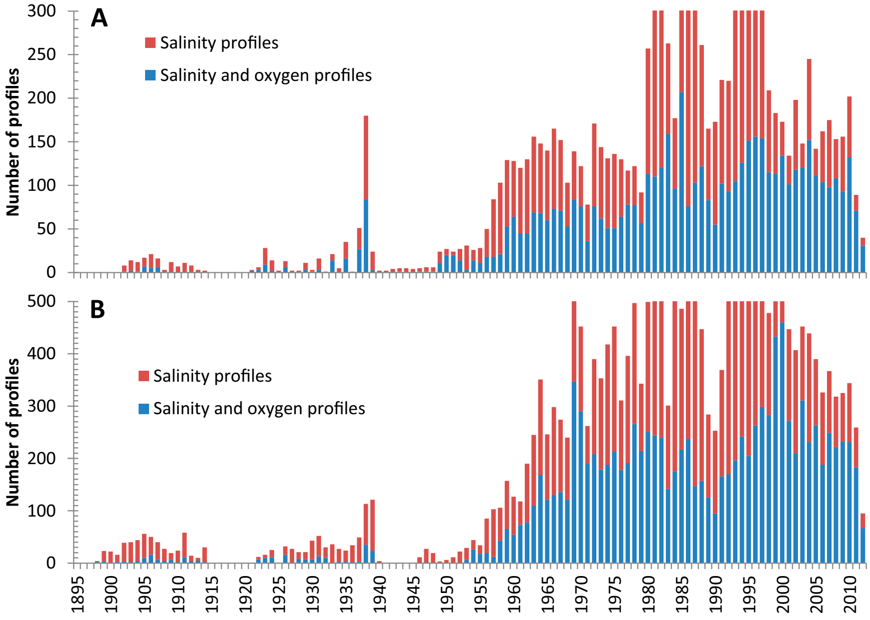

Fig. S1. Number of deep profiles for salinity and oxygen through time. Bornholm Basin (*A*) and Gotland Basin (*B*). Profiles with sufficient number of samples below the halocline were used for estimating trends of hypoxia in the Bornholm Basin and the Gotland Basin. Note that the second axes have a maximum cutoff to better display the lower number of counts in the early part of the time series.

