Supporting Information

Escherichia coli Reduction by Bivalves in an Impaired River Impacted by Agricultural Land Use

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Use of *k*-value to Calculate Clearance Rate

The clearance rate is defined as the removal rate of particulate matter and is reported as a volume per unit time. The k-value (uptake rate) is reported on a per time basis. The k-value was calculated based on fitting data to a first order kinetic model. The clearance rate is then calculated from the k-value based on the definition of clearance rate.

The first order kinetic reaction equation used to calculate *k*-value (no tailing) is:

$$\mathrm{C_t}=\mathrm{C_o}e^{-\mathrm{kt}} \quad (1)$$

$$lnC_t - lnC_o = -kt \quad (2)$$

The general clearance rate equation for batch systems as derived in Coughlan [1] is:

$$\frac{\mathrm{dC}}{\mathrm{dt}} = -\mathrm{C}\frac{\mathrm{n}\times\mathrm{CR}}{\mathrm{V}} \quad (3)$$

where *C* is the concentration of particles (CFU/ml), *n* is the number of bivalves (bivalve), *V* is the volume of the suspension (ml), *CR* is the clearance rate of a single bivalve (ml hr^{-1} $bivalve^{-1}$), and *dC/dt* is the rate of decrease of concentration *C*.

The solution of Eq (1) is

$$\int \frac{dC}{C} = -\frac{nCR}{V}\int dt \quad (4)$$

$$lnC_t - lnC_o = -\frac{nCR}{V}t \quad (5)$$

Letting n=1 for a single bivalve and plugging in Eq(2) to Eq(5)

