Supporting Information

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SI Materials and Methods

Sampling Locations. Surface water samples were collected from stations CB908 (39°08′N, 76°20′W), CB858 (38°58′N, 76°23′W), CB818 (38°18′N, 76°17′W), CB804 (38°04′N, 76°13′W), and CB707 (37°07′N, 76°07′W) on 24 occasions (September 2002; March, April, June, July, August, and October 2003; February, March, May, June, July, August, and October 2004; February, May, July, August, and October 2005; March, June, July, and November 2006; February 2007; Fig. S3). Station CB858 and CB707 were sampled on all research cruises, but station CB908 was only sampled in 2002–2003. One mesohaline station, either CB804 or CB818, was also sampled on each sampling date. Temperature and salinity measurements were recorded from the last surface water Niskin bottle that was closed on the conductivity–temperature–depth. Concentrations of ammonia, nitrate and nitrite, and phosphate were determined from a 50-mL water sample collected concurrently with abundance sampling as reported (1). OC and silica concentrations, stream flow, and tide data were retrieved from online depositories provided by the Chesapeake Bay Program (ref. 1; www.chesapeakebay.net/data_waterquality.aspx), the United States Geological Survey (va.water.usgs.gov/chesbay/RIMP/adaps2/susq.adaps.dat list site), and the National Oceanic and Atmospheric Administration (www.co-ops.nos.noaa.gov/).

VP Methodological Considerations. Several factors can influence the accuracy of VP estimates, and the following precautions were taken. First, cycles of VP and decay can occur faster than the 12-h incubation period monitored in this study (2). Calculating the VP rate based only on increases in VA, i.e., the slope of a first-order regression between initial VA and time points showing increasing VA in a 12-h incubation (2), can account for these cycles. Applying this approach produced the same spatial and temporal trends observed in the original calculation. The same filtration flow rates and processing times were used in all experiments. VP samples were consistently collected between 6:00 AM and noon to avoid introduction of diel variations (2).

Statistical Calculations and Analyses. VP was calculated as the slope of the first-order linear regression line from plots of VA over time (Table S3). For each experiment, VP estimates were corrected for bacterial loss during diafiltration (Table S3; ref. 3). Outliers in replicate VP estimates, defined as greater or less than two SD from the mean of the other two replicates, were removed. Viral burst sizes were empirically derived from changes in VA and BA within VP incubations (Table S3). All VP was assumed to result from bacterial cell lysis. Estimates of VMM, the amount of dissolved OC released by viral lysis, %BA lysed per hour, and % BP consumed by viral lysis were calculated from an assumed burst size of 50 viruses released per cell lysed (3) and from empirically derived burst sizes using the equations in Table S3. Viral turnover time was also calculated (Table S3). Negative values were removed before statistical analysis and mean calculations. All data were log transformed to meet requirements for parametric statistical tests. Statistical tests were performed by using SPSS 11 software (SPSS, Inc.). Contour plots were generated by using Aable (v2.1.0, Gigawiz). Seasons were defined as follows: winter, December 22–March 21; spring, March 22–June 21; summer, June 22–September 21; and autumn, September 22–December 21.

1. Kan JJ, Wang K, Chen F (2006) Temporal variation and detection limit of an estuarine bacterioplankton community analyzed by denaturing gradient gel electrophoresis (DGGE). *Aquat Microb Ecol* 42:7–18.
2. Winget DM, Wommack KE (2009) Diel and daily fluctuations in virioplankton production in coastal ecosystems. *Environ Microbiol* 11:2904–2914.
3. Wilhelm SW, Brigden SM, Suttle CA (2002) A dilution technique for the direct measurement of viral production: a comparison in stratified and tidally mixed coastal waters. *Microb Ecol* 43:168–173.