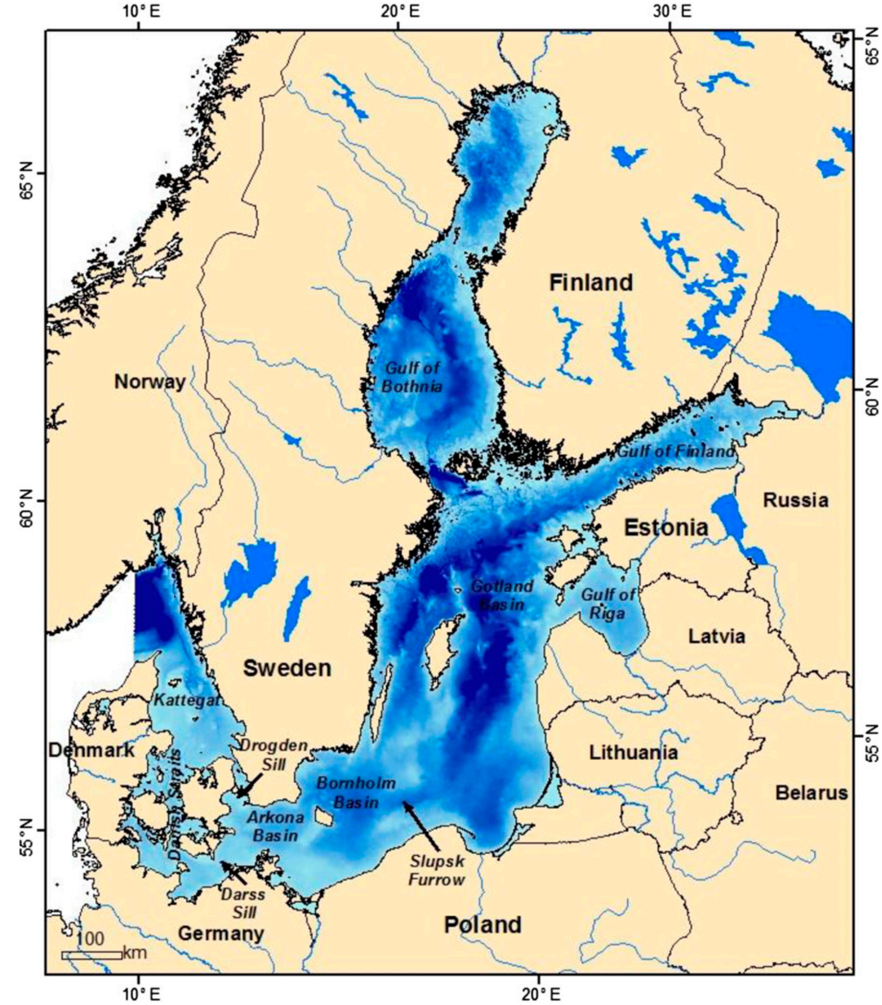

Fig. S2. Bathymetry of the Baltic Sea with the different regions indicated.