$$-kt = -\frac{nCR}{V}t \quad (6)$$

Hence when n=1 for a single bivalve

$$kV = CR \quad (7)$$

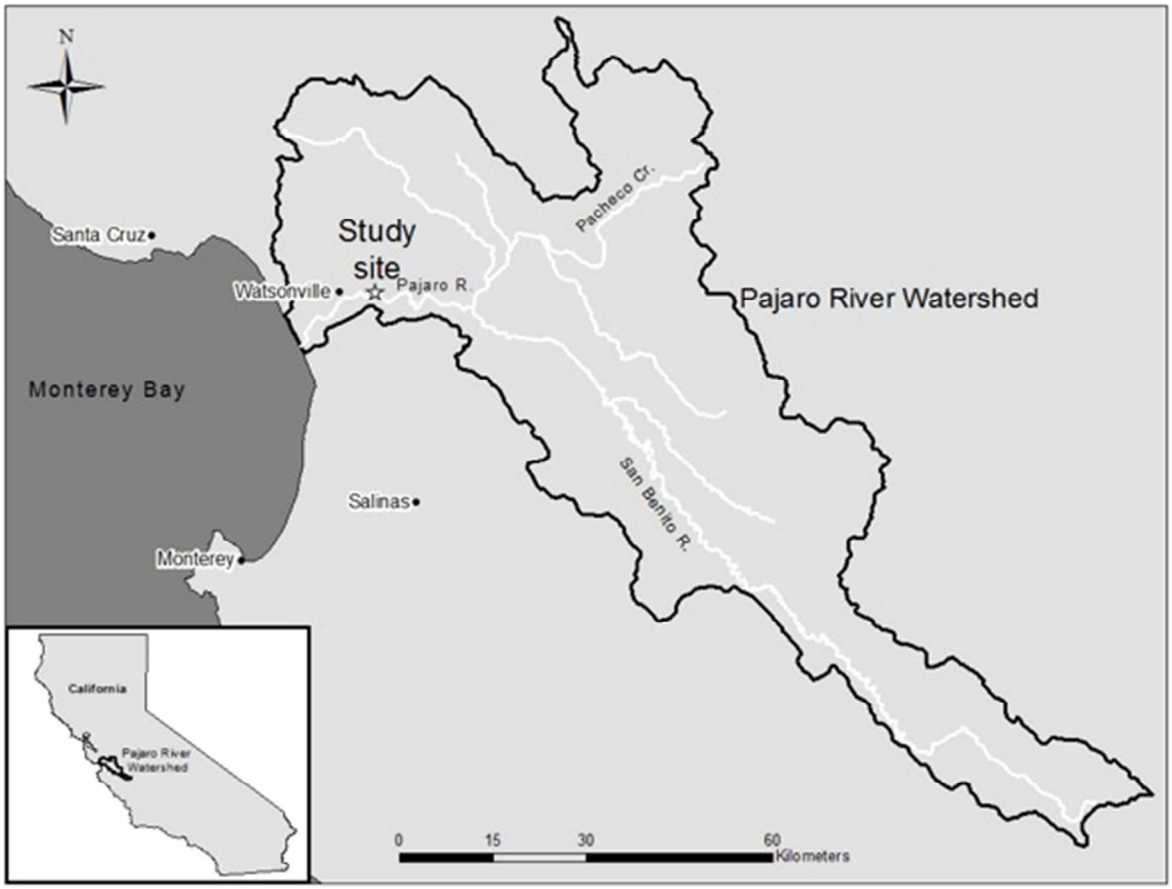

Figure S1. Map of Study Area. This map was created using ArcGIS® software by Esri®

Figure S2. Two images of distinct pools sampled in the Pajaro River.

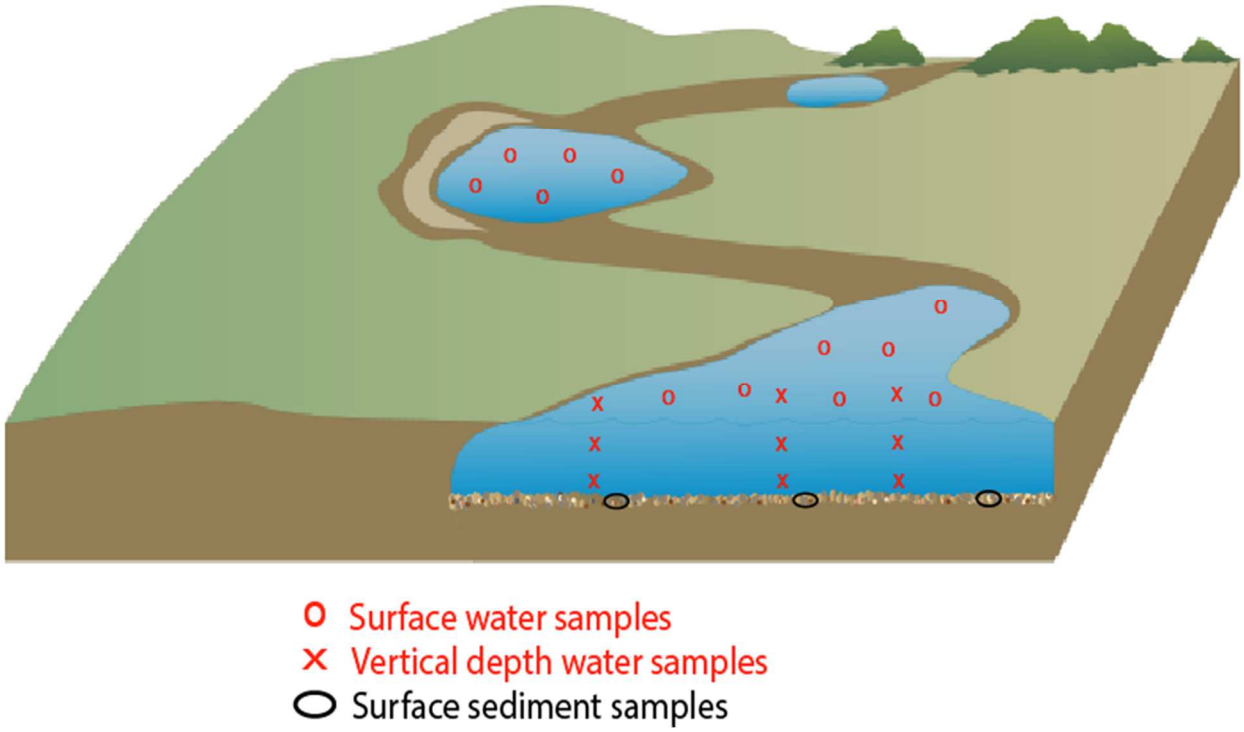

Figure S3. Schematic of pools and sampling regime.