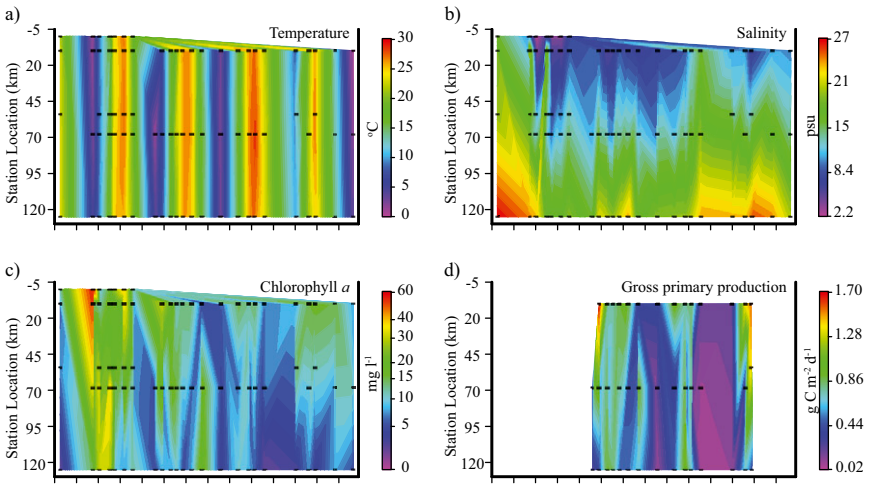

Fig. S1. Surface water temperature (*A*), salinity (*B*), Chl *a* (*C*), and gross primary production (*D*). Sampling locations are given in kilometers south from station CB908 (0 km). Black squares represent dates and locations of sample collections.

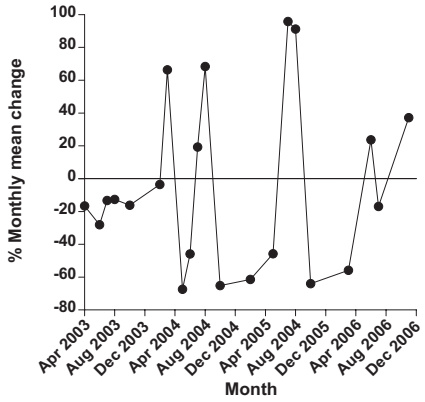

Fig. S2. Monthly mean changes in VP, calculated as (monthly VP mean/yearly VP mean) × 100. Peaks in each year occur in early spring and late summer through fall. Data for 2002 and 2007 were not included, as the monthly mean equaled the yearly mean for these years. Data for March 2003 are not plotted, as this month was an outlier.

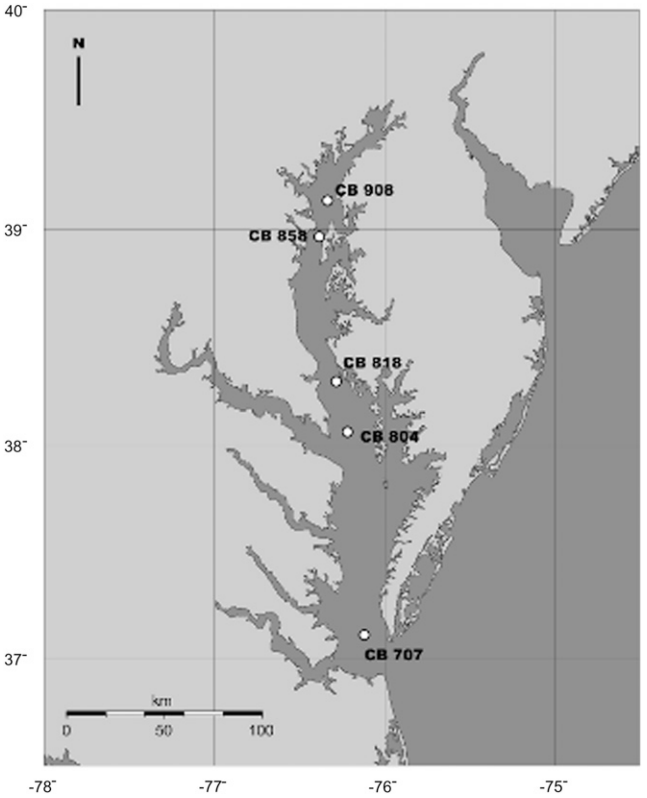

Fig. S3. Sampling locations in the Chesapeake Bay.