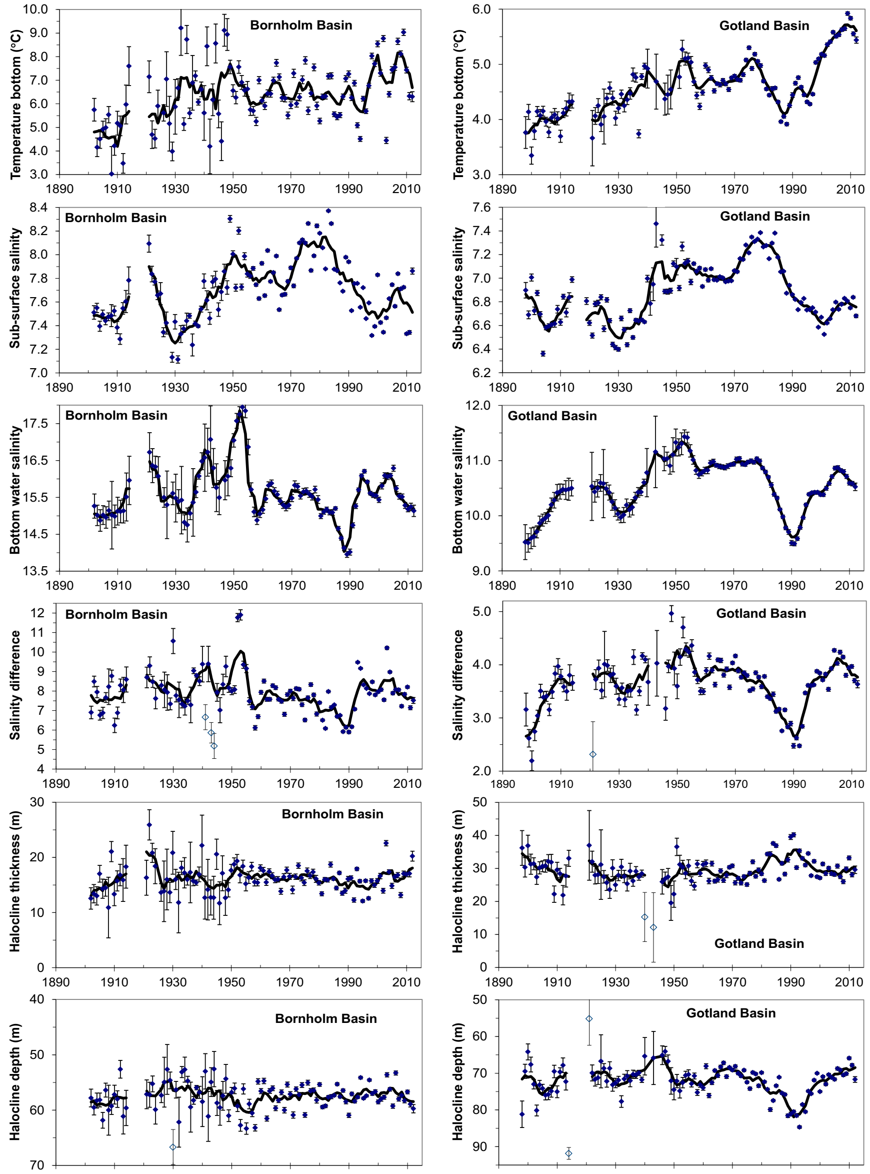

Fig. S3. (Continued)

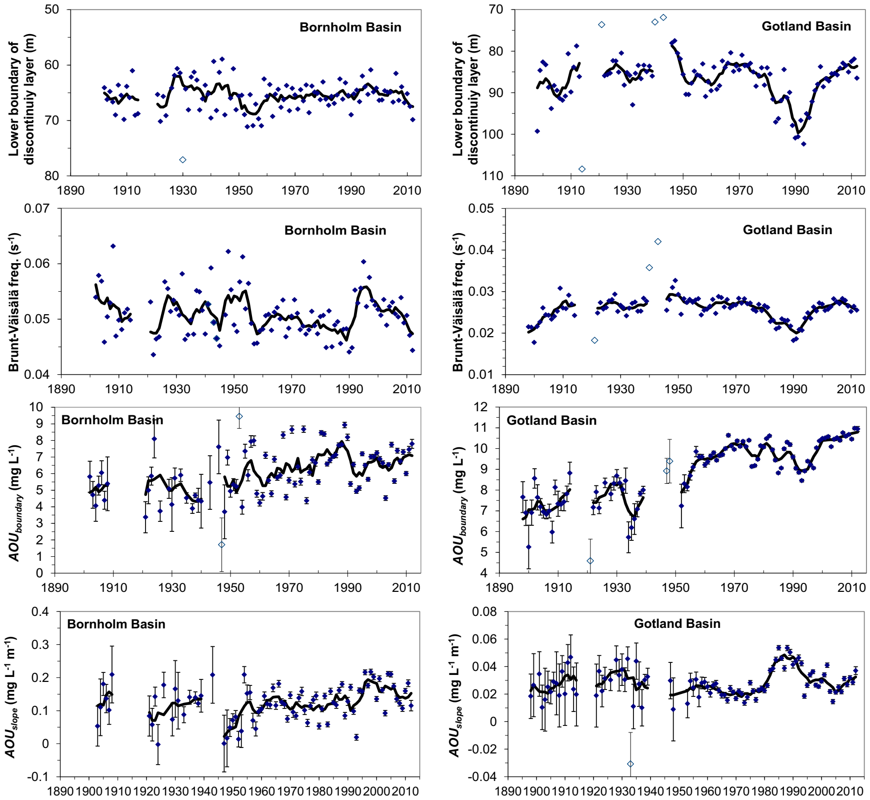

Fig. S3. Trends in annual means of parameter estimates from the salinity and oxygen profiles (Fig. S4). Outlier years are shown with open symbols and error bars show the SE of the annual means. The solid lines are the 5-y moving average of the annual means, not including outlier years. The lower boundary of the discontinuity layer was found as the halocline depth plus half the halocline thickness. Brunt–Väisälä was calculated according to the formula in the description in *Data and Methods*.