Figure S4. Location of pools surveyed for bivalve density and *E. coli* concentration. Red dots represent pools that were surveyed for bivalve density and *E. coli* concentration then used in the 24 hour sampling study. The pink square represents the region of the river in which water was collected for laboratory experiments and filtered to isolate indigenous bacteria. This map was created using ArcGIS® software by Esri®

Description of Surface Water Spatial Sampling

The number of surface water samples collected was determined by the size of the pool and date of sampling.

For sampling completed on 30 September 2014, five to seven surface samples were collected per pool. Seven samples were collected from pools that had a surface area greater than 25 m^2 and five samples were collected from all other pools less than 25 m^2. The general approach was as follows:

1) Divide the pool into 3 or 4 roughly equal sections based on the length and width of the pool.
2) Take one surface water sample from the center of each of these sections (total of 3 or 4 samples)
3) Take 2 or 3 samples from the perimeter of the pool equidistant between the center samples and on alternating sides.

For sampling completed on 7 and 9 October 2014, three surface water samples were taken based following steps 1 & 2 above.

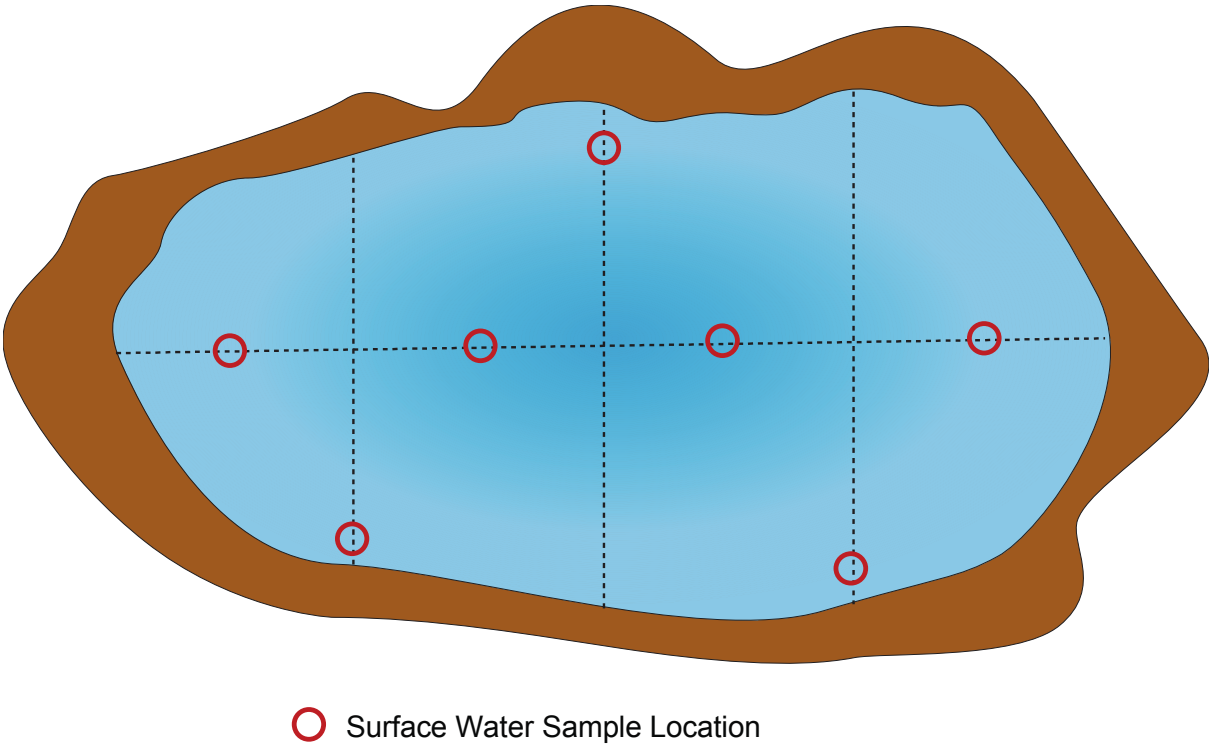

Figure S5. Schematic diagram illustrating approach used for determining location of spatial surface water samples.