Table S1. Microbial and environmental parameters at Chesapeake Bay sampling locations

	n	VA, x 10^8 per mL	BA, x 10^6 per mL	BP, x 10^5 cells per mL per h	VBR	VP, x 10^6 viruses per mL per h	VMM, x 10^5 cells per mL per h	%BA lysed, per hour	%BP lysed	Dissolved OC release, μg per L per d	Viral turnover time, per d	Salinity, psu	Water temp., °C
Grand mean	84	1.5 (0.10)	6.6 (0.50)	1.5 (0.15)	30 (2.1)	7.9 (1.0)	1.6 (0.20)	2.7 (0.38)	280 (59)	76 (9.6)	1.2 (0.12)	14 (0.65)	17 (0.96)
Location													
CB707	24	1.5 (0.18)	6.2 (0.83)	1.4 (0.26)	31 (3.5)	9.9 (1.5)	2.0 (0.31)	3.6 (0.61)	330 (100)	95 (15)	1.6 (0.21)	21(0.65)	17(1.7)
CB804	23	1.6 (016)	6.9 (1.1)	1.5(0.26)	31(3.8)	5.4 (0.95)	1.1 (0.19)	2.1 (0.49)	160 (40)	52 (9.2)	0.87 (0.17)	13 (0.46)	17 (2.0)
CB818	7	1.8 (0.44)	9.8 (2.0)	2.5 (0.95)	22 (3.1)	11 (7.9)	2.3 (1.6)	1.4 (0.35)	290 (2760)	110 (76)	0.8 (0.12)	13 (1.4)	17 (3.5)
CB858	23	1.6 (0.24)	6.1 (0.80)	1.5 (0.26)	31 (4.8)	6.9 (1.8)	1.4 (0.36)	2.4 (0.99)	230 (110)	67 (17)	1.2 (2.8)	9.7 (0.87)	17 (1.9)
CB908	7	1.1 (0.18)	7.8 (2.0)	1.3 (0.53)	20 (4.9)	7.9 (2.3)	1.6 (0.46)	3.8 (1.7)	590 (400)	76 (22)	1.8 (0.46)	7 (1.7)	17 (3.5)
Year													
2002	4	0.8 (0.1)	6.9 (0.78)	1.2 (0.14)	12 (1.0)	3.1 (0.51)	0.61 (0.10)	0.88 (0.04)	50 (10)	29 (4.9)	0.91 (0.11)	20 (2.4)	24 (0.40)
2003	29	1.9 (0.19)	9 (0.95)	1.7 (0.31)	28 (4.1)	9.2 (2.1)	1.8 (0.43)	2.3 (0.53)	330 (120)	88 (20)	1.2 (0.19)	12 (1.1)	16 (1.6)
2004	21	0.98 (0.06)	4.1 (0.50)	1.8 (0.32)	27 (2.1)	3.6 (0.74)	0.72 (0.15)	1.9 (0.33)	130 (50)	35 (7.1)	0.88 (0.16)	13 (1.3)	17 (1.9)
2005	15	1.6 (0.33)	6.7 (1.3)	1.5 (0.34)	31 (5.4)	6.1 (1.7)	1.2 (0.33)	1.9 (0.20)	120 (27)	59 (16)	1.1 (0.28)	15 (1.3)	19 (2.5)
2006	12	1.9 (0.24)	7.2 (1.4)	1.1 (0.23)	32 (4.4)	15 (2.0)	2.9 (0.41)	5.3 (1.0)	490 (160)	140 (20)	2 (0.28)	16 (1.9)	18 (2.0)
2007	3	1.6 (0.11)	2.6 (0.23)	0.47 (0.11)	65 (9.6)	14 (8.0)	2.8 (1.6)	7.9 (5.1)	920 (720)	130 (76)	2.3 (1.4)	15 (3.1)	1.7 (0.95)