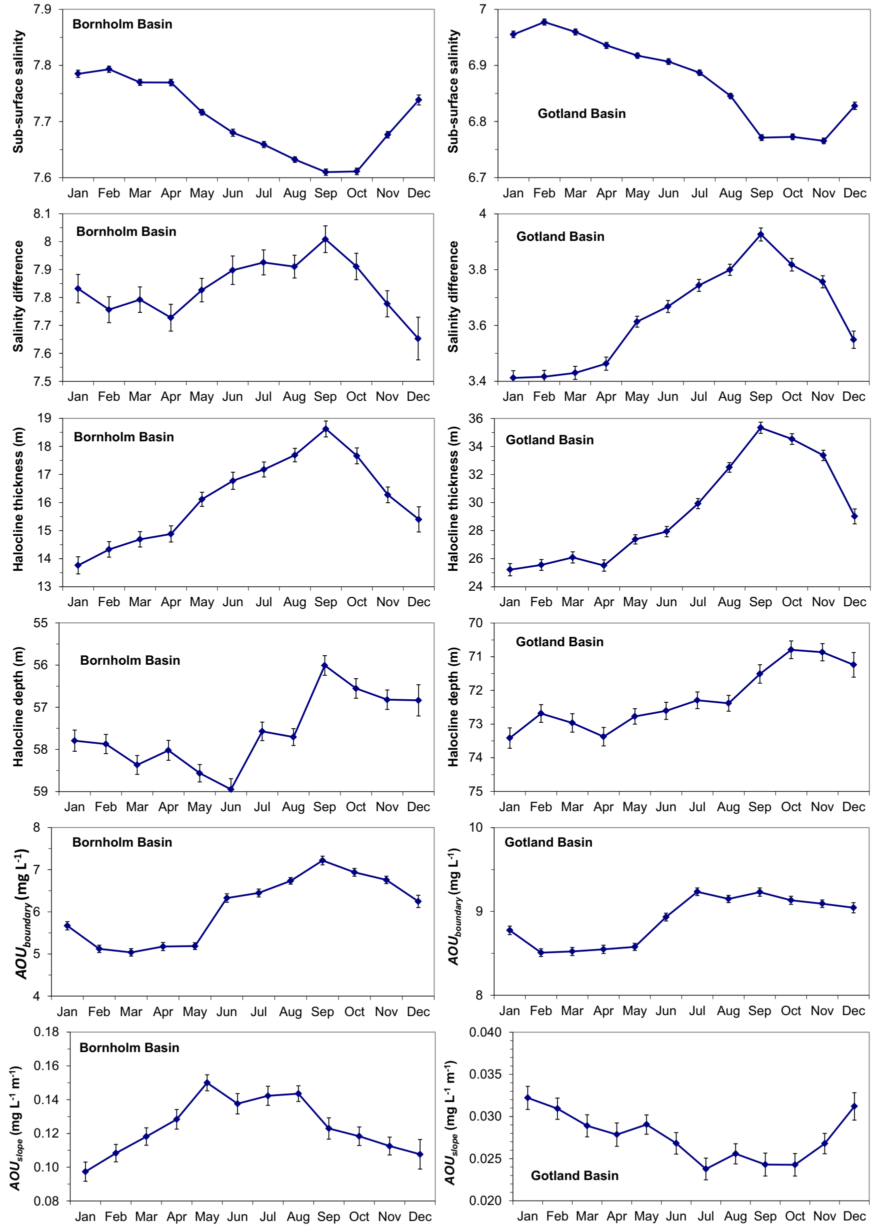

Fig. S4. Seasonal variation of parameter estimates from the salinity and oxygen profiles (Fig. S8). Symbols are monthly means, and error bars show the SE of these means.