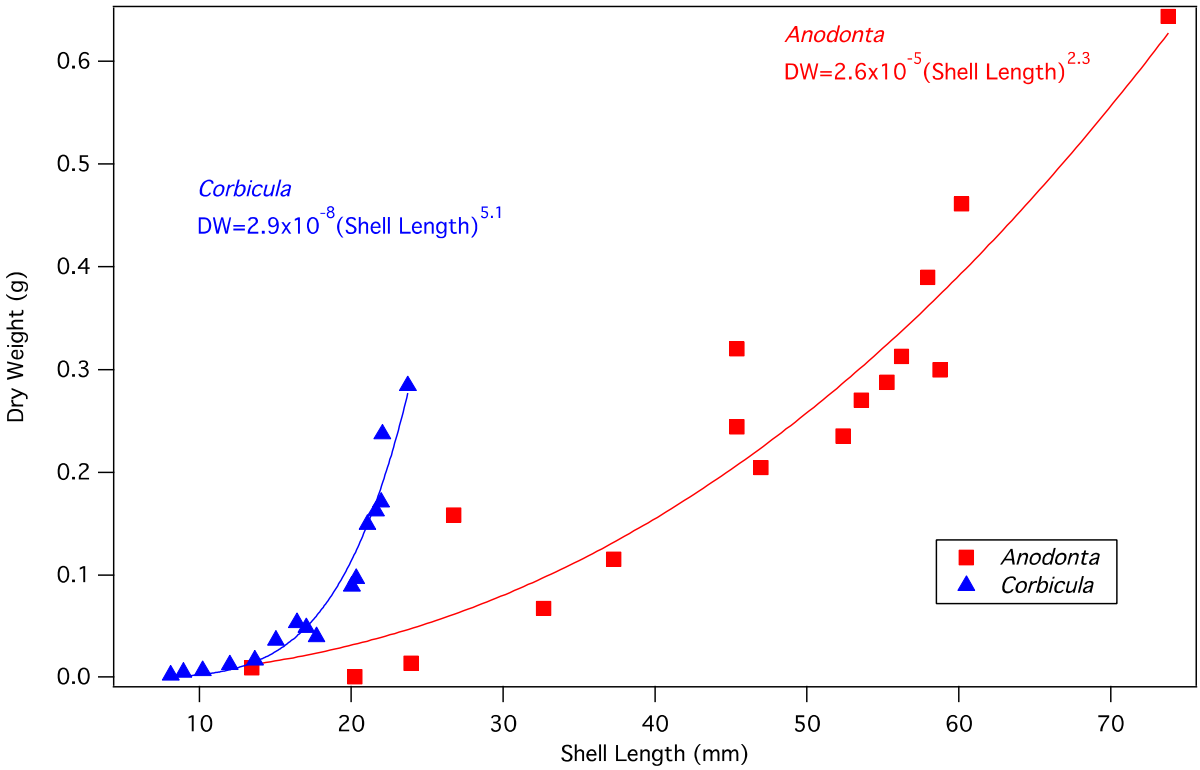

Figure S6. Non-linear regression power law fit of dry weight of bivalve tissue to shell length obtained from laboratory measurements.