Season													
Winter	16	1.1 (0.12)	2.7 (0.34)	0.44 (0.07)	45 (6.0)	10 (4.6)	2.0 (0.91)	4.3 (1.4)	540 (200)	98 (44)	1.3 (0.38)	15 (1.3)	3 (0.53)
Spring	25	1.5 (0.16)	6.2 (0.86)	1.2 (0.16)	30 (3.1)	6.8 (1.3)	1.4 (0.27)	2.7 (0.62)	279 (123)	65 (13)	1.1 (0.21)	13 (1.2)	15 (0.95)
Summer	25	1.8 (0.20)	10 (0.95)	3 (0.30)	19 (1.6)	8.6 (1.2)	1.7 (0.24)	1.9 (0.40)	157 (84)	82 (12)	1.3 (0.18)	13 (1.2)	26 (0.27)
Autumn	18	1.8 (0.29)	5.5 (0.49)	9.2 (0.12)	34 (4.5)	6.9 (1.8)	1.4 (0.35)	2.5 (0.79)	230 (65)	66 (17)	1.2 (0.27)	16 (1.3)	19 (0.93)
Month													
February	8	1.1 (0.16)	2.6 (0.40)	0.39 (0.06)	45 (6.6)	7.1 (3.7)	1.4 (0.74)	4.2 (2.5)	480 (310)	69 (36)	1.4 (0.63)	13 (1.7)	2.2 (0.43)
March	11	0.97 (0.17)	2.9 (0.45)	0.61 (0.11)	42 (8.6)	12 (6.1)	2.4 (1.2)	4.5 (0.60)	460 (200)	110 (58)	1.1 (0.18)	16 (1.7)	5.6 (1.2)
April	5	1.1 (0.17)	3.3 (0.62)	0.34 (0.08)	41 (11)	7.7 (3.3)	1.5 (0.66)	4.8 (2.4)	950 (550)	74 (32)	2 (0.79)	11 (3.7)	8.8 (0.18)
May	6	1.1 (0.49)	4.2 (0.81)	1.2 (0.18)	31 (4.2)	2.5 (0.63)	0.49 (0.13)	1.2 (0.38)	49 (13)	24 (6.0)	0.48 (0.11)	13 (2.5)	16 (0.14)
June	11	2 (0.28)	9.6 (1.5)	1.6 (0.29)	21 (1.4)	8.3 (2.4)	1.7 (0.47)	2.0 (0.56)	150 (48)	80 (23)	1.1 (0.23)	14 (1.6)	19 (0.92)
July	14	1.7 (0.19)	11 (1.2)	3.1 (0.51)	19 (2.2)	8.9 (1.6)	1.8 (0.33)	2.1 (0.66)	220 (140)	85 (16)	1.3 (0.21)	12 (1.7)	26 (0.34)
August	11	1.9 (0.41)	9.2 (1.5)	2.9 (0.27)	19 (2.5)	8.2 (1.9)	1.6 (0.37)	1.7 (0.31)	62 (21)	78 (18)	1.3 (0.32)	13 (1.9)	27 (0.33)
September	4	0.8 (0.1)	6.9 (0.78)	1.2 (0.14)	12 (1.1)	3.1 (0.51)	0.61 (0.10)	0.88 (0.4))	50 (11)	29 (4.9)	0.91 (0.11)	20 (2.5)	24 (0.40)
October	11	2 (0.45)	5.5 (0.67)	0.91 (0.18)	37 (6.1)	4.6 (1.4)	0.91 (0.27)	1.5 (0.33)	150 (40)	44 (13)	0.82 (0.29)	14 (1.6)	20 (0.89)
November	3	1.7 (0.16)	4.6 (1.0)	0.53 (0.08)	39 (5.4)	21 (2.7)	4.1 (0.53)	9.2 (0.78	780 (20)	200 (26)	3 (0.32)	17 (4.0)	14 (0.40)