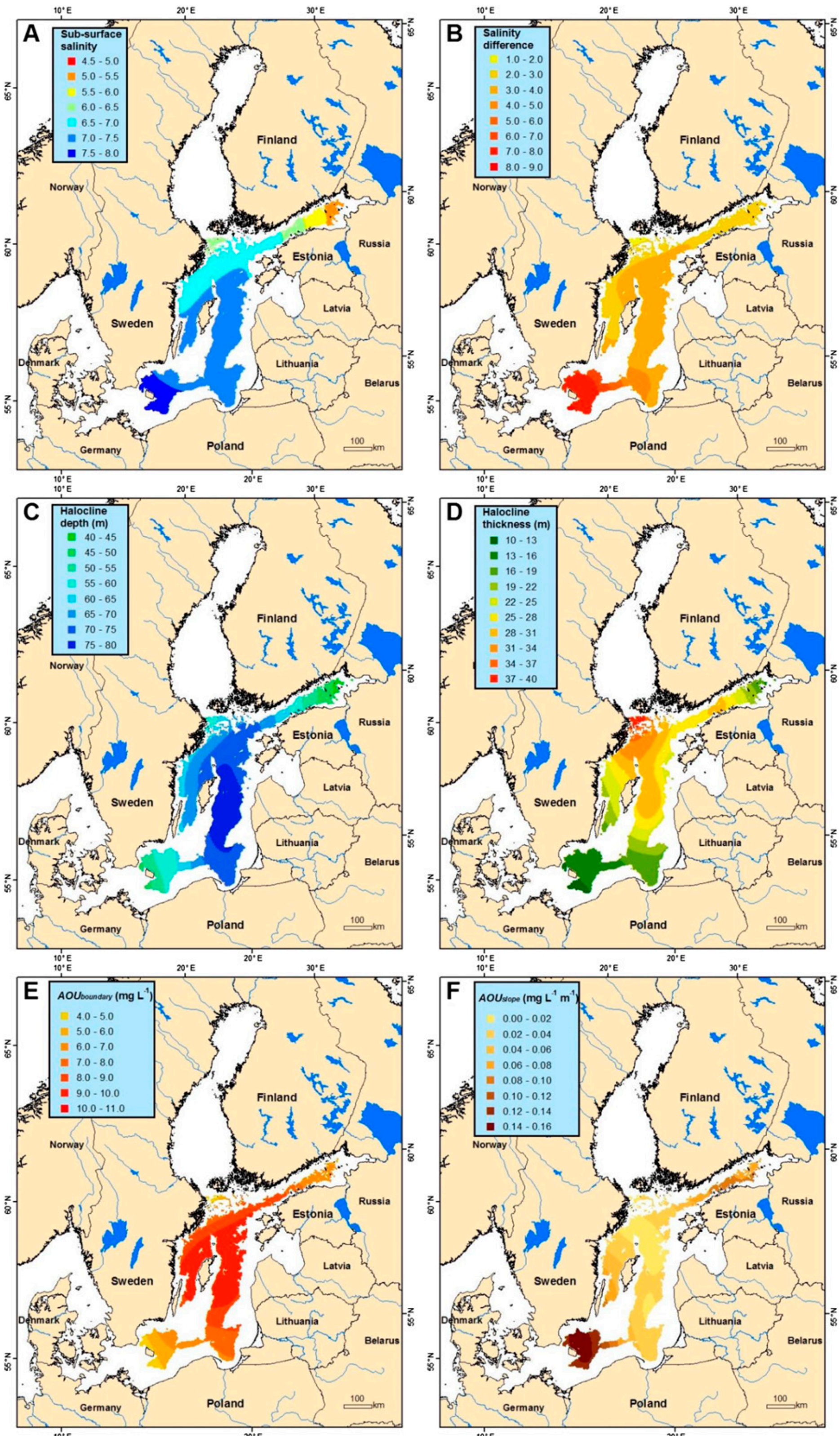

Fig. S5. Spatial distribution of salinity and oxygen profile parameters estimated by generalized additive model. Subsurface salinity (*A*), salinity difference (*B*), halocline depth (*C*), halocline thickness (*D*), AOU below the discontinuity layer (*E*), and change in AOU with depth (*F*). The spatial distributions are shown for water depth deeper than the mean halocline depth and represent means for all years with data (1898–2012; Fig. S1).