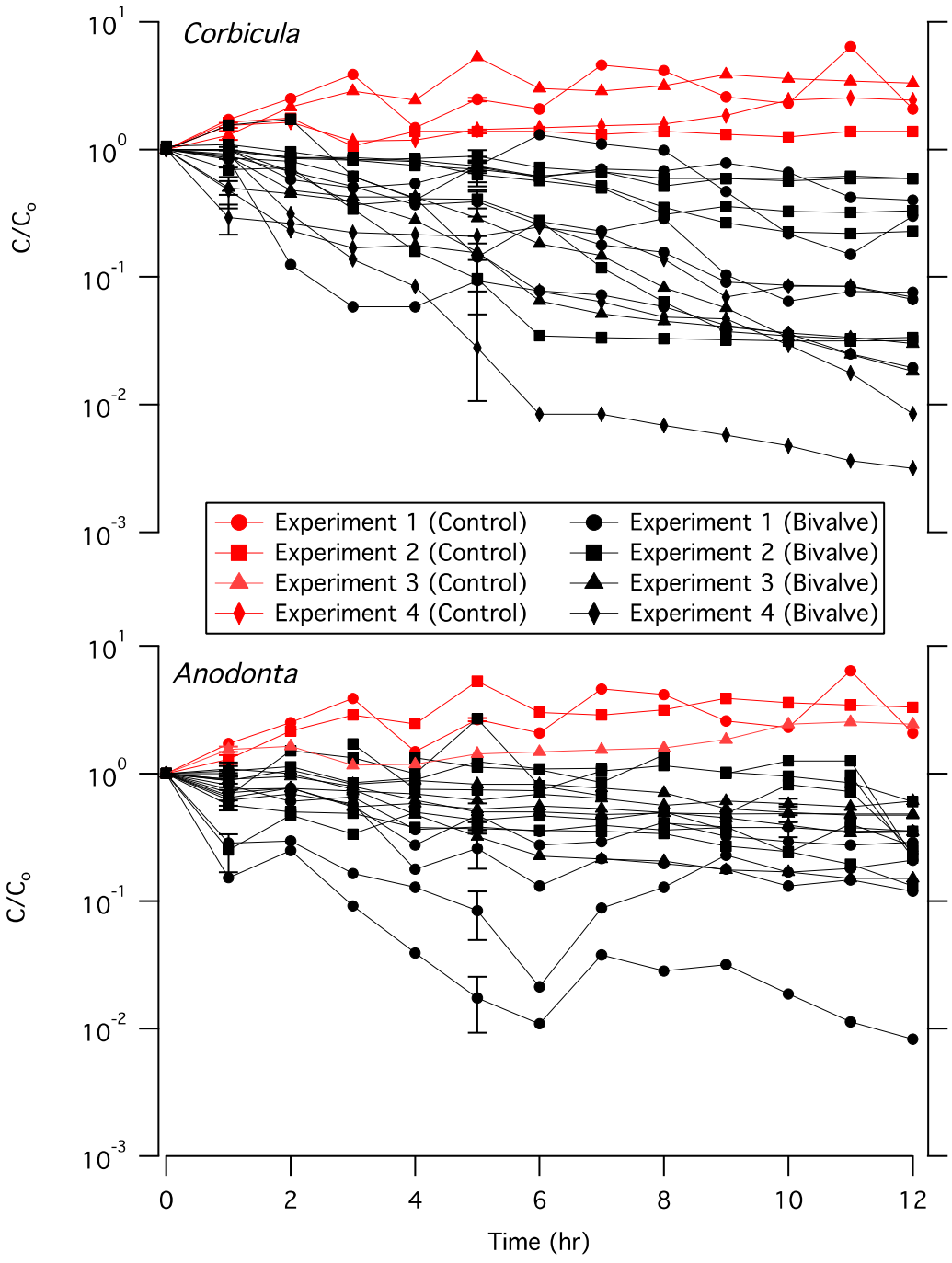

Figure S7. Removal of *E. coli* by individual bivalves exposed to filtered Pajaro River water spiked with indigenous bacteria in a batch, laboratory experiment. Error bars represent one standard deviation for analytical triplicates collect at a single time point for each bivalve. The data in this figure were significantly correlated (Spearman's, $\rho>0.5$, $p<0.05$) and used to calculate clearance rates shown in Figure 2 in the main text.