Data reported as mean (SEM). *n* represents the number of samplings.

Table S2. Spearman's rank correlation coefficients between variables in the Chesapeake Bay

	Temperature	Salinity	BP	*Synechococcus* abundance	VA	BA	VBR
VP	0.015	0.213	−0.027	0.015	0.344**	0.260*	−0.147
VMM	0.016	0.213	−0.027	0.015	0.343**	0.260*	−0.148
OC release	0.015	0.213	−0.028	0.014	0.344**	0.259*	−0.147
%BP	−0.475**	0.190	−0.690**	−0.455**	0.142	−0.236*	0.264**
%BA	−0.368**	0.238*	−0.418**	−0.314**	0.068	−0.359*	0.388**
VBR	−0.463**	0.175	−0.557*	−0.447**	0.250*	−0.631*	
BA	0.663*	−0.119	0.624**	0.558**	0.577**		
VA	0.252*	0.082	0.155	0.275*			

All data were log transformed before analysis except salinity. *$P \leq 0.05$; **$P \leq 0.01$.

Table S3. Equations used in estimating VP, VMM, and related variables

	Description	Equation
VP	Calculates VP from VA and time data and corrects for loss of bacteria during filtration in viruses per hour. A VP rate is calculated for each replicate incubation, and the mean value is reported.	VP = [(Vf-Vi)/Tf] x (Ba/Bi)
Empirical burst size (Bz)	Calculates burst size, in viruses per cell, from observed increase in VA over the same time period as an observed decrease in bacterial abundance within VP incubations.	Bz = (Vx-Vi) / (Bx-Bi)
VMM	Calculates amount of bacterial cells lysed by viruses per hour	VMM = VP/50 or VMM = VP/Bz
OC released by viral lysis	Estimates amount of OC released by viral lysis per hour. Based on an assumed carbon content of 20 x 10^{-15}g of C released per host cell lysed (1).	OC = VMM x 20 fg C
%BA lysed by viruses	Calculates percentage of bacterial community lysed by viruses per hour (2).	%BA = VMM/BP × 100
%BP lysed by viruses	Calculates the %BP consumed by viral lysis (3).	%BP = VMM/BP × 100
VTT	Calculates turnover rate of viral assemblage	VTT = VP/Va
VBR	Calculates the ratio of viruses to bacteria	VBR = VA/BA
Percent OC (%OC) supplied by viral lysis	Calculates percent of OC needed to support BP provided by viral lysis assuming 20 x 10^{-15}g of C per cell and bacterial growth efficiency of 20%	%OC = OC / [(Ba × 20 × 24 × 1000)/0.2]

Vf, VA at final time point; Vi, VA at initial time point; Tf, time in hours at final time point; BA, ambient bacterial abundance; Bi, mean bacterial abundance at initial time point in all incubations; Vx, VA at time point x; Bx, BA at time point x; VA, ambient viral abundance; BP, BP in cells per mL per h.

1. Lee S, Fuhrman J (1987) Relationships between biovolume and biomass of naturally derived marine bacterioplankton. *Appl Environ Microbiol* 53:1298–1303.
2. Jiang SC, Paul JH (1994) Seasonal and diel abundance of viruses and occurrence of lysogeny/bacteriocinogeny in the marine environment. *Mar Ecol Prog Ser* 104:163–172.
3. Steward GF, Smith DC, Azam F (1996) Abundance and production of bacteria and viruses in the Bering and Chukchi Seas. *Mar Ecol Prog Ser* 131:287–300.

Table S4. VMM and viral impacts on BA and BP based on empirically determined burst sizes in the Chesapeake Bay

	n	Burst size	VMM, x 10^5 cells per mL per h	%BA lysed, per day	%BP lysed
Season					
Winter	23	100 (130)	1.0	93	230
Spring	31	130 (190)	0.52	20	44
Summer	25	31 (59)	2.8	68	94
Autumn	25	42 (59)	1.6	69	173
Month					
February	11	130 (180)	0.55	50	140
March	15	150 (190)	0.80	64	120
April	8	120 (110)	0.64	46	180
May	7	14 (9.4)	1.8	100	150
June	13	130 (190)	0.64	16	41
July	17	18 (14)	4.9	106	160
August	8	61 (100)	1.3	36	47
September	6	23 (15)	1.4	47	110
October	19	48 (66)	0.96	42	100

Data reported as mean (SD). *n* represents total number of burst sizes calculated.