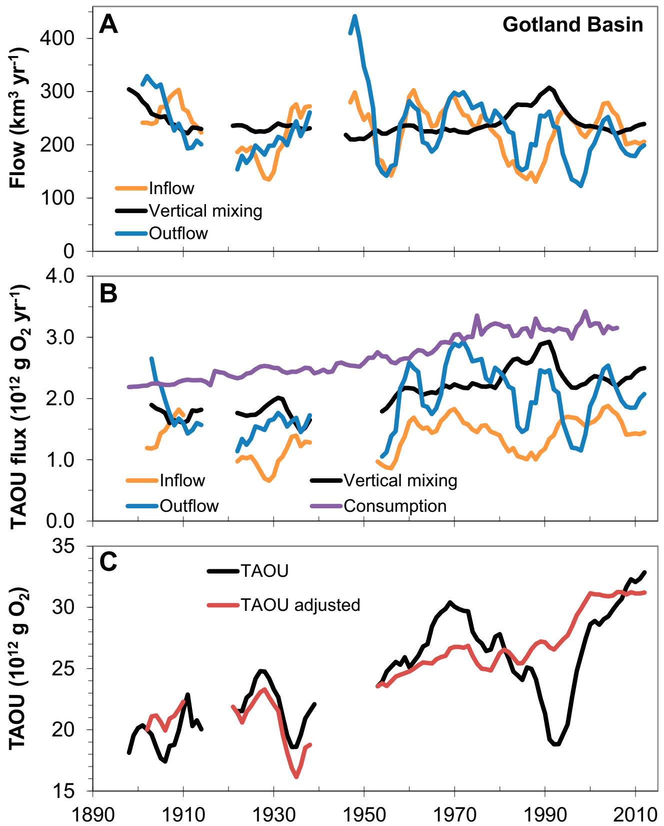

Fig. S6. Same as Fig. 3; using phosphorus input from land to model oxygen consumption. Water transports for the Gotland Basin deep water (*A*), annual fluxes of total apparent oxygen utilization (TAOU) (*B*); and TAOU in the deep water, estimated (5-y moving average; Fig. 1*P*) and adjusted by subtracting variations in lateral transports and vertical mixing (*C*). Phosphorus input from land and atmosphere was used to describe the oxygen consumption.