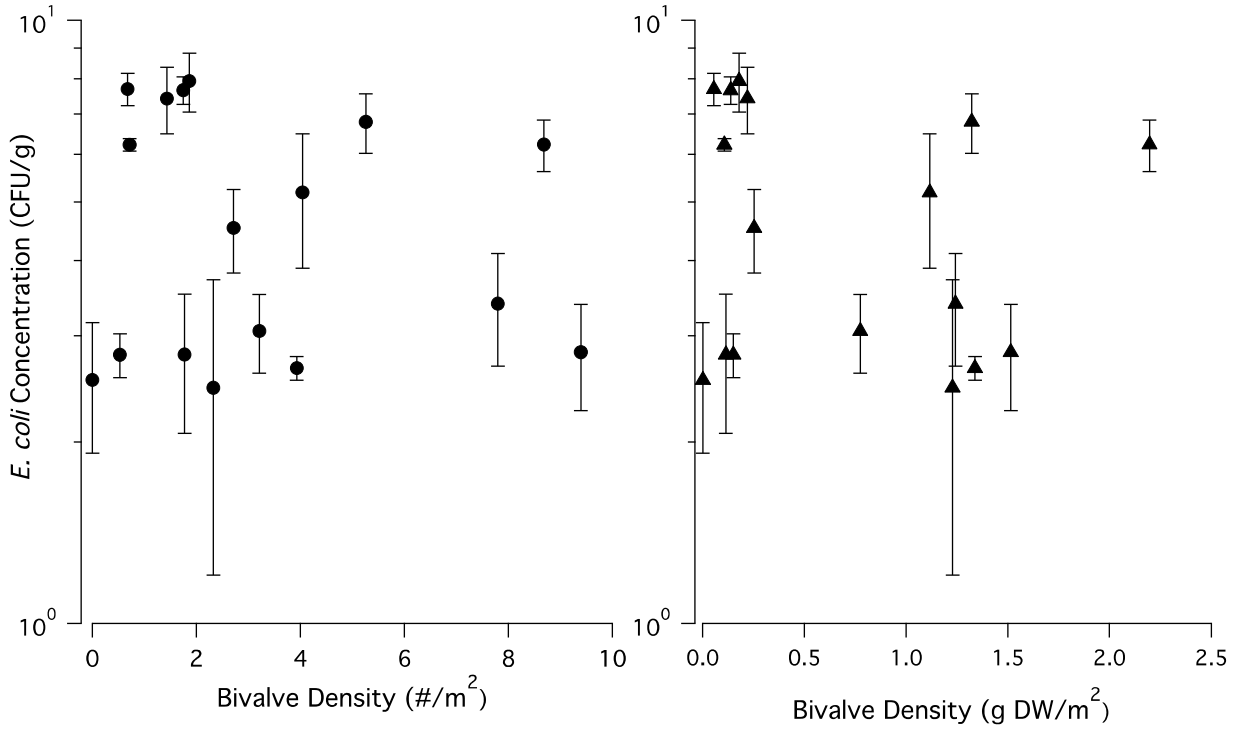

Figure S8. *E. coli* concentration eluted from sediment samples in ponds (n=17) as a function of bivalve density in that pond. Error bars represent one standard deviation for sediment samples collected within different spatial areas of the pools (n=3-5).