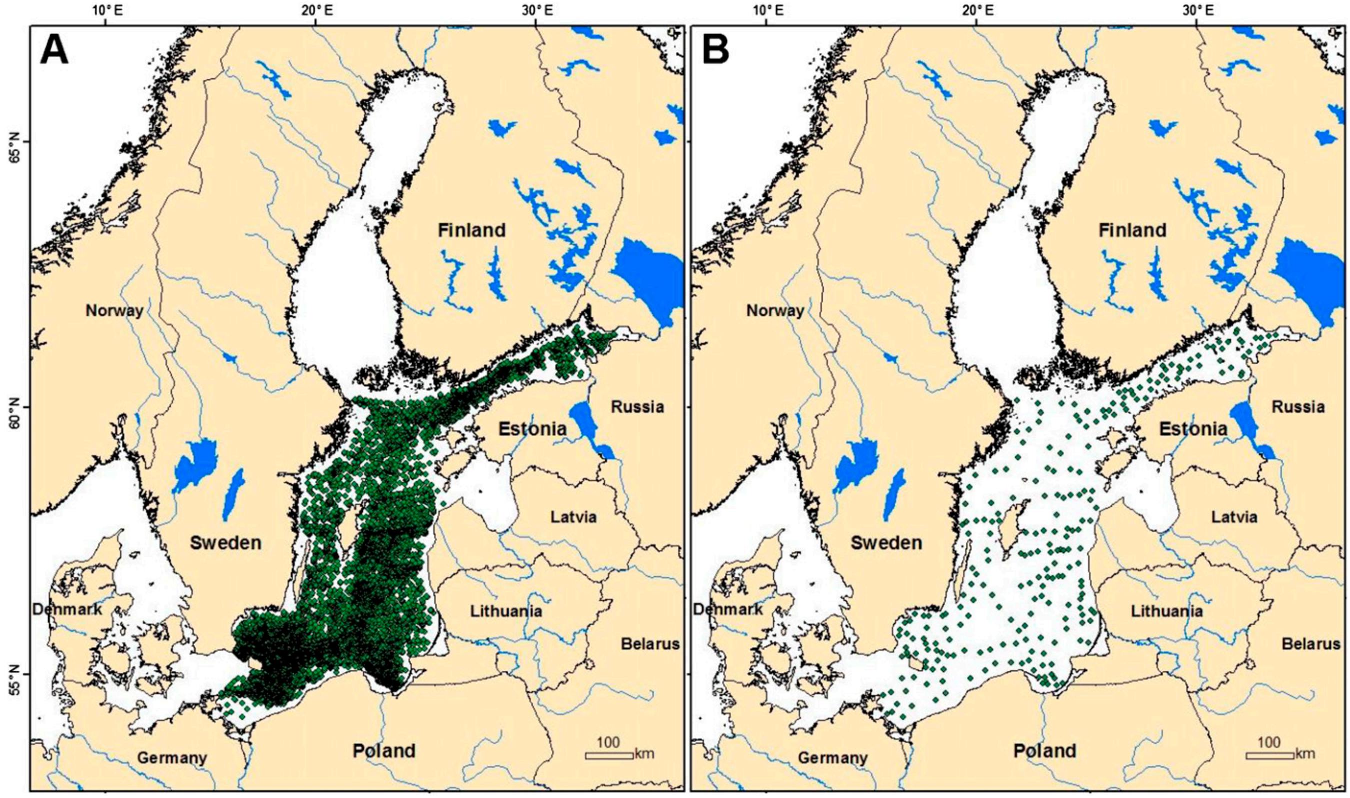

Fig. S7. Spatial distribution of salinity and oxygen profiles. Monitoring locations used in the present study (*A*) and aggregated onto existing monitoring network (*B*).

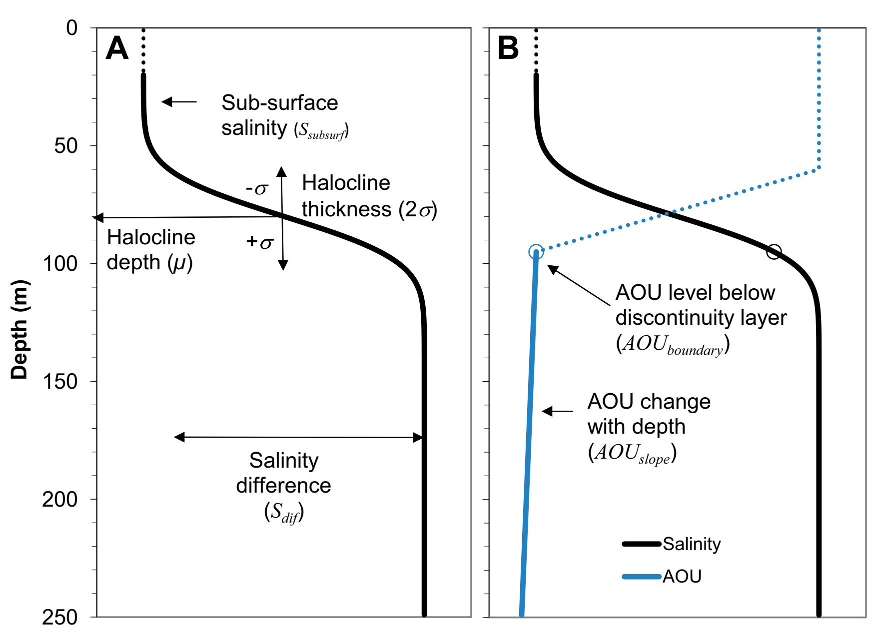

Fig. S8. Parameterization of salinity and oxygen profiles. Four parameters (*A*) were used to characterize the salinity profile at depths below 20 m, and two parameters (*B*) were used to characterize the oxygen profile [shown as apparent oxygen utilization (AOU)] below the discontinuity layer (i.e., depths below $\mu + \sigma$).

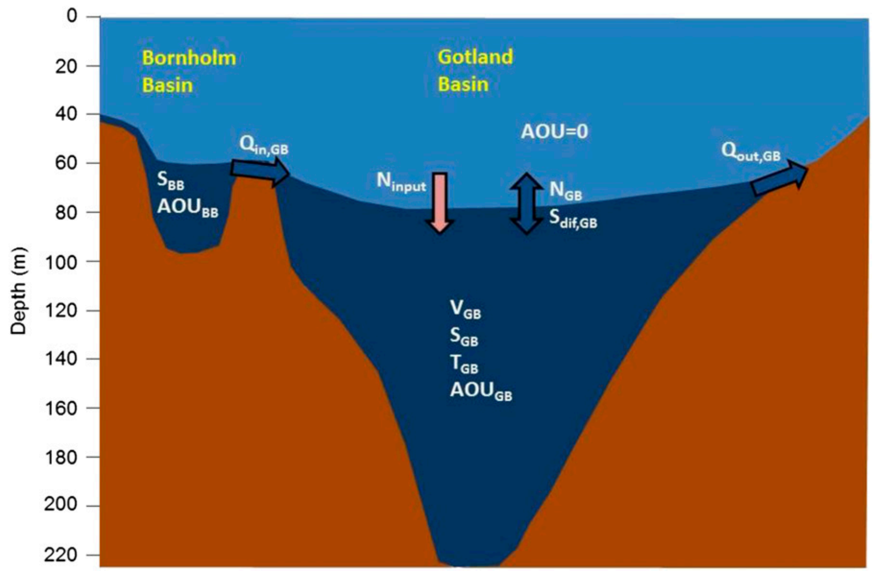

Fig. S9. Conceptual model for salt and oxygen budgets in the Gotland Basin. Notation for flows, volume, and concentrations follows the mass balances without time index.

Table S1. Parameter estimates and fit statistics from time series models of $\Delta TAOU_{GB}(t)$

Parameter/statistic	Unit	Nitrogen input for oxygen consumption	Phosphorus input for oxygen consumption
$\hat{a}_{BV,GB}$	$m^3 \cdot s^{-2}$	0.196	0.195
$\hat{a}_{0,GB}$	10^{12} g $O_2 \cdot y^{-1}$	1.08	1.28
$\hat{a}_{N,GB}$	—	0.083	0.246
$\hat{Q}_{10,GB}$	—	3.66	2.82
R^2	—	0.642	0.645
MSE	10^{12} g O_2	0.550	0.548

The oxygen consumption term was linearly related to nutrient inputs from land and atmosphere, either total nitrogen or total phosphorus. The parameter $\hat{a}_{N,GB}$ was scaled by stoichiometry and Redfield ratios to describe the proportion of nutrient input leading to oxygen consumption in the deep waters. For both models, $n = 78$ observations were used in the estimation. MSE, mean squared error.

Table S2. Data sources for the analysis of hypoxia in the Baltic Sea

Country	Data host
Denmark	Danish Centre for Environment, Aarhus University
Estonia	Estonian Marine Institute, Tallinn
Finland	Finnish Environment Institute, Helsinki
Germany	Institute of Oceanography, Warnemünde
	Bundesamt für Seeschifffahrt und Hydrographie, Hamburg
International	ICES, Copenhagen, Denmark
Latvia	Latvian Institute of Aquatic Ecology, Riga
Lithuania	Environmental Protection Agency, Vilnius
Poland	Chief Inspectorate for Environmental Protection, Warsaw
Russia	Russian Academy of Sciences, St. Petersburg
Sweden	Swedish Meteorological and Hydrological Institute, Gothenburg

These data sources were made available through the Baltic Nest Institute's Baltic Environmental Database (BED) (http://nest.su.se). In addition to the monitoring data, profiles from various research cruises, submitted to BED and International Council for Exploration of the Seas (ICES), were used.