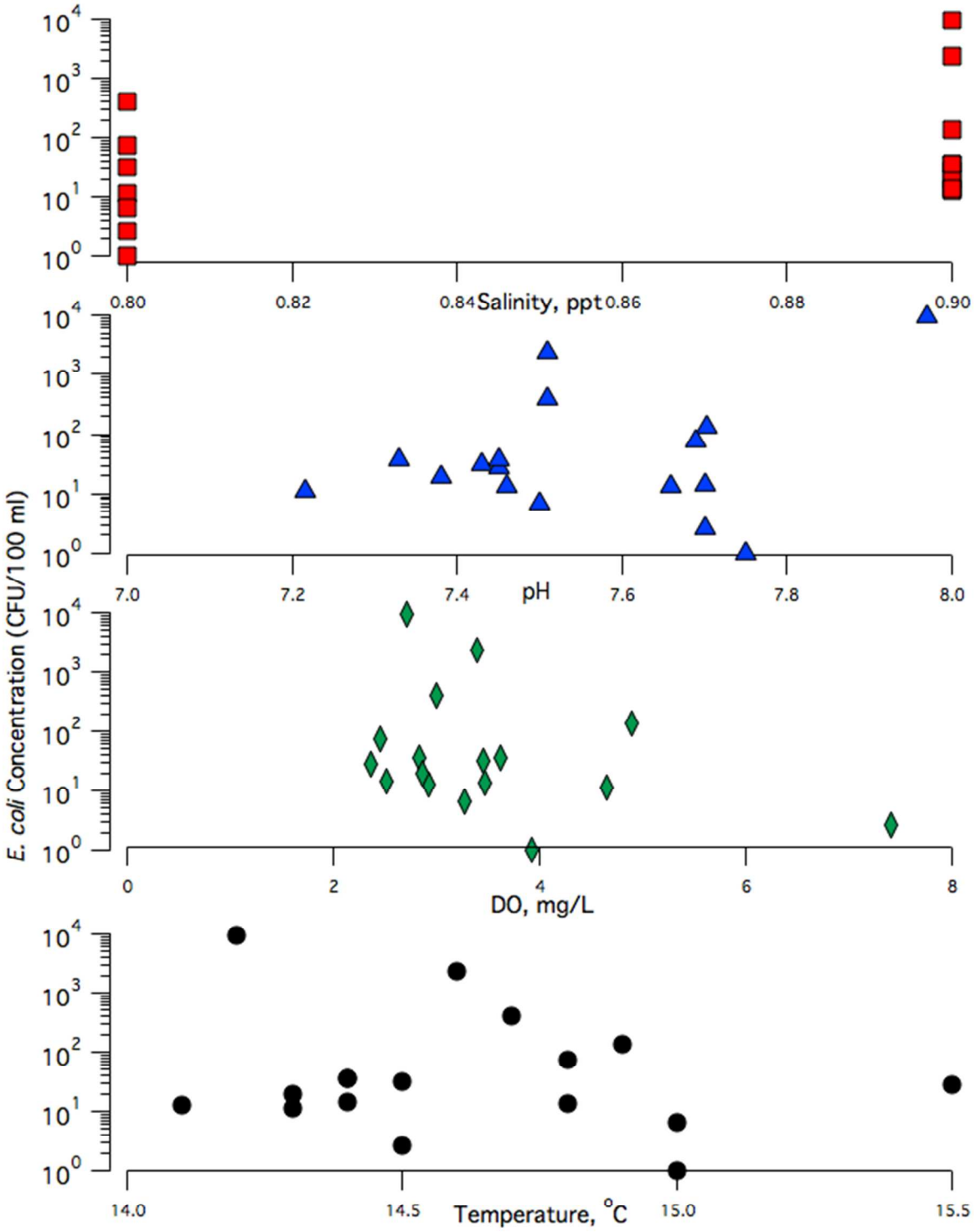

Figure S9. *E. coli* concentration of water samples as a function of temperature, dissolved oxygen (DO), pH, and salinity from the 17 pools. Note the different scales on the x-axes.

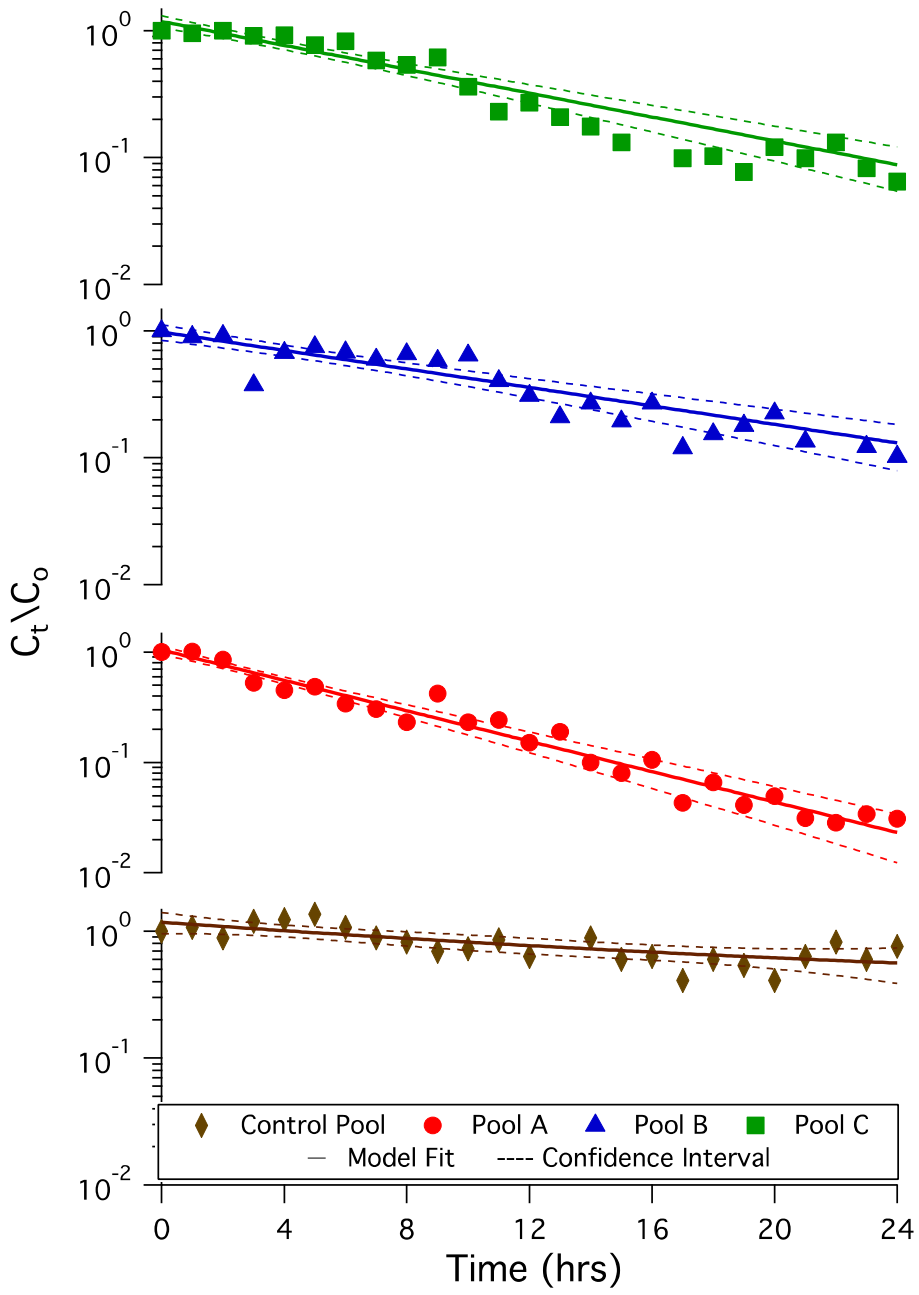

Figure S10. Removal of *E. coli* from water during 24-hour sampling experiment conducted in the field. The markers represent the experimental values and the solid lines are the values predicted by the log-linear model fit. Dashed lines represent the 95% confidence interval for the generated first order (log-linear) fit.

Calculation of Removal of *E. coli* during flow conditions of the Pajaro River:

Experimental data from the in situ field experiment were utilized to estimate the removal of *E. coli* that could be achieved during periods of flow in the Pajaro River. The average clearance rate (L hr^{-1} $bivalve^{-1}$) and bivalve density (bivalve m^{-2}) were used from Table 1 ($days^{-1}$ $mussel^{-1}$).

We then calculated the length of the river needed to achieve 1-log removal of *E. coli* based on the mean flow rate from 2014 from the Chittenden gauging station (USGS, Station # 11159000, Chittenden). The Chittenden gauging station is located approximated 10 miles upstream of our field site. Parameters used in the calculation were:

ρ=bivalve density=5.2 bivalve m^{-2}
CR=clearance rate=4.4 L hr^{-1} $bivalve^{-1}$=1.23x10^{-6} m^3 $s^{-1}$$bivalve^{-1}$
Q=flow rate= 2.32×10^{-1} m^3s^{-1}
d=depth=0.5m
w=width=10 m
l=length=unknown

$$HRT = \frac{d \times w \times l}{Q} = \frac{0.5 \times 10 \times l}{2.32 \times 10^{-1}}$$

Substituting in the value of HRT and k into the first order rate equation yields:

$$0.1 = e^{-k(21.55l)}$$

Then we calculate k based on the number of clams in the system and clearance rate and substitute into the first order rate equation

$$0.1 = e^{-\left(1.23\times10^{-6}\frac{m^3}{s\cdot bivalve}\right)\left(\frac{1}{0.5\ m}\right)\left(\frac{5.2\ bivalve}{m^2}\right)(21.55\cdot l\ s)}$$

Solving for the length of river,

$$L = 8352\ m \approx 8\ km$$

The reported value serves as preliminary estimate. Additional system parameters are needed to test assumptions used for this preliminary estimates. For example, hydraulic characteristics and system inputs/output can impact *E. coli* concentration and bivalve clearance rates.

References

1. Coughlan, J. The estimation of filtering rate from the clearance of suspensions. *Mar. Biol.* **1969,** *2* (4), 356-358; 10.1007/BF00355716.